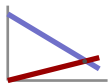
Biodiversity

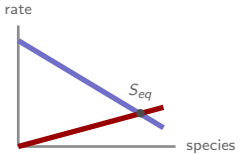
AP Environmental Science ▪ Unit 2

AP Environmental Science



What we will cover

1. What biodiversity is
2. Ecosystem services
3. Island biogeography
4. Ecological tolerance
5. Disruptions and adaptation
6. Ecological succession



1 Biodiversity

What biodiversity is

Biodiversity 生物多样性 is the variety of life, at three levels: genetic, species, habitat.

> More diversity ⇒ more resilience. Diversity = richness × evenness.

Coral reef: high richness and evenness

Biodiversity has three levels, and the exam wants all three

genetic 遗传 diversity	variety of genes *within* one species – more variety means the population can meet **environmental stressors** 环境压力; a **population bottleneck** 种群瓶颈 strips it away
species diversity	**species richness** 物种丰富度 (how many) plus evenness (how equally spread)
ecosystem diversity	variety of habitats and communities across a region

Species-rich ecosystems are more **resilient** 有韧性的: when conditions change, varied species can fill the roles the lost ones held.

2

Services

Ecosystem services

Nature's free work for people, in four groups:

Provisioning 供给
goods: food, water, wood

Regulating 调节
clean air, flood control, pollination

Cultural 文化
beauty, recreation, spirit

Supporting 支持
soil, photosynthesis, cycling

> A wetland that cleans water for free is worth the treatment plant we would otherwise build.

The four kinds of ecosystem service

provisioning	products taken directly: food, fresh water, timber, fibre
regulating	processes that keep conditions stable: climate regulation, water filtration, pollination, flood control
supporting	the ones the others rest on: soil formation, nutrient cycling, photosynthesis
cultural	non-material value: recreation, beauty, spiritual and educational worth

Anthropogenic 人为的 activity disrupts these, and the cost is economic as well as ecological – which is the point the essay question wants made.

Island biogeography, and what disturbs an ecosystem

island size	a larger island supports more species – more habitat, larger populations, lower extinction
distance	a nearer island receives more colonists from the mainland
so	big, near islands hold the most species; small, remote ones the fewest
isolation drives evolution	island species often become specialists, which makes them vulnerable to **invasive species** 入侵物种
zones of stress 胁迫区	at the edges of a species' tolerance range, where individuals survive but do not thrive or reproduce well
over geological time	climate has shifted for many reasons, and sea level has risen and fallen with the amount of glacial ice

Anthropogenic 人为的 activity disrupts ecosystem services at a real economic and ecological cost – losing pollinators forces farmers to pay for pollination.

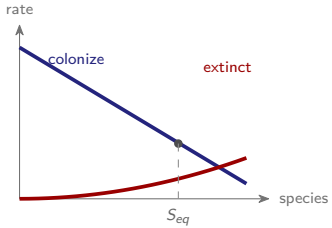
3 Island biogeography

Island biogeography

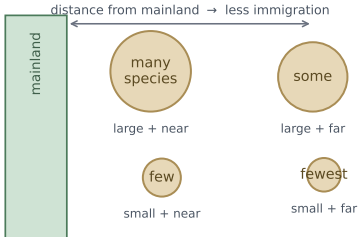
Island species number is a balance of two rates:

- **colonization** 定居 – new arrivals
- **extinction** 灭绝 – species dying out

> Richest islands are large & near; isolation breeds **endemic species** 特有种 found nowhere else.



Larger and nearer islands hold more species



larger area ↑ species · nearer mainland ↑ immigration · equilibrium richness

Larger and nearer islands hold more species, balancing immigration against extinction

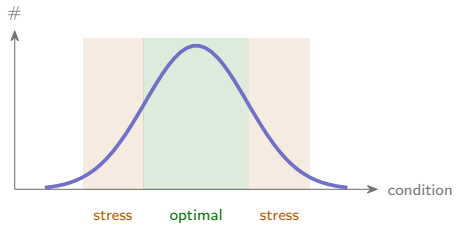
4 Tolerance

Ecological tolerance

Every species survives only within a **range of tolerance** 耐受范围:

- **optimal range** 最适范围 in the middle
- a **zone of stress** 胁迫区 on each side
- limits beyond which it dies

> A population's range is wider than one organism's – individuals vary.



5 Disruptions

Disruptions and adaptation

Disruptions: periodic, episodic (wildfire), random. Adaptation by natural selection: structural, physiological, behavioral.

> When the environment changes, selection can favour a different trait.

