Populations

AP Environmental Science ▪ Unit 3

AP Environmental Science

What we will cover

1. Generalists and specialists
2. r- and K-selection
3. Survivorship curves
4. Carrying capacity
5. Age structure
6. Fertility and the transition

Generalists, specialists, r and K

r-selected: many young, fast recovery

K-selected: few young, slow recovery

r fills disturbed places; *K* stays near capacity.

Survivorship curves

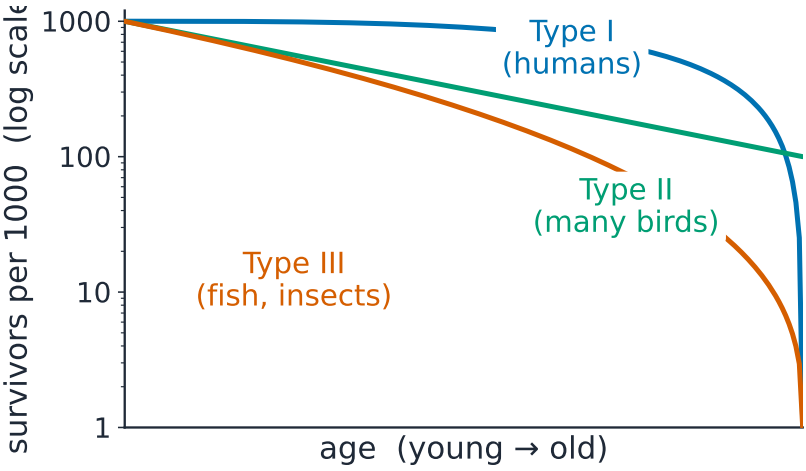
A **survivorship curve** 存活曲线 shows the fraction alive at each age:

- **Type I**: die old (humans)
- **Type II**: steady rate (birds)
- **Type III**: die young (oysters)

> Type III goes with *r*-selection; Type I with *K*-selection.

human pop density

Survivorship curves



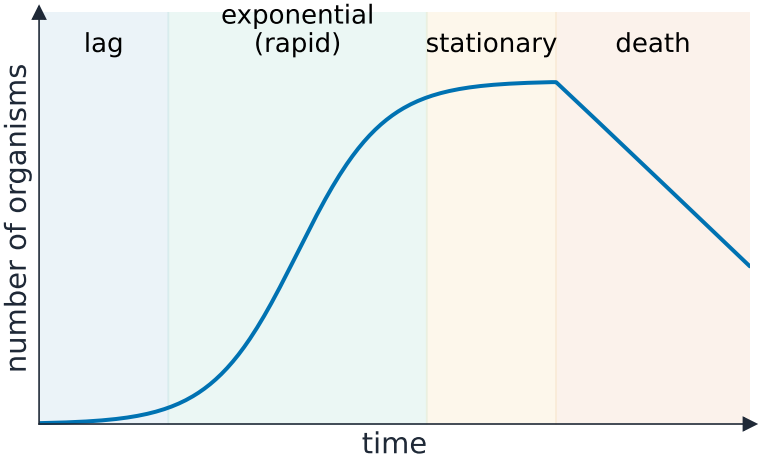
Carrying capacity

Carrying capacity 环境容纳量 K is the most an environment can support. Populations overshoot then die-off; limiting factors set K.

> J-curve $\rightarrow$ S-curve; K itself shifts with the weather.

Carrying capacity limits wildlife populations

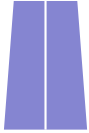
Carrying capacity



Age structure diagrams

The shape of an **age structure diagram** 年龄结构图 predicts the future:

Growing
wide base

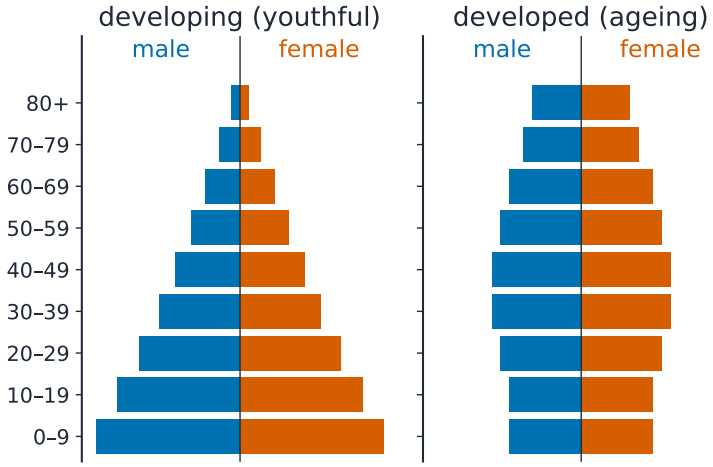


Stable
straight sides

Declining
narrow base

A big **pre-reproductive** 繁殖前期 group guarantees growth even if births fall today (population momentum).

Age structure diagrams

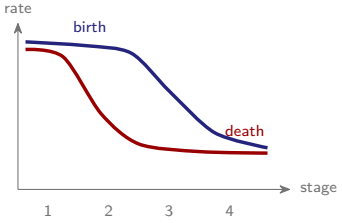


Fertility and the demographic transition

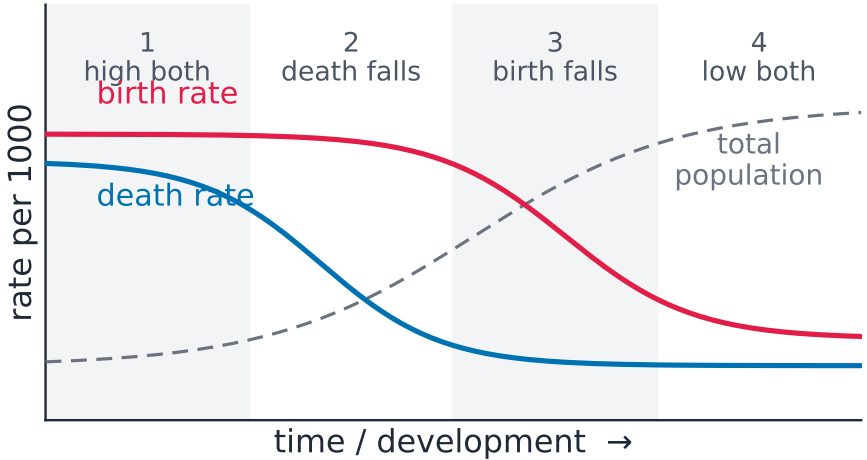
Total fertility rate 总和生育率 (TFR) is children per woman.

- **replacement** 更替水平生育率 ≈ 2.1
- doubling time (rule of 70): $t = \frac{70}{r}$

As a country industrializes, deaths fall first, then births – the **demographic transition** 人口转变.



Fertility and the demographic transition



Worked example – the rule of 70

A country's population grows at 2% per year. Find its doubling time, and the growth rate that would halve it.

- Rule of 70: doubling time $= \dfrac{70}{\%\text{ growth rate}}$
- $= \dfrac{70}{2} = 35$ years
- To halve the doubling time to 17.5 years you would need $70/17.5 = 4\%$.
- Growth is exponential: a small rate change moves the doubling time a long way.

Doubling time $= 70/r$ works for anything growing exponentially – population, GDP, energy use. Put r in as a percent, not a decimal.

Unit 3 – key takeaways

1 Strategies

generalist vs specialist; r (many young) vs K (few)

2 Survivorship

Type I late death, II steady, III early death

3 Capacity

K; overshoot then die-off; J-curve to S-curve

4 Human pop.

age structure shape; TFR ≈ 2.1; the transition

Check yourself

1. Is a panda a generalist or a specialist?
2. Which survivorship type fits an oyster?
3. What TFR keeps a population steady?
4. At $r = 2\%$, what is the doubling time?

Answers **1.** specialist **2.** Type III **3.** about 2.1 **4.** $70/2 = 35$ years