CH 36: Population ecology

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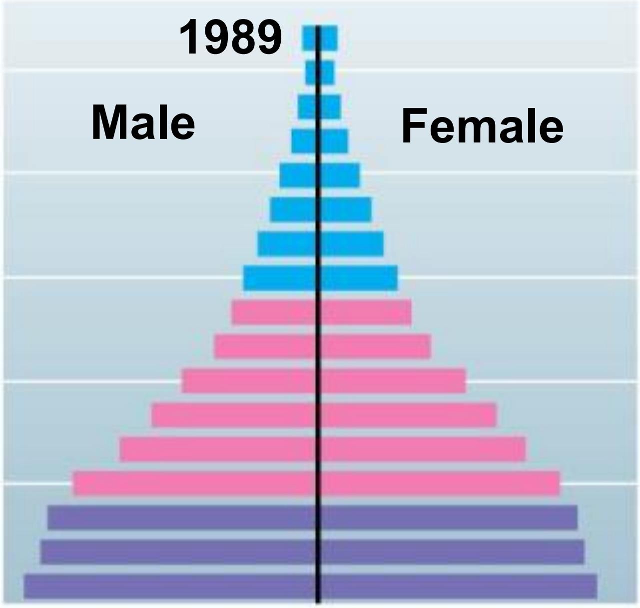
Chapter 36: Big Ideas

Population Structure and Dynamics



The Human Population

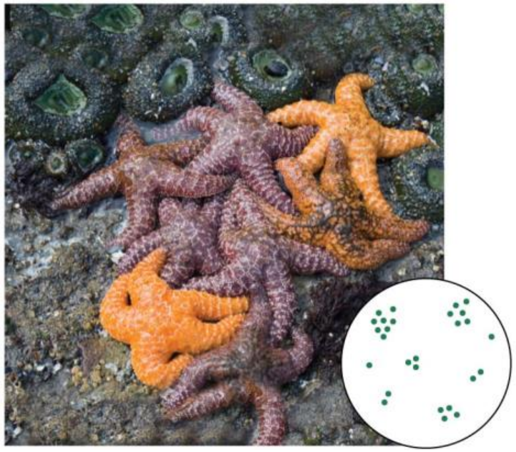
POPULATION STRUCTURE AND DYNAMICS

36.1 Population ecology is the study of how and why populations change

- A **population** is a group of individuals of a single species that occupy the same general area.
- **Population ecology** is concerned with
  - the changes in population size and
  - factors that regulate populations over time.

