Course notes

International Baccalaureate · IB Diploma · Environmental Systems and Societies · SL

IB IB Diploma · Environmental Systems and Societies · SL: teaching notes

Version: First assessment 2026

These notes cover selected topics of the course; they are not the whole specification.

Assessment and course boundaries

- ESS integrates ecological evidence with human values, systems and sustainability; it is not a generic Biology course.
- HL adds environmental law, environmental/ecological economics and ethics as lenses integrated with topic evidence, alongside deeper topic coverage.
- Both levels have practical work 30 h, collaborative sciences project 10 h and individual investigation 10 h. Use school-approved fieldwork and ethical social-data collection.
- Written assessment and investigation details are recorded from the 2026 brief; the old SL-only 2017 brief is not the current course.
- 2026 assessment: SL Paper 1 is 1 h/25%, Paper 2 is 2 h/50%, investigation 25%; HL Paper 1 is 2 h/30%, Paper 2 is 2.5 h/50%, investigation 20%. Paper 1 uses an unseen case study; Paper 2 has short/data questions and structured essays. The individual investigation is a real student-formulated inquiry, 10 h and a maximum 3,000-word report.

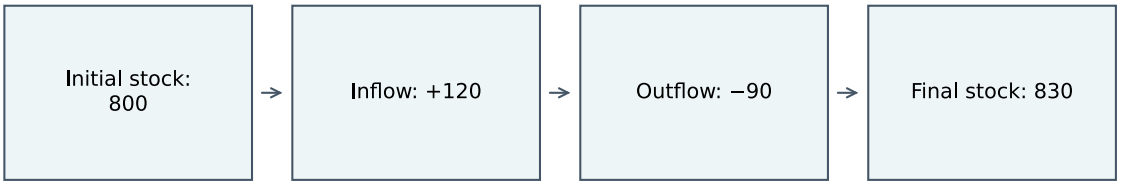
Environmental systems, feedback and perspectives

Official-unit focus: 1 Foundation; 2 Ecology

A lake can respond to the same nutrient input differently depending on its current state. Environmental outcomes depend on stocks, flows and feedback.

A system model has a boundary, stores and flows. Negative feedback counteracts change; positive feedback amplifies it. An environmental perspective shapes what people value and which management outcomes they prioritize.

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Separate physical evidence from value judgements. A stock is an amount at a time; a flow is an amount per time. Sustainability decisions require ecological, social and economic evidence and a stated scale.

Draw the system boundary before calculating a budget. Identify inflows, outflows and possible unmeasured terms. Compare stakeholder claims using the same evidence, then explain where values lead to different choices.

■ Checked worked case

Known: a reservoir begins with 800 units, receives 120 and loses 90 during a week. Change in storage = inflow-outflow = 120-90 = 30. Final storage = 800+30 = 830 units. The model assumes no omitted flow.

■ Common error

A balance that closes mathematically can still omit a real process if terms were estimated to fit. Positive feedback does not mean a socially desirable result.

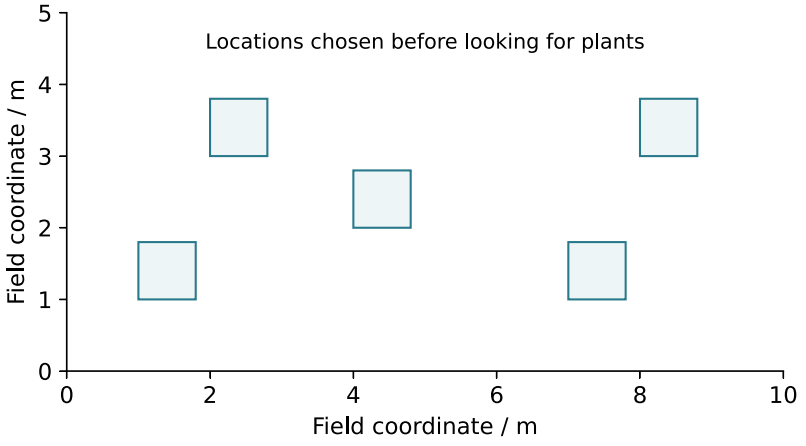
Sampling populations without choosing the answer

Official-unit focus: 2 Ecology

A field edge looks richer in plants than its centre. Choosing only the richest patches would build the desired result into the sampling method.

