

D.4.2 · Sustainability and change

International Baccalaureate · IB Diploma · Biology · HL

Scope and prerequisites

This handout covers selected HL/SL topics for the course first assessed in 2025; it is not the whole syllabus.

Prerequisites: populations and ecosystems from D.4.1 and energy flow from earlier ecology.

The examples are original and fictional: they are not real measurements or real student investigations.

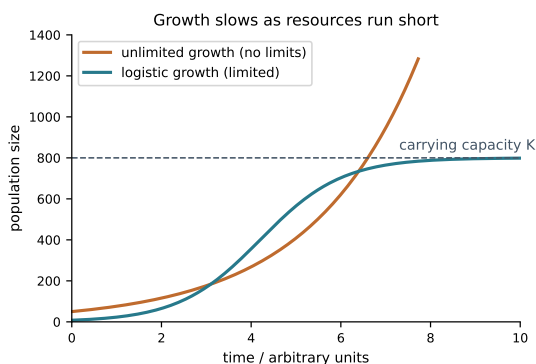
Sustainability and change

■ What would explain this observation?

- A fishery that harvests the same tonnage every year can thrive for decades, while a neighbouring one collapses in five. Both fish the same sea – what separates them?

■ Build the model

- Populations cannot grow without limit. The **logistic model** shows growth slowing as resources run short, levelling at the environment's **carrying capacity** – the largest population the habitat can support. Food, space, disease and predation supply the limits.
- A **renewable resource** is sustainable only when harvest stays at or below regrowth. Change is constant in ecosystems: climate shifts, species arrive, and human activity alters habitats, so management must track stocks and adjust.
- logistic model: Growth that levels at the carrying capacity as resources become limiting; carrying capacity: The largest population an environment can support; renewable resource: A resource that regenerates, such as a fish stock or a forest.



A renewable stock stays if harvest $\leq$ regrowth

fish stock 1,000 tonnes
regrowth 100 tonnes/year
sustainable harvest $\leq$ 100 tonnes/year



harvest 150 → stock falls 50/year
stock after 2 years: 900 tonnes

Conservation keeps use at or below renewal

Growth levels off at carrying capacity; harvesting above regrowth shrinks the stock

■ Choose evidence that can test it

- Compare the stock before and after each harvest season: a sustainable fishery holds the stock near its level, while decline year on year means harvest exceeds regrowth. Distinguish a falling stock from a falling CATCH, which can hide the decline until late.
- Track the same population over several years rather than once; a single count cannot show a trend.

■ Work from known quantities

- Known: a fish stock is 1,000 tonnes and regrows 100 tonnes per year. A harvest of 150 tonnes per year gives net change = regrowth – harvest = $100 - 150 = -50$ tonnes per year. After two years the stock is $1,000 - 2 \times 50 = 900$ tonnes – a sustainable harvest at this regrowth is at most 100 tonnes per year.

Example:

After better management the regrowth is 120 tonnes per year and the harvest quota is set at 80 tonnes per year. Find the yearly change in the stock and the stock after three years from 900 tonnes, using the same sequence: known quantities → model → relation → substitution → unit and interpretation. (Answer: net change = $120 - 80 = +40$ tonnes per year; after three years, $900 + 3 \times 40 = 1,020$ tonnes – the stock recovers.)

■ Check the conclusion and its limits

- The balance model assumes a constant regrowth rate; in reality regrowth depends on the stock size itself, collapsing fastest when the stock is already small. One year's figures cannot establish a trend – management needs the whole time series and honest catch reporting.

Warn:

A renewable resource cannot be used up. This claim is false: renewable means it CAN regenerate, not that it always outpaces use – a stock harvested faster than its regrowth shrinks every year and can collapse entirely, as overfished cod stocks did.

Key:

Sustainability and change: populations level at the carrying capacity, and renewable resources stay only if harvest $\leq$ regrowth. Track stocks over time and set harvests from measured regrowth, because ecosystems never stand still.