36.2 Density and dispersion patterns are important population variables

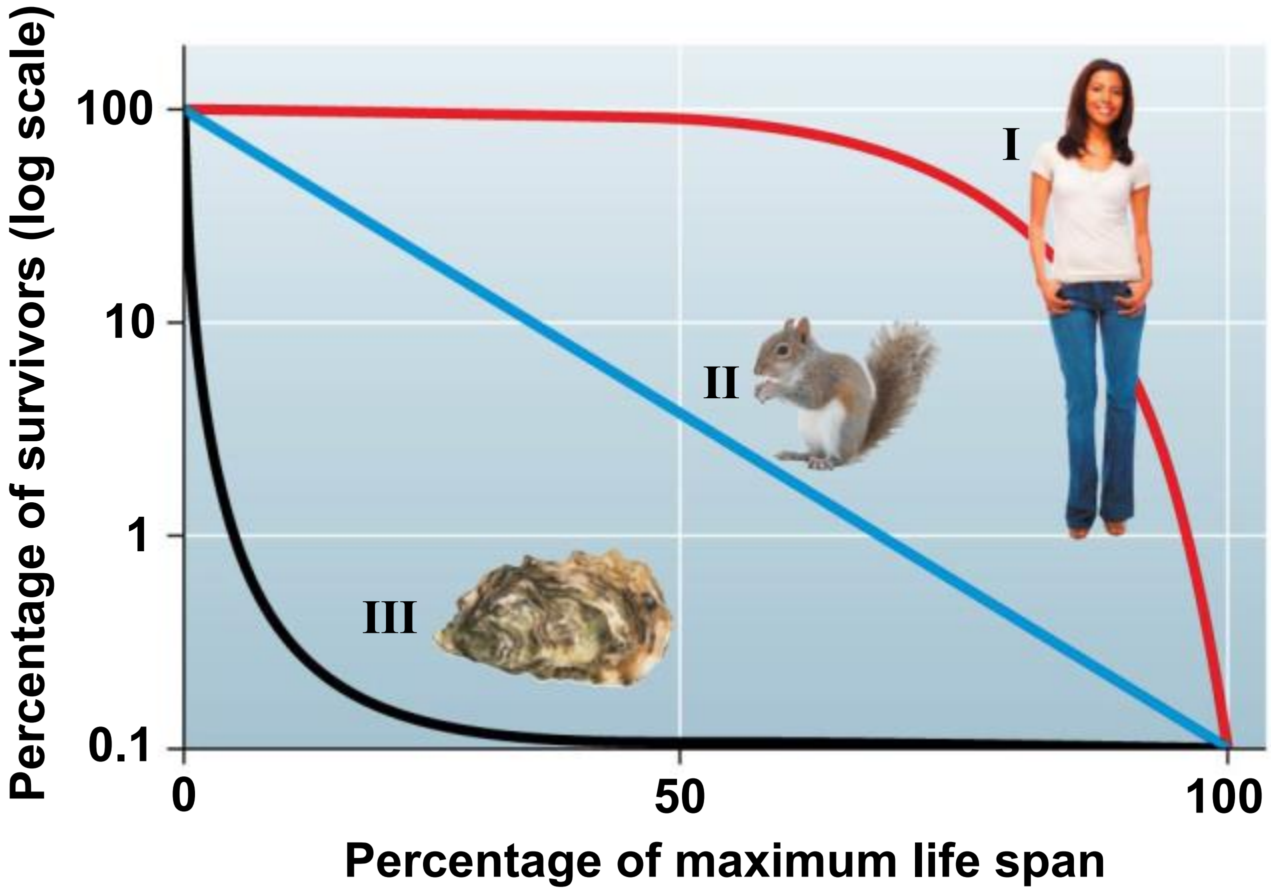
- The **dispersion pattern** of a population refers to the way individuals are spaced within their area.
  - **clumped dispersion pattern**
  - **uniform dispersion pattern**
  - **random dispersion pattern**



36.3 Life tables track survivorship in populations

- **Survivorship curves** plot survivorship as the proportion of individuals from an initial population that are alive at each age.
- There are three main types of survivorship curves.
  - Type I
  - Type II
  - Type III

Figure 36.3b


Percentage of survivors (log scale)
100
10
1
0.1
0
50
100
Percentage of maximum life span
I
II
III

36.4 Idealized models predict patterns of population growth

- The rate of population increase under *ideal conditions* is called exponential growth. It can be calculated using the **exponential growth model** equation, $G = rN$, in which
  - G is the growth rate of the population,
  - N is the population size, and
  - r is the **per capita rate of increase** (the average contribution of each individual to population growth).
    - https://en.wikipedia.org/wiki/Exponential_growth#/media/File:E.coli-colony-growth.gif