A population consists of organisms of one species in a defined area. Random quadrats estimate density without deliberately selecting patches. A transect investigates change along an environmental gradient.

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Estimate total abundance by multiplying mean density by area, with consistent units. This assumes sampled areas represent the habitat. Patchiness and too few samples widen uncertainty.

Choose coordinates with random numbers before visiting the patches. Record quadrat area and counting rules. For a transect, use fixed distances and measure a relevant abiotic variable. Do not damage habitats or sample unsafe locations.

■ Checked worked case

Known: five 0.25 square metre quadrats contain 3, 4, 6, 5 and 2 plants. Mean count $= 20/5 = 4$. Density $= 4/0.25 = 16$ plants per square metre. Estimated abundance in 100 square metres $= 16 \times 100 = 1{,}600$ plants.

■ Common error

Quadrats suit organisms that do not move quickly. A food chain arrow shows the direction of energy transfer, not the direction a predator travels.

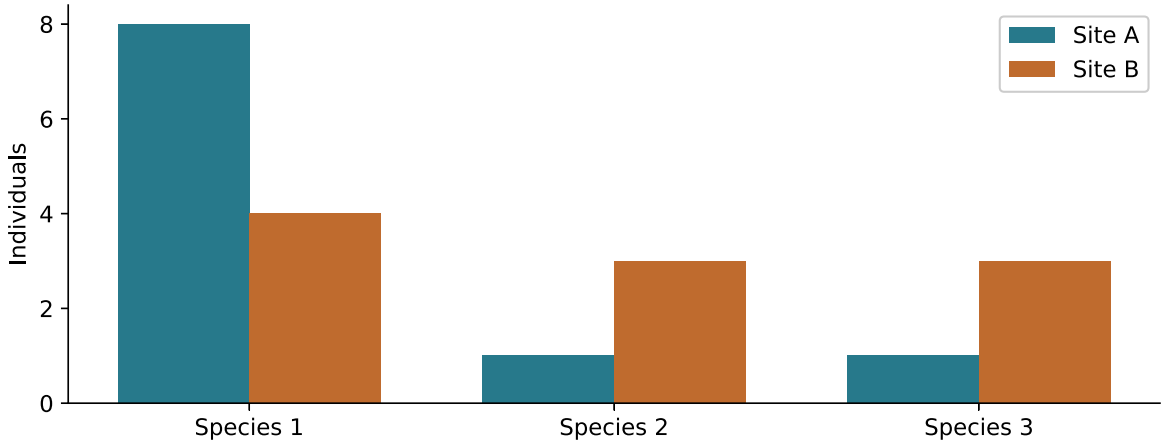
Biodiversity, conservation and sampling evidence

Official-unit focus: 3 Biodiversity and conservation

A site with many individuals can still be dominated by one species. Abundance, richness and evenness describe different features of biodiversity.

Species richness counts species. Evenness concerns relative abundance. Conservation can protect habitats, populations or genetic diversity; a management judgement must state the conservation goal.

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Compare surveys with similar area, effort, season and identification rules. A diversity index is meaningful only with its formula and conventions specified. Habitat fragmentation can affect movement and gene flow even when total area changes little.

Use non-destructive field sampling approved by the school. Identify organisms with a suitable key and record uncertain identifications rather than inventing species. Combine ecological evidence with stakeholder perspectives on land use.

■ Checked worked case

Known: site A has counts 8, 1 and 1; site B has 4, 3 and 3. Both have richness 3 and total abundance 10. The most abundant species occupies 80% in A and 40% in B. B is more even under these counts.

■ Common error

An index cannot by itself explain the cause of a difference. A newly recorded species may reflect improved observation rather than a recent ecological arrival.

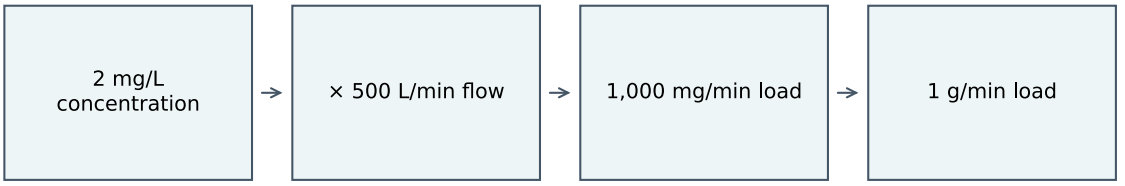
Water, pollution and management trade-offs

Official-unit focus: 4 Water

A downstream sample has less dissolved oxygen after a nutrient input. The explanation must connect biological processes with the water-system evidence.