Episodic disruption: wildfire resets succession

Natural disruption comes on three schedules

periodic 周期性 regular cycles – seasons, tides

episodic 偶发性 occasional and irregular – fires, floods, volcanic eruptions

random 随机 no pattern at all – a meteor strike

A single natural event can rival or exceed a human-made one, and over geological time the climate and sea level have shifted for reasons that had nothing to do with us.

Adaptations

An **adaptation** 适应 is an inherited trait that improves survival and reproduction in an environment.

> Adaptations arise through **natural selection** 自然选择 – incremental genetic change accumulating over generations, not within a single lifetime.

6 Succession

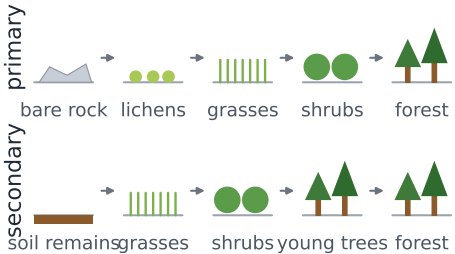
Ecological succession

Life returns in a predictable order: pioneer $\rightarrow$ climax.

> Primary starts on bare rock; secondary keeps the soil – far faster.

Pioneer lichen on bare rock

Primary succession builds from bare rock; secondary



primary: bare substrate (no soil) · secondary: soil remains ⇒ faster recovery

> Primary succession builds from bare rock; secondary succession regrows from surviving soil

Succession runs from bare rock to a climax community

pioneer species 先锋物种	first arrivals on bare rock – **lichens** 地衣 and mosses, which break rock down into the first soil
primary succession 原生演替	starts with no soil at all (new lava, retreating glacier) – very slow
secondary succession 次级演替	follows a disturbance that leaves the soil intact – after a fire or abandoned farmland – so it is much faster
climax community 顶极群落	the stable end community for that climate, until the next disturbance

The single discriminator between the two kinds is soil. If soil survived the disturbance, it is secondary.

Introduction to Biodiversity

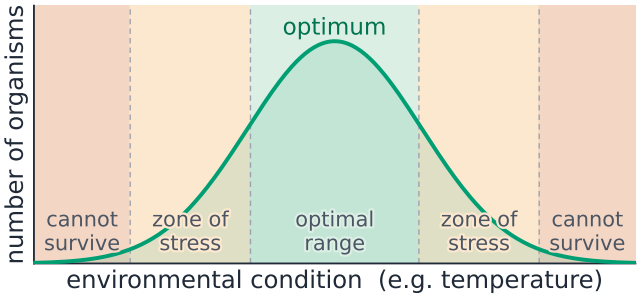
ecosystem diversity

species diversity

genetic diversity (within a species)

Biodiversity has three levels: genetic, species, and habitat

Ecological Tolerance, continued



range of tolerance: optimum peak · outside = stress or death

> Within its optimal range a species thrives; toward the limits it is stressed, then cannot survive

Exam tips

- Describe biodiversity at three levels: **genetic, species, and habitat**, and link higher diversity to greater **resilience**.
- **Specialist** species (narrow needs) are more vulnerable than **generalists** when a habitat changes.
- Distinguish **primary** succession (bare rock, no soil, slow) from **secondary** (soil intact, faster).
- Explain a **keystone species** (outsized effect) and an **indicator species** (signals ecosystem health).
- Name the four **ecosystem services** (provisioning, regulating, cultural, supporting) with examples.

7 Recap

Worked example – species diversity

Wood A has 100 birds of 1 species; Wood B has 100 birds evenly split across 4 species. Compare their diversity.

- Richness = number of species: A has 1, B has 4.
- Evenness = how equally individuals are spread: B is perfectly even.
- B wins on both $\Rightarrow$ B is far more diverse.
- Higher diversity $\Rightarrow$ more resilience: if one species fails, others fill its role.

Diversity = richness + evenness. A monoculture has richness 1 and no evenness – which is exactly why a single pest can destroy a whole crop.

Unit 2 – key takeaways

1 Biodiversity

genetic/species/habitat; richness × evenness

2 Services

provisioning, regulating, cultural, supporting

3 Islands & tolerance

large+near hold most; optimal vs stress zones

4 Succession

primary (bare rock) vs secondary; pioneer to climax

Check yourself

1. Name the two numbers that together give species diversity.
2. Which island holds more species: large-near or small-far?
3. What is a species found nowhere else called?
4. Which succession keeps the soil and so is faster?

Answers **1.** richness and evenness **2.** large-and-near **3.** endemic **4.** secondary succession