Populations

AP Environmental Science

Generalist and Specialist Species

A **generalist** 广适性物种 can live in many habitats and eat many foods (raccoon, cockroach) – flexible, so it copes well with change. A **specialist** 狭适性物种 needs specific conditions or foods (panda, koala) – efficient in a stable habitat but very vulnerable if that habitat changes.

K-Selected and r-Selected Species

Two reproductive strategies:

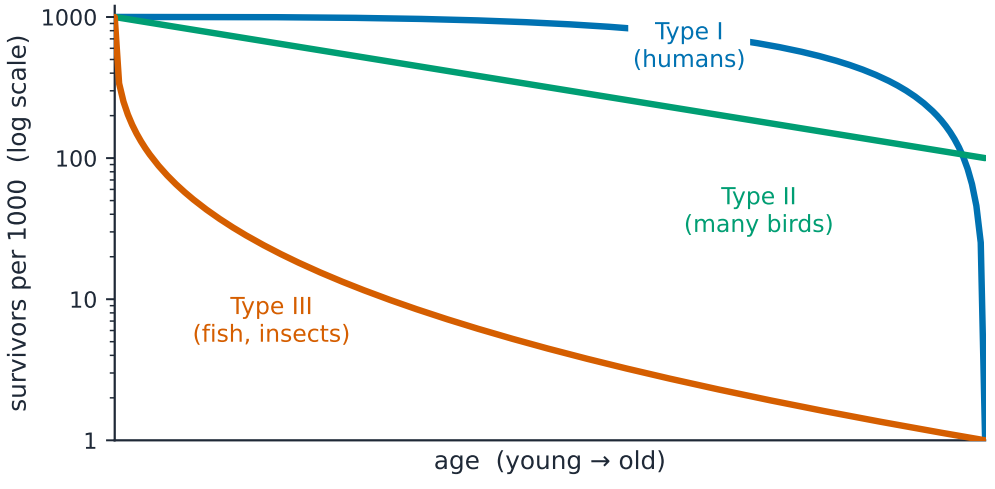
- ***r*-selected** species produce **many** offspring with little care, mature fast, and have short lives (insects, weeds). They colonize quickly and boom-and-bust.
- ***K*-selected** species produce **few** offspring with much care, mature slowly, and live long (elephants, humans). They do well near **carrying capacity** in stable environments but recover slowly from losses.

An elephant with its single calf: a K-selected species has few young but invests heavily in each one, so it recovers slowly if numbers fall

A young rabbit: r-selected species produce many offspring quickly with little parental investment

Survivorship Curves

A **survivorship curve** 存活曲线 plots how many individuals survive at each age (on a log scale). **Type I** (humans): most survive to old age, then die – a convex curve. **Type II** (many birds): a constant death rate at all ages – a straight line. **Type III** (*r*-selected: fish, insects): most die young, a few survive – a concave curve.

