

Populations

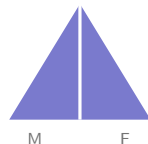
AP Environmental Science ■ Unit 3

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.

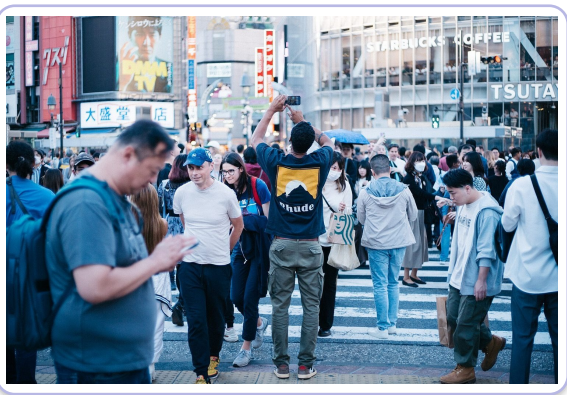


Survivorship curves

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

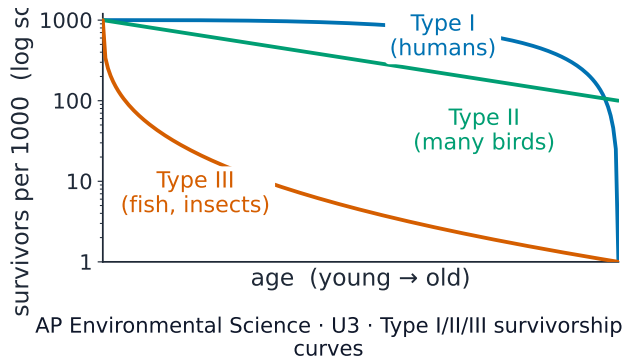
- **Type I:** die old (humans)
- **Type II:** steady rate (birds)
- **Type III:** die young (oysters)

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



Human pop density

Type I, II, and III survivorship curves



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



Carrying capacity

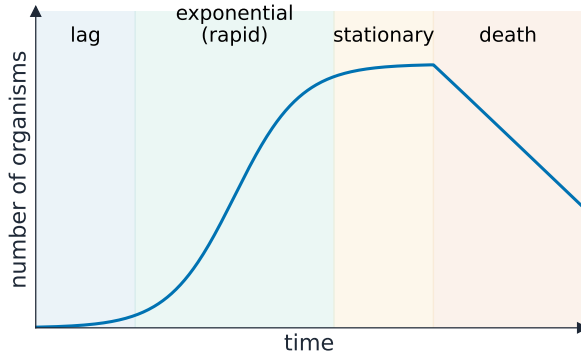
Carrying capacity K is the most an environment can support. Populations overshoot then die-off; limiting factors set K .

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



Carrying capacity limits wildlife populations

Population growth levels off at the carrying



Population growth levels off at the carrying capacity of the environment

Carrying capacity, and what happens past it

carrying capacity

K – the maximum population an environment can support long-term

approaching K

growth slows as resources per individual fall – the logistic curve flattens

overshoot

a population may exceed K when resources are temporarily abundant

then a die-off

the excess cannot be supported, and numbers crash – sometimes below K

what sets K

the scarcest resource: food, water, nesting sites, or space

and it moves

K is not a constant – a wet year or a new technology raises it

K is a property of the environment, not of the species. That is why a habitat's degradation lowers it even when the population has not changed.

Population Growth and Resource Availability

With abundant resources a population grows **exponentially** (J -curve).

As resources become limited, growth slows to **logistic** (S -curve), leveling at K .



Age structure diagrams

The shape of an **age structure diagram** predicts the future:



Growing

wide base



Stable

straight sides

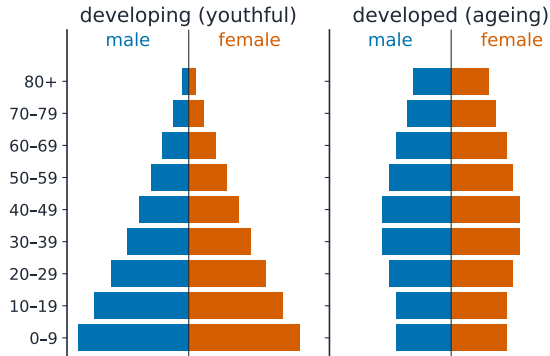


Declining

narrow base

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

Population pyramids of a developing and a developed country



Population pyramids of a developing and a developed country



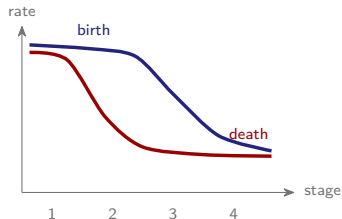
Fertility and the demographic transition

Total fertility rate (TFR) is children per woman.

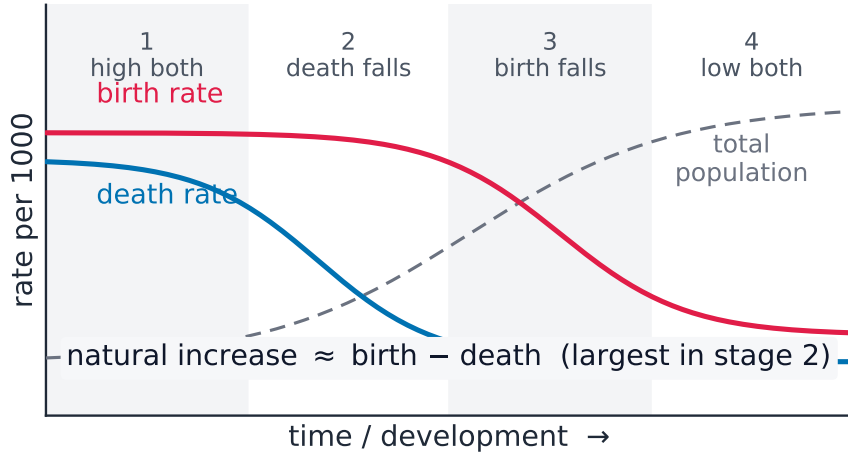
- **replacement** ≈ 2.1
- doubling time (rule of 70):

$$t = \frac{70}{r}$$

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



The four stages of the demographic transition



The four stages of the demographic transition

Human Population Dynamics

Human population growth depends on **birth rate**, **death rate**, and **migration**.

Rapid growth strains resources and increases the **ecological footprint** .

Exam tips

- Use the **rule of 70**: doubling time $\approx 70 \div \text{growth-rate}(\%)$; a growth rate is (births — deaths) per 1000 $\div 10$.
- 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.

Generalist and Specialist Species

A **generalist** can live in many habitats and eat many foods (raccoon, cockroach) – flexible, so it copes well with change.

A **specialist** 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

- **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).



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
$$= \frac{70}{\% \text{ growth rate}}$$
- $= \frac{70}{2} = 35 \text{ years}$
- 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