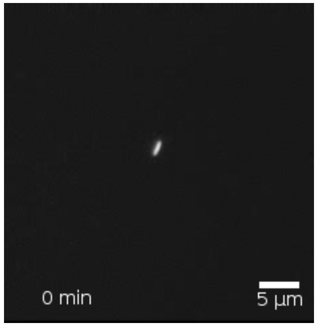
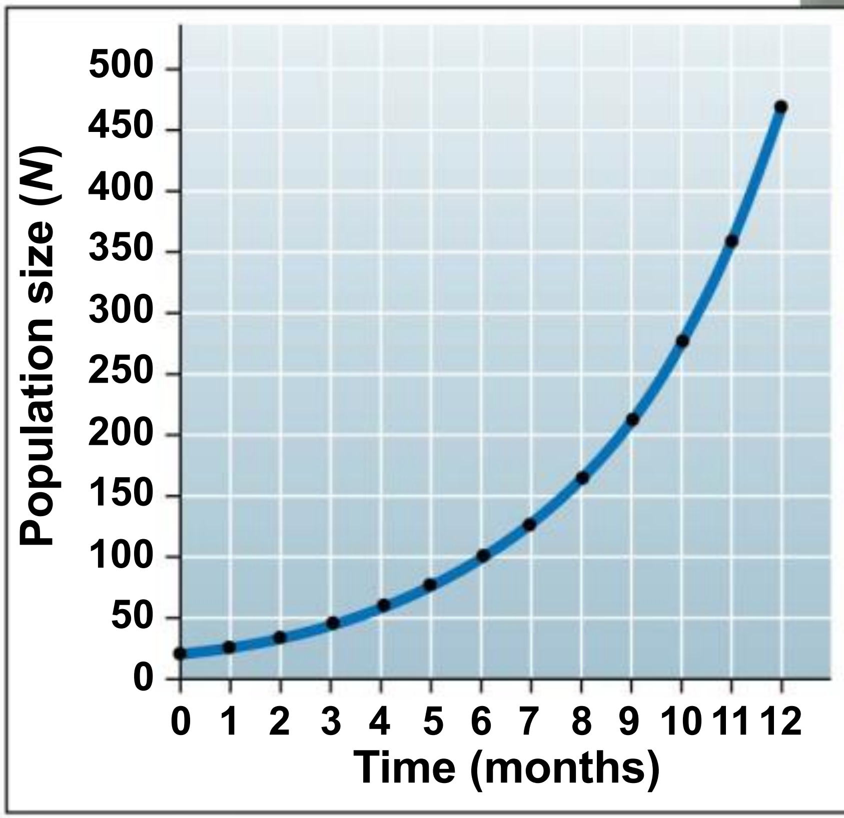