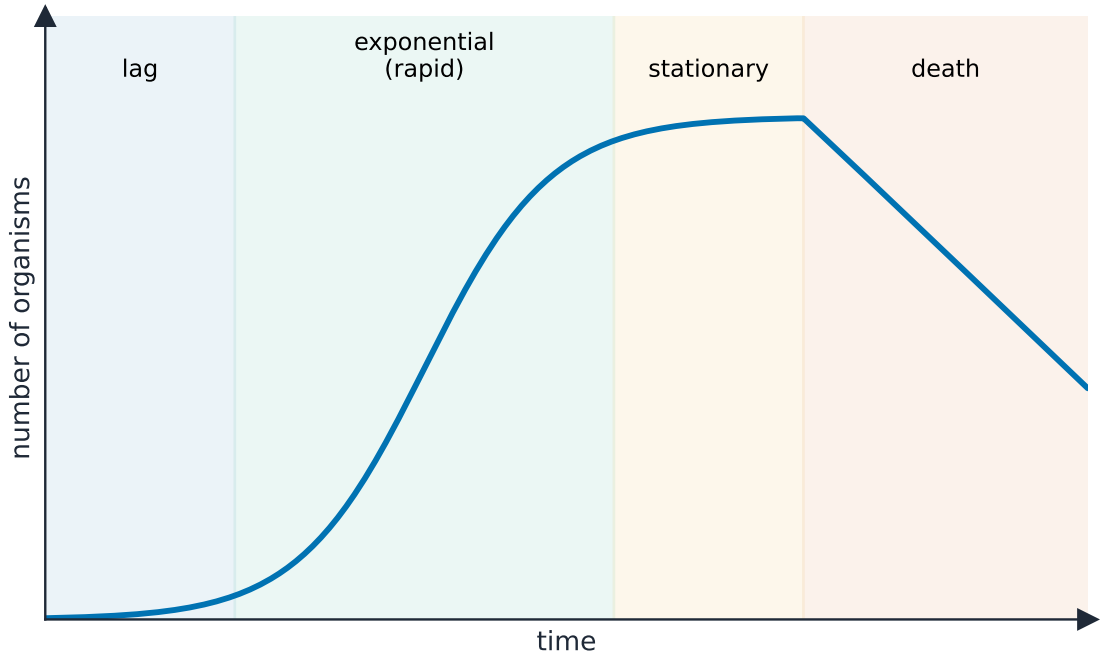


AP Environmental Science · U3 · Type I/II/III survivorship curves

Type I, II, and III survivorship curves on a log scale

Carrying Capacity

The **carrying capacity** 环境容纳量 (K) is the maximum population an environment can support long-term. A population may **overshoot** K when resources are temporarily plentiful, then **crash** (**dieback**) as resources run out. Populations tend to fluctuate around K.



Population growth levels off at the carrying capacity of the environment

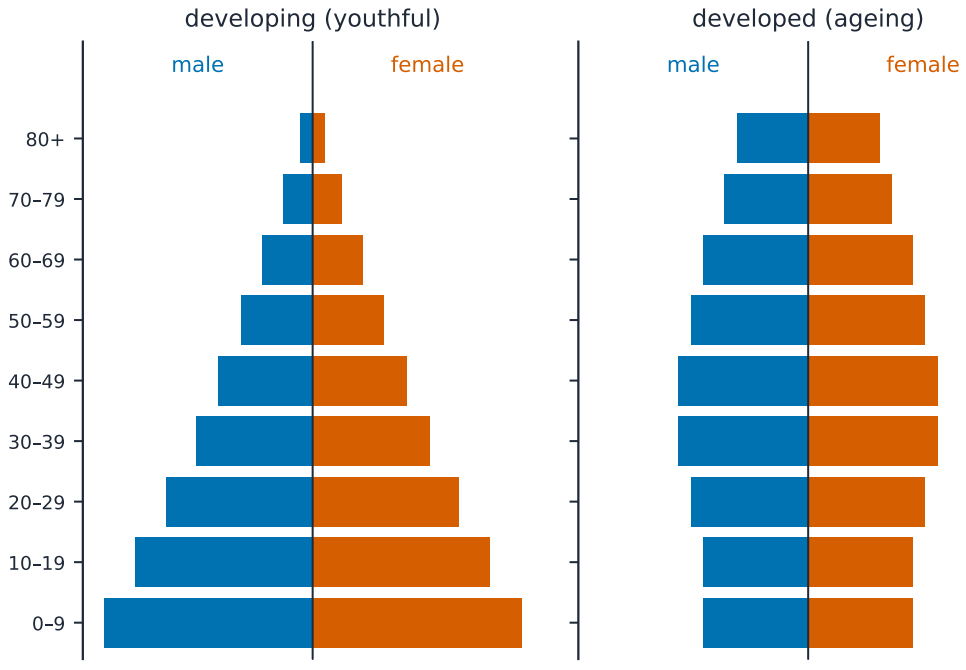
A deer herd: when a population approaches carrying capacity, resources limit further growth

Population Growth and Resource Availability

With abundant resources a population grows **exponentially** 指数增长 (J-curve). As resources become limited, growth slows to **logistic** 逻辑斯蒂增长 (S-curve), leveling at K. **Limiting factors** 限制因素 (food, water, space, disease) set the ceiling.

Age Structure Diagrams

An **age-structure diagram** 年龄结构图 shows the proportion of a population in each age group. A wide base (many young) predicts **rapid growth**; even bars predict a **stable** population; a narrow base predicts **decline**. They forecast a country's future population.



