Biodiversity has several levels

Biodiversity is the variety of life. A species count is useful, but it does not describe all the variation within populations or among habitats.

1. GENETIC DIVERSITY: WITHIN A SPECIES

Genetic diversity is variation in inherited DNA, including different versions of genes called alleles. For example, one frog population may contain inherited differences in disease resistance. A large number of genetically similar individuals does not necessarily mean high genetic diversity.

2. SPECIES DIVERSITY: AMONG SPECIES

Species richness counts how many different species are present. Species diversity can also consider evenness: how individuals are distributed among those species. A pond with several fish species demonstrates species-level variety, not necessarily genetic variation within each fish species.

3. HABITAT DIVERSITY: DIFFERENT LIVING PLACES

Habitat diversity is the variety of habitats, such as streams, marshes and woodland in a landscape. Different conditions and resources support different organisms. At a broader scale, ecosystem diversity includes the variety of ecosystems and their ecological processes.

4. MATCH THE EVIDENCE TO THE LEVEL

DNA or inherited trait variation → genetic diversity

Species identities and abundances → species diversity

A map of different habitats → habitat diversity

Three levels of biodiversity: College Board, ERT-2.A.1.
Genetic, species and ecosystem diversity: OpenStax, Biology 2e 47.1.

Scope: College Board AP Environmental Science CED, Topic 2.1, p. 52.

Richness is not the number of individuals

Count distinct species, not repeated individuals. The two invented samples below each contain 20 individuals belonging to the same four species.

1. COMPARE EQUAL-SIZED SAMPLES

Species	Sample A	Sample B
Species W	5	17
Species X	5	1
Species Y	5	1
Species Z	5	1
Total individuals	20	20
Species richness	4	4

A has greater evenness. B is dominated by species W, yet its richness is still 4.

2. INTERPRET WHAT CHANGES

If one more W individual is counted, abundance increases but richness stays 4. If a previously absent fifth species is found, richness becomes 5. Losing the only individual of species X from sample B reduces the richness of that sample to 3.

3. COMPARE LIKE WITH LIKE

Match sampling area, effort, season and methods. Larger or more thoroughly searched samples may reveal more species. Observed richness does not prove that every species present has been detected.

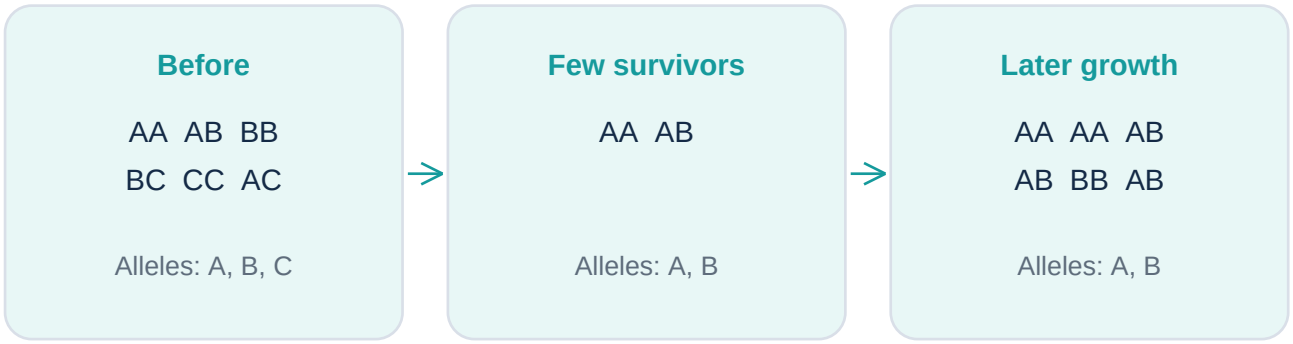
Richness counts different species: College Board, ERT-2.A.5.
Relative abundance and species diversity: OpenStax, Biology 2e 47.1.

Scope: College Board AP Environmental Science CED, Topic 2.1, p. 52.

Variation can help systems persist

Biodiversity can support responses to stress and recovery after disruption. It does not prevent all disturbance or guarantee that every population survives.

1. A BOTTLENECK CAN REMOVE ALLELES



Each pair is one individual at one gene locus. This hypothetical chance reduction loses allele C. Population size later rises, but C does not return simply through reproduction of the survivors.

2. GENETIC VARIATION SUPPORTS ADAPTATION

With more inherited variation, some individuals are more likely to tolerate a new stressor and reproduce. Selection can then change the population over generations. Stress does not make all individuals acquire the needed allele on demand.

3. HABITAT LOSS DOES NOT AFFECT ALL SPECIES EQUALLY

Specialists depend on a narrow range of resources or conditions and often decline before flexible generalists. Species needing large territories are also vulnerable when too little suitable space remains. Continued habitat loss can eventually remove generalists too.

More species can support recovery through varied responses and ecological roles. Resilience depends on which species remain and the disturbance, not richness alone.

Bottlenecks and genetic drift: OpenStax, Biology 2e 19.2.
Genetic variation, recovery and habitat sensitivity: College Board, ERT-2.A.2-4.
Habitat destruction: OpenStax, Biology 2e 47.3.

Scope: College Board AP Environmental Science CED, Topic 2.1, p. 52.