# Resources influence vital rates

Population growth depends on survival, reproduction and movement. Food, water, light, nutrients and suitable space can limit growth; which resource matters depends on the organism.

## 1. FOLLOW TWO RESOURCE PATHWAYS

### WHEN NEEDED RESOURCES ARE ABUNDANT

More usable resources → Survival or reproduction improves → Growth can accelerate

### WHEN THE RESOURCE BASE SHRINKS

Less available per individual → Mortality rises or fecundity falls → Growth slows or becomes negative

## 2. DEFINE THE LINK: FECUNDITY

Fecundity describes reproductive output or capacity to produce offspring. Poor nutrition can reduce the number of young produced or delay reproduction. Mortality concerns deaths. A smaller resource base may lower fecundity, raise mortality, or do both; these are mechanisms, not just a statement that numbers fall.

## 3. TOTAL SUPPLY AND ACCESS BOTH MATTER

Resources are finite even when some are renewed. Competition can make access unequal: a dominant animal may obtain food while another goes hungry. Plant growth can be limited by water even when light is plentiful. Adding a resource that is not limiting need not increase population growth.

Resource limits, fecundity and mortality: College Board, ERT-3.F.1-4.
Competition and population regulation: OpenStax, Biology 2e 45.4.

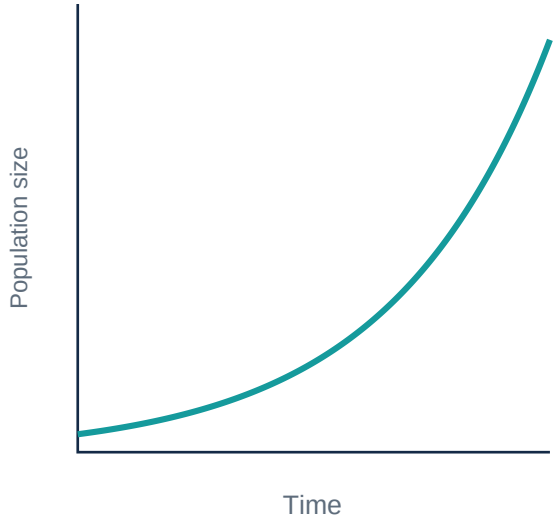
Scope: College Board AP Environmental Science CED, Topic 3.5, p. 69.

# Compare J-shaped and S-shaped growth

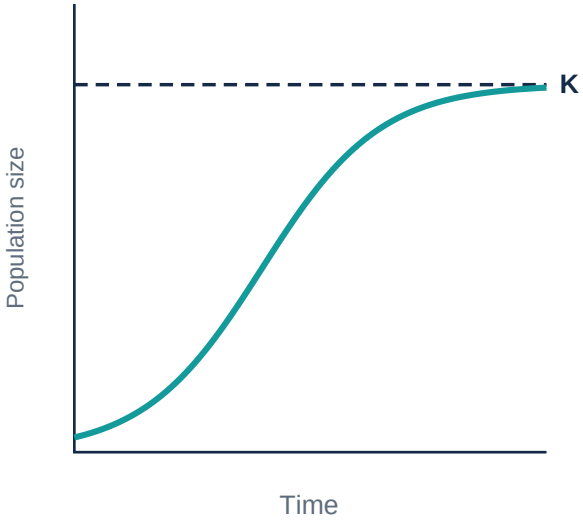
Growth patterns summarize changes over time. Exponential and logistic models make different assumptions about limits; neither is a promise that a wild population will follow a perfect curve.

## 1. RECOGNIZE THE MODELS

### EXPONENTIAL: J-SHAPED




### LOGISTIC: S-SHAPED




Schematic curves without numeric scales. Compare shapes, not exact population sizes or growth rates between the two panels.

## 2. EXPONENTIAL: A CONSTANT PROPORTION

With favorable conditions and a constant per-capita growth rate, a larger population adds more individuals in the same time. For example, doubling gives 100, 200, 400, 800: the increases are 100, 200, 400, not a fixed number. Sustained exponential increase eventually encounters finite resources.

## 3. LOGISTIC: RESOURCE FEEDBACK SLOWS GROWTH

As crowding increases, resource limitation reduces net growth. The curve levels near carrying capacity, K, under constant conditions. A flatter upward slope means slower increase, not a shrinking population. A downward slope means population size is decreasing.

Exponential and logistic growth: OpenStax, Biology 2e 45.3.
Population growth and environmental limits: OpenStax, Concepts of Biology 19.2.

Scope: College Board AP Environmental Science CED, Topic 3.5, p. 69.

# Track the four population flows

Use counts for the same population and time interval. Births and immigration add individuals; deaths and emigration remove them. A change in resource supply can affect more than one of these terms.

## 1. ACCOUNT FOR ALL FOUR FLOWS

$$\text{Population change} = (B + I) - (D + E)$$

B = births; I = immigration; D = deaths; E = emigration. Here each term is a count over one year, not a per-capita rate. Final population = initial population + change.

## 2. COMPARE TWO ALTERNATIVE YEARS

| Scenario | B | I | D | E | Change |
|---|---|---|---|---|---|
| Favorable resources | 80 | 20 | 45 | 15 | +40 |
| Resource shortage | 30 | 10 | 70 | 20 | -50 |

Invented scenarios, each starting with 500 individuals. They are alternatives, not two consecutive years.

## 3. WORK THE FAVORABLE-RESOURCE EXAMPLE

**Change = (80 + 20) - (45 + 15) = 40 individuals**

**Final population = 500 + 40 = 540 individuals**

$$\frac{40}{500} \times 100 = 8\% \text{ increase over the year}$$

In the shortage scenario, the final count is 450. Lower births and higher deaths fit a resource-limitation explanation, but the numbers alone do not establish the cause. Evidence about food, habitat and movement strengthens the explanation.

Resource effects on growth: College Board, ERT-3.F.
Population change and limiting factors: OpenStax, Concepts of Biology 19.2.

Scope: College Board AP Environmental Science CED, Topic 3.5, p. 69.