Figure 36.4a-0



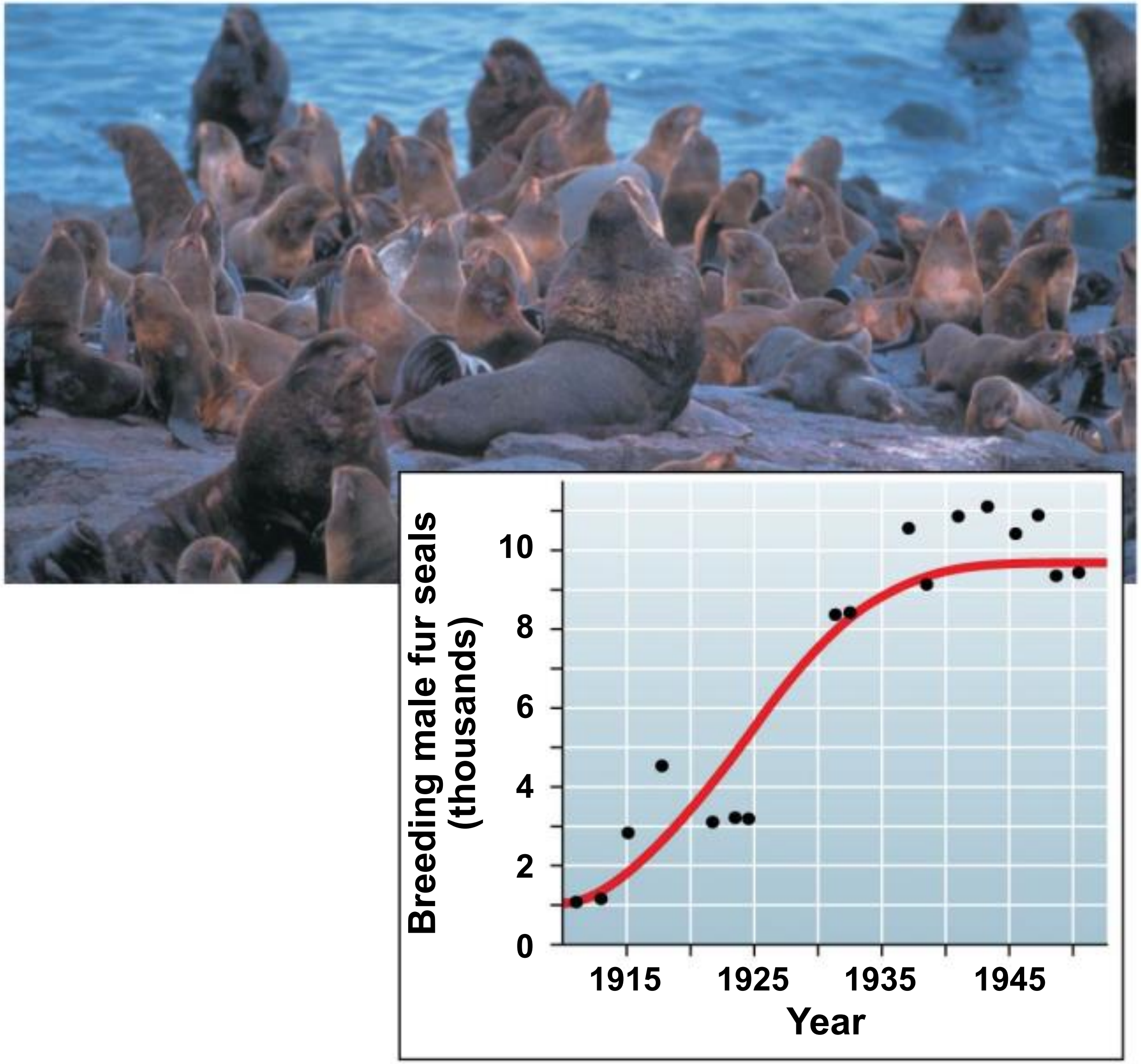
36.4 Idealized models predict patterns of population growth

- **Limiting factors** will restrict population growth.
- The **logistic growth model** is a description of idealized population growth that is slowed by limiting factors as the population size increases.
- *K* stands for **carrying capacity**, the maximum population size a particular environment can sustain.

