# Conservation of biodiversity

A4.2 · SL

# Does a large number of plants mean high biodiversity?

## Specify the level and evidence before setting a goal

A field can contain thousands of individuals of one crop variety. A wetland can contain many species and habitats.

A4.2 is common SL/HL content: biodiversity evidence, extinction and ecosystem loss, pressures, conservation methods and EDGE priorities.

Numerical datasets and maps are invented unless a published source is named. They are not observations from the school grounds.

# Three levels require different evidence

| Level | What can vary or be lost |
| --- | --- |
| Genetic | Alleles and inherited variation within a species; distinct populations can be lost before global extinction |
| Species | Species present and their relative abundances |
| Ecosystem | Different communities, habitats and physical environments |

# Individuals, richness and evenness are different quantities

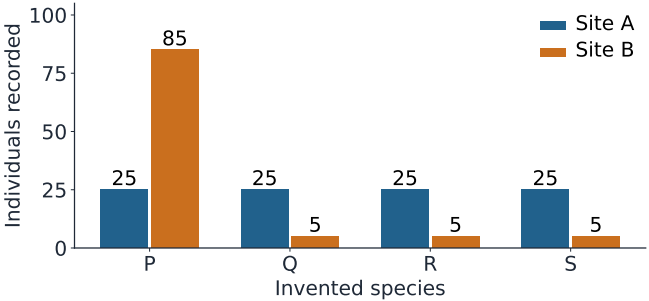
## A high abundance can hide low diversity

Total abundance counts individuals. Species richness counts recorded species. Evenness concerns their relative abundances.

Adding individuals of one common species does not restore a missing species or ecosystem.

State the conservation level, goal and measure of success. A single count cannot describe every aspect of biodiversity.

# Compare equal richness with different evenness




Both invented samples: total = 100; richness = 4.
Dominant species: A 25%; B 85%.

Both invented sites contain four species and 100 individuals; A is more even.

# Use the denominator in the dominance comparison

1. **Site A.** Counts 25, 25, 25, 25: total 100; richness 4; dominant share $25/100 = 25\%$.
2. **Site B.** Counts 85, 5, 5, 5: total 100; richness 4; dominant share $85/100 = 85\%$.
3. **Interpret.** Equal totals and richness do not imply equal composition. State a diversity index's formula and convention if using one.

# Three levels of biodiversity



ecosystem diversity

species diversity

genetic diversity (within a species)

Genetic variation within one species

# Recorded counts are not equally complete censuses

## Sampling and classification affect comparisons

Fossils show diversification interrupted by major losses, but preservation differs among organisms, rocks and habitats.

Survey effort and revised species boundaries can increase recorded counts without a sudden ecological increase.

High present richness can coexist with rapid declines. Population or habitat losses can occur before global extinction is confirmed.

# Distinguish three kinds of disappearance

| Term | What the evidence would need to establish |
|---|---|
| Extinction | A species has disappeared everywhere |
| Local extirpation | It has disappeared from one area but may survive elsewhere |
| Extinct in the wild | It remains in captivity or cultivation, rather than a self-sustaining wild population |

# North Island giant moa: over-exploitation of terrestrial megafauna

## Connect removal to population replacement

The flightless *Dinornis novaezealandiae* lived in New Zealand. Its remains are widespread in archaeological sites.

Human hunting for food was the main cause of extinction. Sustained removal can exceed a population's replacement.

A large body does not protect a species from over-exploitation. The museum species account is linked in the handout.

# Caribbean monk seal: a marine species was not protected by the sea

## A last confirmed sighting is different from an assessment

Heavy hunting for oil and meat and human disturbance contributed to decline.

The last confirmed sighting was in 1952. NOAA's 2008 review concluded that the species was extinct; 2008 was not an observed final death date.

The current name is *Neomonachus tropicalis*; older records use *Monachus tropicalis*.

# Chinese paddlefish: a connected river habitat matters

## Overfishing and fragmentation can act together

*Psephurus gladius* lived in the Yangtze system. Overfishing and habitat fragmentation contributed to its decline.

Dams can obstruct movement between feeding and spawning habitats. Water remaining in the river does not establish successful reproduction.

A 2020 study inferred extinction using records and surveys; the 2022 assessment announcement treated it as extinct. Distinguish this species from other Yangtze fishes.

# A plantation can contain many trees and still replace a forest

## Mixed dipterocarp forest in Southeast Asia

Timber extraction changes structure; roads divide habitats and improve access. Further clearance for plantations replaces the forest ecosystem.

A single-species planting does not automatically recreate the forest's diverse community and processes.

Logged forest can retain substantial biodiversity. The Sabah study supports protection of repeatedly logged forests, not treating them as empty land.

# Tidal-flat loss involves both land use and sediment processes

## Yangtze estuary and delta case

Intertidal flats are covered and exposed by tides and provide feeding habitats and specialized communities.

