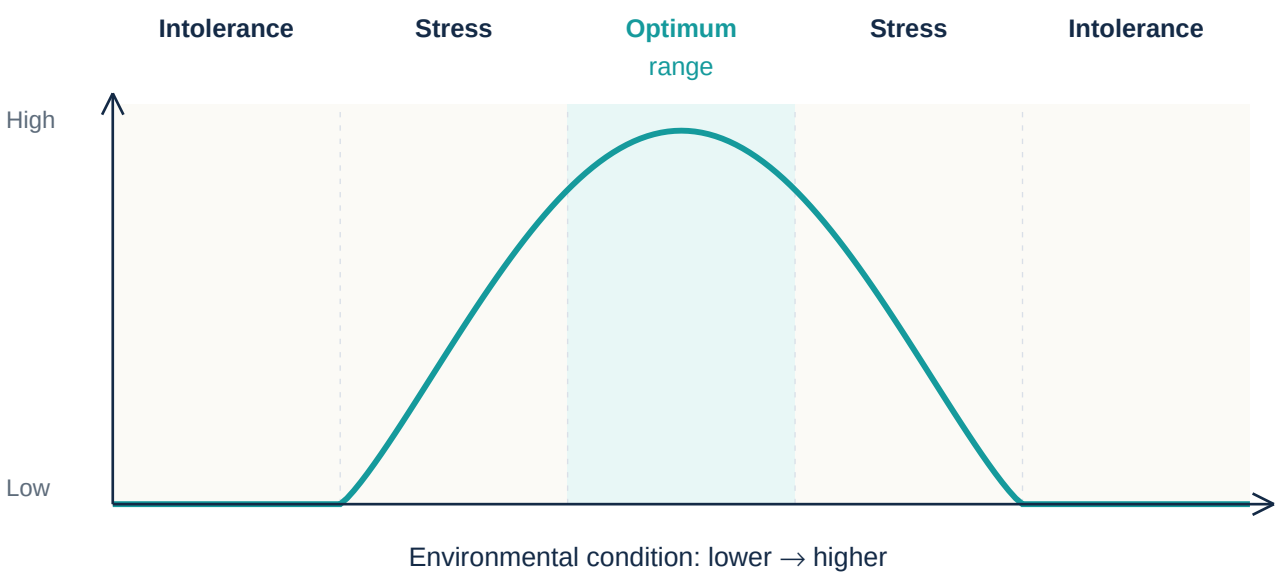
Surviving is not the same as thriving

Ecological tolerance is the range of environmental conditions an organism can endure before injury or death. Examples include temperature, salinity, flow rate and sunlight.

1. READ A TOLERANCE CURVE



Vertical axis: relative performance. Schematic only; real curves need not be symmetric.

2. DISTINGUISH THE THREE ZONES

In the optimum range, the measured performance is strongest. In stress zones, organisms may survive but grow slowly or reproduce poorly. Beyond survival limits, conditions cannot sustain the organism under the stated exposure. The optimum is only part of the full tolerance range.

3. CHECK WHAT THE GRAPH ACTUALLY MEASURES

The vertical axis might show growth, reproduction, survival or abundance. These are not interchangeable. A reproduction curve can reach zero while some adults remain alive. An abundance curve also reflects movement and interactions with other species, not just physiological tolerance.

Definition and examples: College Board, ERT-2.F.1-2.
Environmental conditions and species distribution: OpenStax, Biology 2e 44.2.

Scope: College Board AP Environmental Science CED, Topic 2.4, p. 55.

Survival and reproduction can differ

Illustrative experiment, not real species data: equal groups of 100 adults are held at different temperatures for 30 days. Food, salinity and oxygen are kept the same.

1. THE SAME FACTOR, TWO DIFFERENT RESPONSES

Temperature (degrees C)	Adults alive after 30 days (%)	Offspring produced per initial adult
5	0	0
10	60	0
15	90	2
20	100	4
25	90	2
30	50	0
35	0	0

20 degrees C gives the highest observed survival and offspring output in this dataset.

2. INTERPRET ONLY WHAT WAS TESTED

Adults survive at tested temperatures from 10 to 30 degrees C, but offspring are produced only from 15 to 25 degrees C. At 30 degrees C, 50% survive without producing offspring. Persistence for 30 days does not prove a population can replace itself long term.

3. DO NOT INVENT PRECISE LIMITS

No adults survive at 5 or 35 degrees C in this experiment. The exact transition temperatures are not known: values between the test points were not measured. Use smaller temperature intervals and repeated trials to refine estimates. A different exposure duration may give different results.

Ecological tolerance of individuals and species: College Board, ERT-2.F.
Survival, growth and reproductive responses to temperature: EPA CADDIS.

Scope: College Board AP Environmental Science CED, Topic 2.4, p. 55.

Tolerance helps explain distribution

Tolerance applies to individuals and species. Individuals can differ, and a species-level pattern does not imply that every individual or life stage has identical limits.

1. CONSIDER THE FACTOR AND THE ORGANISM

A freshwater organism may tolerate little salt even if it tolerates a wide temperature range. Strong water flow can dislodge organisms; too little sunlight can limit plant photosynthesis. A broad tolerance for one factor does not guarantee a broad tolerance for all factors.

2. EXAMPLE: A STREAM LOSES ITS SHADE

Streambank vegetation is removed

More sunlight can reach and warm the water.

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Cold-water organisms face changed conditions

Temperature may enter their stress zone or exceed a limit.

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Survival or reproduction can fall

The population may decline or move to cooler refuges.

3. FACTORS CAN ACT TOGETHER

Warmer water can hold less dissolved oxygen at saturation. Aquatic animals may therefore face both temperature stress and reduced oxygen availability. Actual oxygen levels also depend on mixing, photosynthesis and respiration; temperature alone does not determine them.

A missing species is a clue, not proof of one cause. Compare conditions over time and across sites, and consider food, predators, competitors and access to suitable habitat.

Abiotic factors and species distribution: OpenStax, Biology 2e 44.2.
Stream warming and causal evidence: EPA CADDIS, Temperature.
Water temperature and dissolved oxygen: USGS Water Science School.

Scope: College Board AP Environmental Science CED, Topic 2.4, p. 55.