$$G = rN\frac{(K - N)}{K}$$

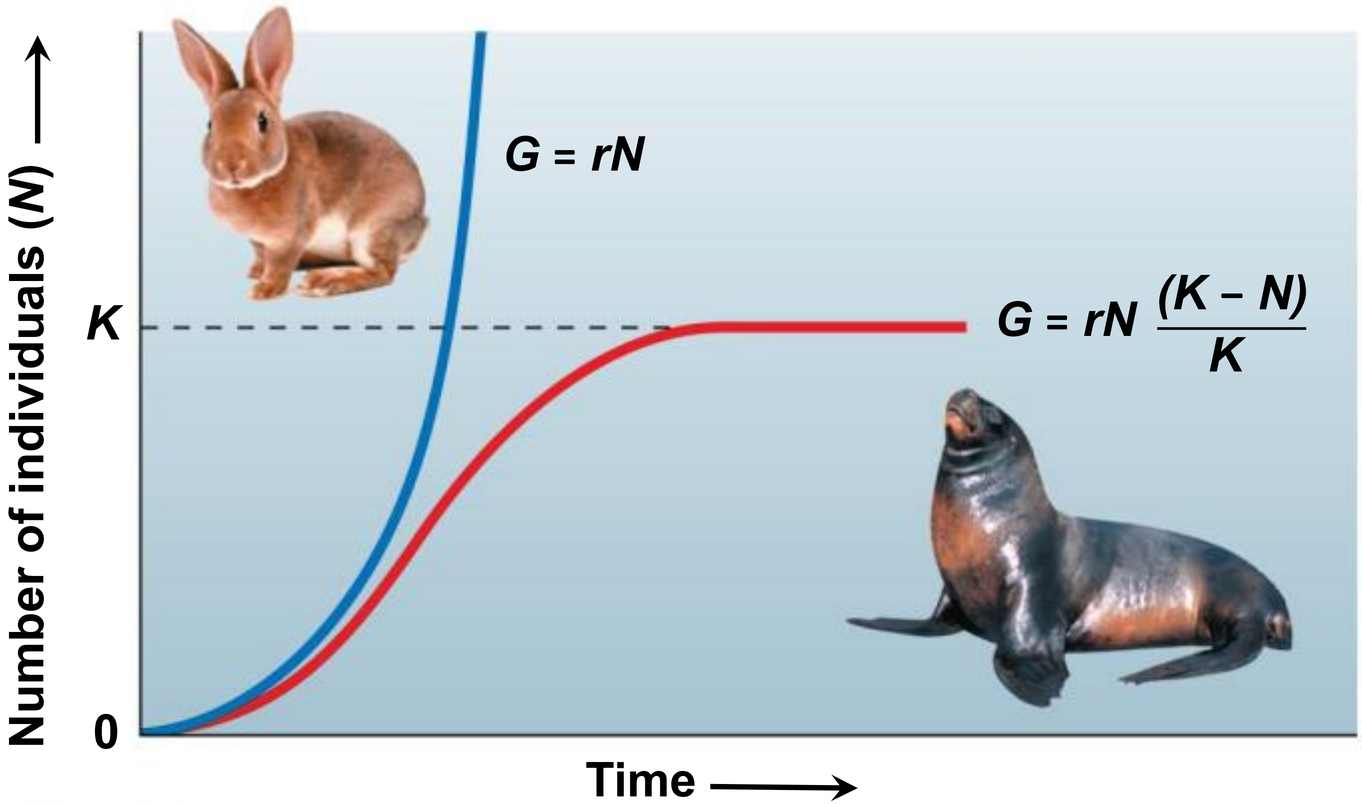
- When does the growth rate G equal zero ?
- When K >>>>>>>>>> N ?