Population pyramids of a developing and a developed country

Total Fertility Rate

The **total fertility rate** 总生育率 (TFR) is the average number of children per woman. A **replacement level** of about **2.1** keeps a population steady; above it grows, below it shrinks. TFR falls with education, access to family planning, and lower infant mortality.

Human Population Dynamics

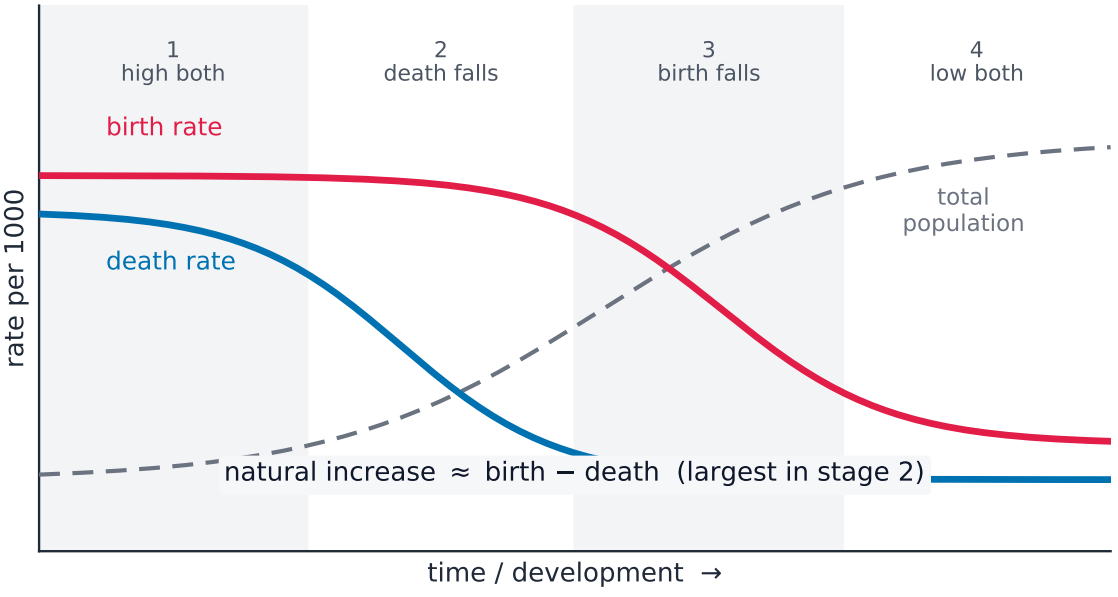
Human population growth depends on **birth rate**, **death rate**, and **migration**. Rapid growth strains resources and increases the **ecological footprint** 生态足迹. Factors lowering birth rates include education (especially of women), urbanization, and economic development.

Worked example. A country has a birth rate of 30 per 1000 and a death rate of 10 per 1000. The natural growth rate is $\dfrac{30 - 10}{10} = 2.0\%$ per year (dividing the per-thousand difference by 10 converts it to a percent). By the **rule of 70**, the population doubles in about $\dfrac{70}{2.0} = 35$ years. If development cut the growth rate to 1.0%, the doubling time would stretch to $\dfrac{70}{1.0} = 70$ years.

A crowded city crossing: human population dynamics depend on birth rates, death rates and migration

Demographic Transition

The **demographic transition** 人口转型 describes how a country's growth changes as it develops, in stages: (1) high birth and death rates (slow growth); (2) death rate falls (rapid growth); (3) birth rate falls (slowing growth); (4) both low (stable). Developed nations are in later stages; many developing nations are in the rapid-growth stages.



The four stages of the demographic transition

The population grows fastest in stages 2 and 3 – the gap between a still-high birth rate and an already-fallen death rate. That lag is why a country's population keeps climbing long after its death rate drops.

Exam tips

- Use the **rule of 70**: doubling time ≈ 70 ÷ growth-rate(%); a growth rate is (births − deaths) per 1000 ÷ 10.
- Read **age-structure diagrams**: a wide base predicts rapid growth, even bars a stable population.
- Contrast **r-selected** (many offspring, little care) and **K-selected** (few, much care) strategies.
- Know the **demographic transition** stages and what lowers birth rates (education, family planning, development).
- A falling **growth rate** still means growth — the population only shrinks when deaths exceed births.