Eutrophication can begin with nutrient enrichment, followed by greater producer growth and increased decomposition after organisms die. Decomposer respiration can lower dissolved oxygen. Water availability depends on quantity, quality and access.

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Distinguish concentration from total pollutant load. Dilution can reduce concentration without removing the pollutant mass. A management plan should consider upstream causes, users and effects on other parts of the catchment.

Collect approved water-quality observations at matched sites and times. Use calibrated instruments and consistent sampling depth. Avoid contact with contaminated water and do not infer potability from clarity.

■ Checked worked case

Known: concentration is 2 mg per litre and flow is 500 litres per minute. Load = concentration × flow = 2×500 = 1,000 mg per minute = 1 g per minute. A lower concentration during high flow can still produce a high total load.

■ Common error

Clear water is not necessarily safe water. Nutrient enrichment does not directly use up oxygen; the pathway includes biological activity and decomposition.

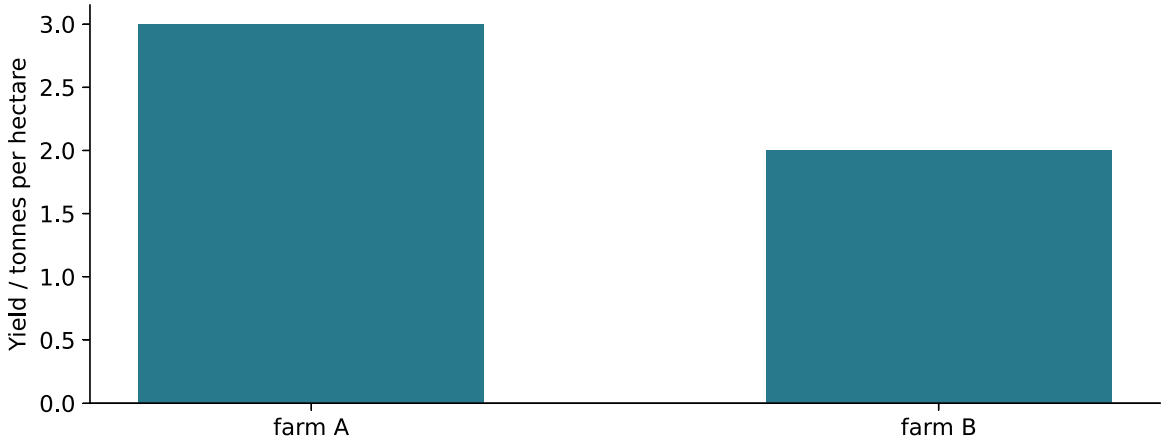
Land, food and resource decisions

Official-unit focus: 5 Land; 7 Natural resources

A farm can increase yield while increasing soil loss or water demand. Food-system evaluation requires more than tonnes harvested.

Soil supports nutrient cycling, water storage and organisms. Erosion removes soil; nutrient depletion changes fertility. Resource use involves extraction, production, distribution and waste.

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Distinguish total yield from yield per area and energy input. Sustainable management must consider regeneration rates and impacts beyond the farm boundary. Different stakeholders may rank food security, biodiversity and income differently.

Compare management options using a stated functional unit and the same timescale. Use approved secondary datasets or non-destructive soil observations. Explain trade-offs instead of claiming a method has no disadvantages.

■ Checked worked case

Known: farm A harvests 18 tonnes from 6 hectares. Yield per area = 18/6 = 3 tonnes per hectare. Farm B harvests 20 tonnes from 10 hectares, so its yield is 2 tonnes per hectare despite a larger total harvest.

■ Common error

A high yield is not proof of long-term soil health. Renewable resources can be depleted when use exceeds regeneration.