Figure 36.4b-0



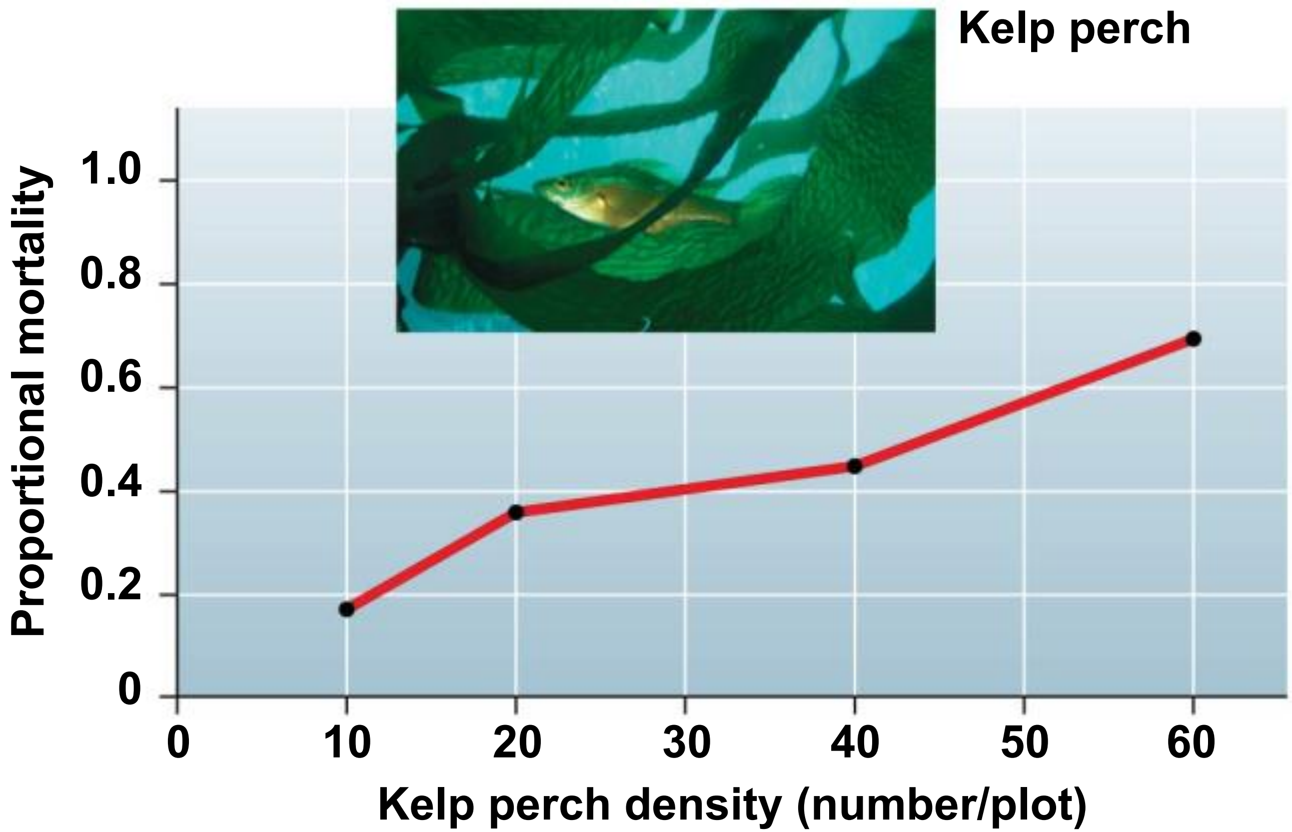
Data from K. W. Kenyon et al., A population study of the Alaska fur-seal herd, *Federal Government Series: Special Scientific Report—Wildlife* 12 (1954).