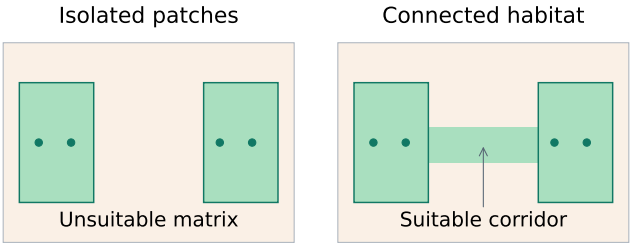
Reclamation can replace these habitats with enclosed land; reduced sediment supply alters deposition and erosion.

A protected label alone cannot preserve the ecosystem if water, sediment and connected feeding habitats are lost. Published studies are linked in the handout.

# A percentage area loss is not a species-extinction percentage

1. **Invented area.** Suitable wetland habitat changes from 1,000 ha to 760 ha under the same mapping definition.
2. **Calculate.** Loss $= 1000 - 760 = 240\,\mathrm{ha}$; percentage loss $= 240/1000 \times 100 = 24\%$; remaining $= 76\%$.
3. **Limit.** Species respond differently, may persist temporarily, or suffer reduced habitat quality. Global extinction is not measured by this map.

# Treat a corridor as a management hypothesis




Invented plan: green = habitat; tan = surrounding land use.
Test movement and breeding; a drawn connection is not proof.

> Suitable habitat connections may help movement; test survival and breeding outcomes.

# A drawn corridor does not guarantee successful connection

## Match habitat and barriers to the target organism

Fragmentation can reduce mating, migration and recolonization. Edge conditions can differ from the habitat interior.

A corridor needs suitable habitat, continuity, width and effective crossings of barriers.

It may fail for one species or spread unwanted organisms. Compare movement, survival and reproduction using suitable surveys.

# Threatened with extinction does not mean already extinct

## Interpret the IPBES 2019 assessment carefully

The assessment estimated around one million species threatened with extinction, based on evidence across many groups and habitats.

This is a risk estimate, not a count of one million confirmed extinctions.

A single local survey cannot establish a global extinction rate. Use repeated comparable surveys to investigate local change.

# Read published population trends with their sampling scope

1. **Published birds.** Rigal et al. (2023): 170 common species, over 20,000 sites, 28 European countries; 1980–2016.
2. **Reported change.** Combined abundance indicator: $-25.4\%$. Farmland-species indicator: $-56.8\%$.
3. **Rescale.** With the farmland indicator initially 100: final $= 100 \times (1 - 0.568) =$ 43.2 index units.
4. **Interpret.** An abundance indicator is not a count of species lost, and 43.2 is not a raw bird count.

# Compare reef cover and bird abundance without mixing indicators

1. **Published reefs.** GCRMN 2020 report: monitoring from over 12,000 sites in 73 countries.
2. **Reported change.** About 14% loss of live hard coral, 2009–2018, estimated using coral-cover observations.
3. **Compare.** Bird abundance and coral cover differ in measured quantity, habitat and interval. Their percentages are not comparable extinction rates.
4. **Extend.** Species-resolved records are needed to compare richness and **evenness**. Check sampling coverage and uncertainty.

# Equal abundance can conceal a community change

1. **Invented start.** P, Q, R, S counts: 40, 30, 20, 10. Total 100; richness 4; dominance 40%.
2. **Later survey.** Counts: 65, 25, 10, 0. Total 100; recorded richness 3; dominance 65%.
3. **Interpret.** Richness and **evenness** decline in these samples. Non-detection of S does not prove S is globally extinct.

# Citizen scientists extend coverage when protocols remain comparable

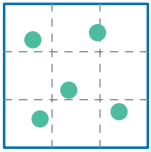
## Control effort and identification, then report uncertainty

Standardize area, duration, season, method and identification rules. Use independent sites or sampling units.

Training, photographs and expert verification can improve identification. Record uncertainty and changes in observer effort.

Published methods allow checking and repetition. Citizen data are neither automatically unreliable nor automatically free of bias.

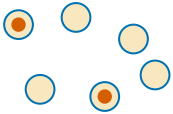
# Three field sampling methods



**quadrat**
count species in a square



**transect**
record along a line



**mark-recapture**
mark some (red), release, then re-catch

Repeated surveys show trends

# Connect each pressure to a biological mechanism

| **Pressure** | **How biodiversity can decline** |
|---|---|
| Over-exploitation | Removals exceed replacement |
| Land-use change | Habitats are replaced or fragmented |
| Pollution | Toxic materials or excess nutrients alter conditions |
| Transport of organisms | Invasive organisms, pests or diseases disrupt communities |
| Climate change | Temperature, rainfall or sea conditions shift suitable habitat |

# Population growth can increase demand, but context matters

## Consumption, technology and management alter impacts

More people can increase demand for land, food, water and energy. Population size alone does not fully predict damage at one site.