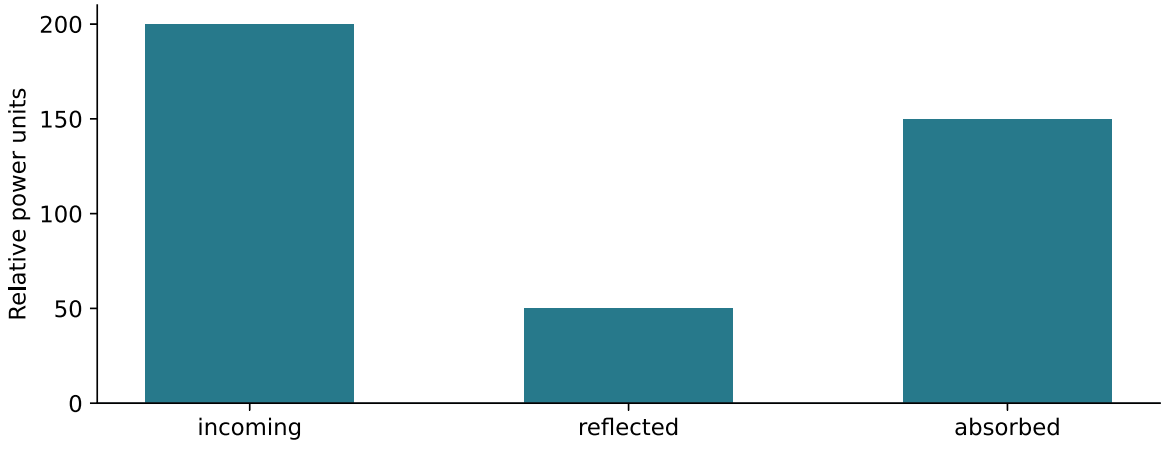
Climate evidence, energy budgets and policy

Official-unit focus: 6 Atmosphere and climate change

One cold day does not disprove a warming climate. Weather describes short-term conditions; climate describes distributions over longer times and regions.

The Earth energy balance includes incoming solar radiation, reflection, absorption and outgoing infrared radiation. Greenhouse gases absorb and emit infrared radiation. Feedback can alter the response to an initial forcing.

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Distinguish mitigation, which addresses drivers, from adaptation, which reduces harm from impacts. A policy assessment needs evidence about effectiveness, cost, equity and uncertainty; one criterion is not the entire decision.

Compare multi-year data using consistent baselines. State the region, timescale and uncertainty. At HL, connect a management decision to law, economics and ethics rather than treating these lenses as extra definitions only.

■ Checked worked case

Known: a surface receives 200 power units and reflects 50. Absorbed input = incoming-reflected = 200-50 = 150. Reflected fraction = 50/200 = 0.25 = 25%. A change in reflectivity alters the absorbed budget under this model.

■ Common error

The greenhouse effect is not the same process as ozone depletion. A carbon footprint estimate depends on its system boundary.

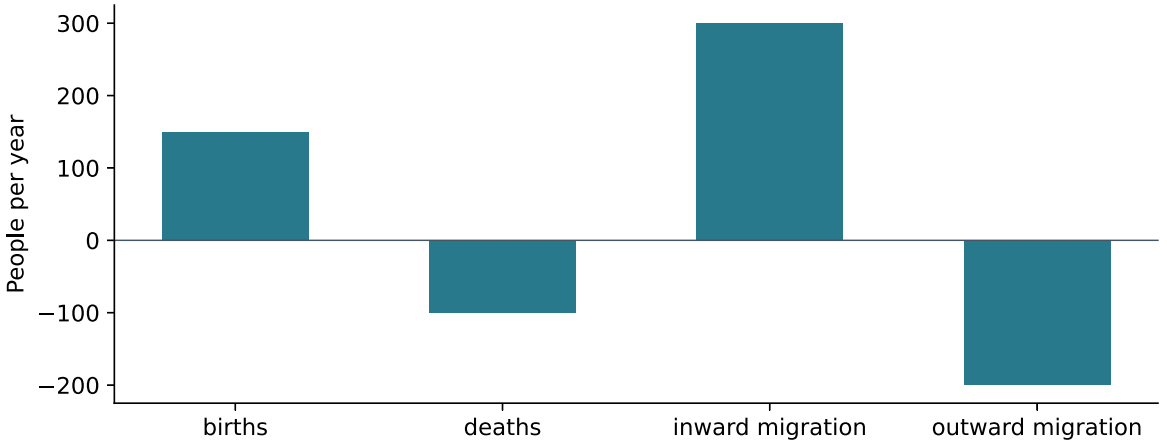
Population, urban systems and indicators

Official-unit focus: 8 Human populations and urban systems

A city can grow because people move into it even when births equal deaths. Population change has several flows.