Figure 36.4c



36.5 Multiple factors may limit population growth

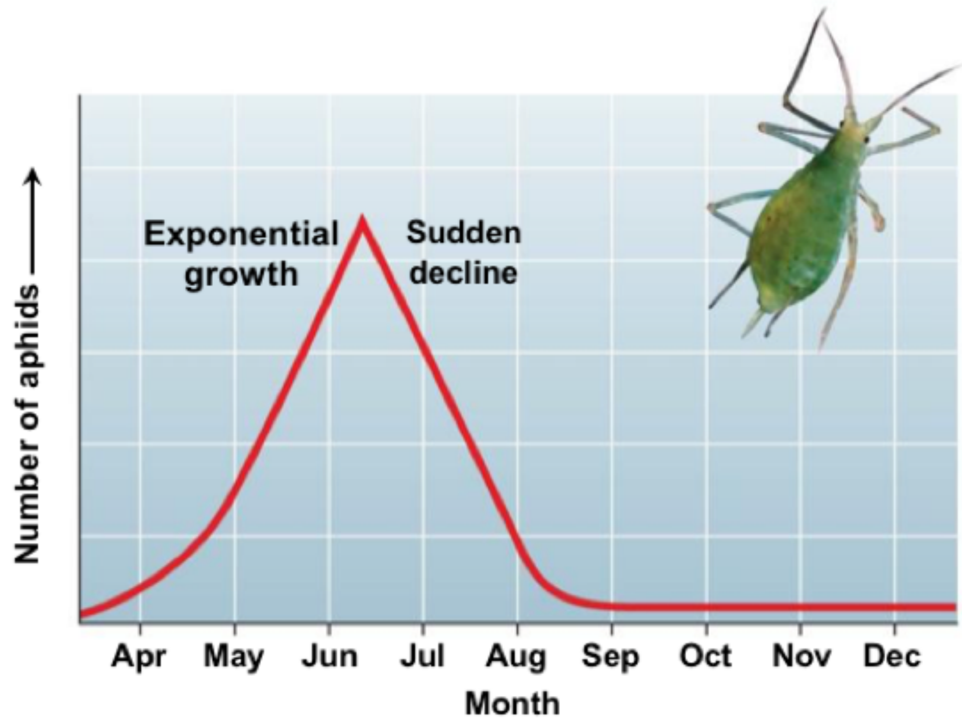
- **Intraspecific competition**



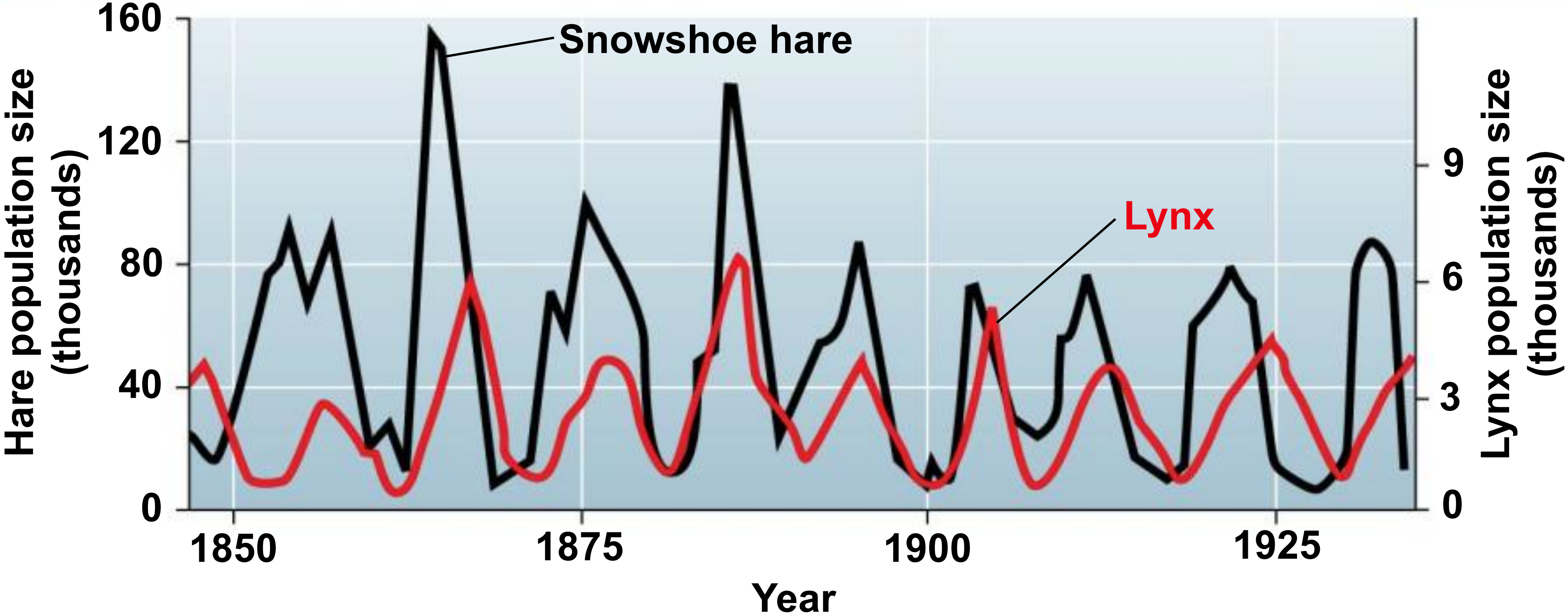
Data from T. W. Anderson, Predator Responses, Prey Refuges, and Density-Dependent Mortality of a Marine Fish, *Ecology* 82: 245–257 (2001).

36.5 Multiple factors may limit population growth

- Abiotic factors such as weather may affect population size well before density-dependent factors become important.



36.6 “boom-and-bust” cycles



Data from C. Elton and M. Nicholson, The ten-year cycle in numbers of the lynx in Canada, *Journal of Animal Ecology* 11 : 215–244 (1942).