Not every introduced organism becomes invasive, and different species respond differently to changing conditions.

Pressures interact: a fragmented population may be less able to move as climate shifts. Name the scale and affected organisms.

# In situ conservation protects organisms within natural habitats

## Reserves require suitable boundaries and management

A reserve can protect communities and ecological processes, but needs management, enforcement and connections.

Important breeding, migration or seasonal feeding areas may lie beyond one boundary.

Monitor the actual threat and population response. A protected label alone does not demonstrate recovery.

# Restoration and rewilding address ecological conditions and processes

## Planting numbers alone are an incomplete measure

Restore suitable water flow, native vegetation or other damaged conditions; remove the original pressure.

Rewilding aims to recover ecological processes and, where appropriate, native organisms. Reintroduction needs suitable habitat and ecological assessment.

Choose reference conditions and a baseline. Monitor survival, reproduction, natural recruitment and continuing threat reduction.

# Ex situ conservation can provide a backup, not a whole ecosystem

## Zoos, botanic gardens and breeding collections

Managed collections can protect populations during immediate threats and support later recovery.

Small populations need management of breeding, genetic diversity, health and suitable behaviour.

Captive survival does not guarantee self-sustaining wild populations or replace functioning habitats.

# Germplasm conservation needs viable, representative material

## Different seeds require different storage approaches

Germplasm is inherited material that can support future reproduction, including seeds or suitable tissue.

Many seeds tolerate drying and storage; others do not. Collections need viability checks, correct identification and genetic representation.

Stored material does not preserve food webs, water flows and every species interaction. It complements habitat conservation.

# Combine measures for an invented drainage-threatened plant

| Measure | Contribution and practical limit |
| --- | --- |
| Protect remaining wetland | Reduces clearance, but external water flows may remain altered |
| Restore hydrology | Addresses habitat conditions; recovery may take time and remain incomplete |
| Seed / tissue backup | Safeguards appropriate genetic material; viability and representation need maintenance |

# 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

Match the method to the threat

# EDGE combines evolutionary distinctiveness and global endangerment

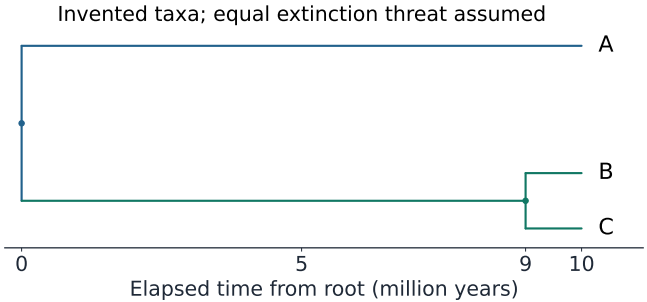
## Phylogeny and extinction risk answer different questions

A species with few close relatives can represent a large amount of relatively unique evolutionary history.

EDGE combines this phylogenetic information with extinction risk to identify priorities.

Unusual appearance or a low individual count alone is not a real EDGE score. The programme's method is linked in the handout.

# Compare threatened branches of evolutionary history




A has a long independent lineage; B and C are close relatives.
This illustrates priority, not a real EDGE score.

Equal threats in an invented tree: losing A removes more uniquely represented history.

# A conservation priority still involves choices and affected people

## State the goal, evidence and trade-offs transparently

Feasibility, cost, ecological roles, local knowledge and cultural values can affect decisions.

A phylogenetic argument contributes evidence but does not remove ethical choices or the need to involve affected communities.

A high ranking is not recovery. Reduce the actual threat and monitor outcomes.

# Try a survey calculation and a conservation decision

## Use comparable definitions before interpreting change

Invented suitable habitat falls from 1,000 to 760 ha. Calculate lost area, percentage loss and percentage remaining.

A community changes from counts 40, 30, 20, 10 to 65, 25, 10, 0. Compare total, richness and dominance.

Explain why neither dataset alone establishes the number of globally extinct species.

# Reveal: area, abundance and extinction require different evidence

1. **Area.** $240\,\mathrm{ha}$ lost; $240/1000 \times 100 = 24\%$ loss; $76\%$ remains.
2. **Community.** Both totals 100; richness 4 $\rightarrow$ 3; dominance 40% $\rightarrow$ 65%, a rise of 25 percentage points.
3. **Limit.** A habitat map does not count global extinctions. Non-detection in one survey can reflect local loss or incomplete detection.

# Check yourself

## Level, comparison, mechanism and goal

Distinguish individuals, species, populations and ecosystems. Compare standardized repeated observations.

Connect each pressure to a mechanism, and each conservation measure to the threat it addresses.

Separate detection, assessment and extinction dates. Make the conservation goal and trade-offs explicit.