Population change depends on births, deaths, immigration and emigration. Urban systems exchange energy, materials and waste with a wider region. A sustainability indicator measures a specified feature rather than total wellbeing.

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Compare rates with a common denominator and interval. An average can hide unequal access to services. At HL, evaluate how economic incentives, legal responsibilities and ethical priorities change an urban management proposal.

Use published demographic and city-service data with dates and definitions. Protect privacy when collecting local opinions. Compare the same geographical boundary rather than mixing an urban core with a whole metropolitan region.

■ Checked worked case

Known: a city has 10,000 people; births 150, deaths 100, immigration 300 and emigration 200 in one year. Change = 150-100+300-200 = 150. Growth percentage = 150/10,000×100 = 1.5%.

■ Common error

A projected population is conditional on assumptions. Urban growth does not automatically mean improved health, income or environmental quality for every resident.

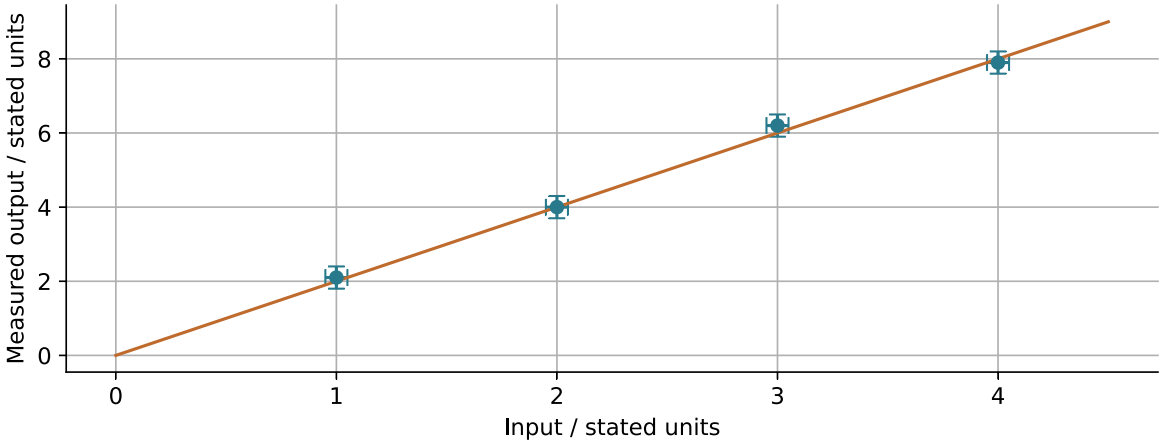
Uncertainty, gradients and model testing

Official-unit focus: Practical Experimental programme

A line passing near every data point is useful, but its gradient can still be uncertain. A graph is evidence for a model within the measurement range.

Random variation makes repeated readings differ. Systematic error shifts results consistently. Absolute uncertainty has the measured unit; relative or percentage uncertainty compares uncertainty with the measured value.

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For a product or quotient, adding fractional uncertainties is a common maximum-uncertainty approximation. For a difference, add absolute uncertainties. A nonzero intercept can reveal an offset or an incomplete model.

Show units on axes and choose a sensible scale. Plot uncertainty bars where justified, draw a best-fit line rather than joining every point, and estimate steepest and shallowest plausible gradients when the course method calls for them.

■ Checked worked case

Known: length = 50.0 mm with uncertainty 1.0 mm. Percentage uncertainty = absolute uncertainty/value $\times 100 = 1.0/50.0 \times 100 = 2.0\%$. For a quotient of two independently measured quantities with maximum percentage uncertainties 2% and 3%, the summed maximum estimate is 5%.

■ Common error

Repeating readings reduces random uncertainty in a mean but does not automatically remove a zero error. Do not quote more decimal places than your measurement can support.

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