36.6 SCIENTIFIC THINKING: Some populations have “boom-and-bust” cycles

- But what causes the boom-and-bust cycles of snowshoe hares?
  - One hypothesis proposed that when hares are abundant, they overgraze their winter food supply, resulting in high mortality.
  - Another hypothesis attributed hare population cycles to excessive predation.

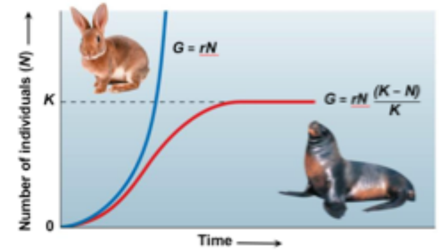
36.6 SCIENTIFIC THINKING: Some populations have "boom-and-bust" cycles

- Using radio collars to track individual hares, researchers determined that
  - 90% of hares had been killed by predators, and
  - none had died of starvation.
- These results support the predation hypothesis.
- However, further experiments showed that although fluctuating food availability is not the primary factor controlling hare population cycles, it does play an important role.

36.7 EVOLUTION CONNECTION: Evolution shapes life histories

- The traits that affect an organism’s schedule of reproduction and death make up its **life history**.
- Key life history traits include
  - age of first reproduction,
  - frequency of reproduction,
  - number of offspring, and
  - amount of parental care.
- Taiwan: 1950’s vs. 2010’s

36.7 EVOLUTION CONNECTION: Evolution shapes life histories



- ***r*-selected** life history traits
  - grow rapidly in unpredictable environments, where resources are abundant,
  - have a large number of offspring that develop and reach sexual maturity rapidly, and
  - offer little or no parental care.
- ***K*-selected** traits
  - long-lived animals (such as bears and elephants) that develop slowly and produce few, but well-cared-for, offspring and
  - maintain relatively stable populations near carrying capacity.
- Most species fall between these two extremes.
- *r*-selected species have NO carrying capacity?

36.7 Can life history evolve?

- A long-term project in Trinidad
  - studied guppy populations,
  - provided direct evidence that life history traits can be shaped by natural selection, and
  - demonstrated that questions about evolution can be tested by field experiments.

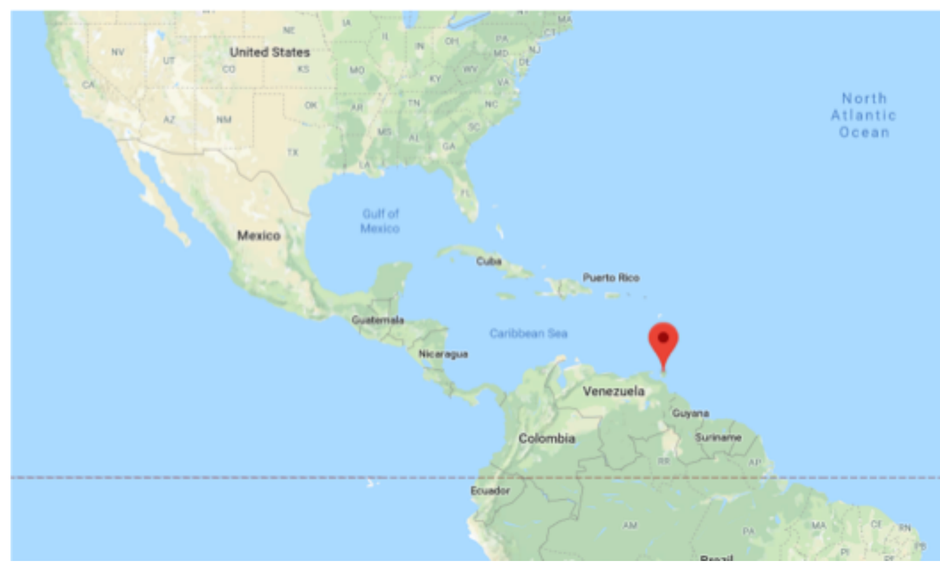
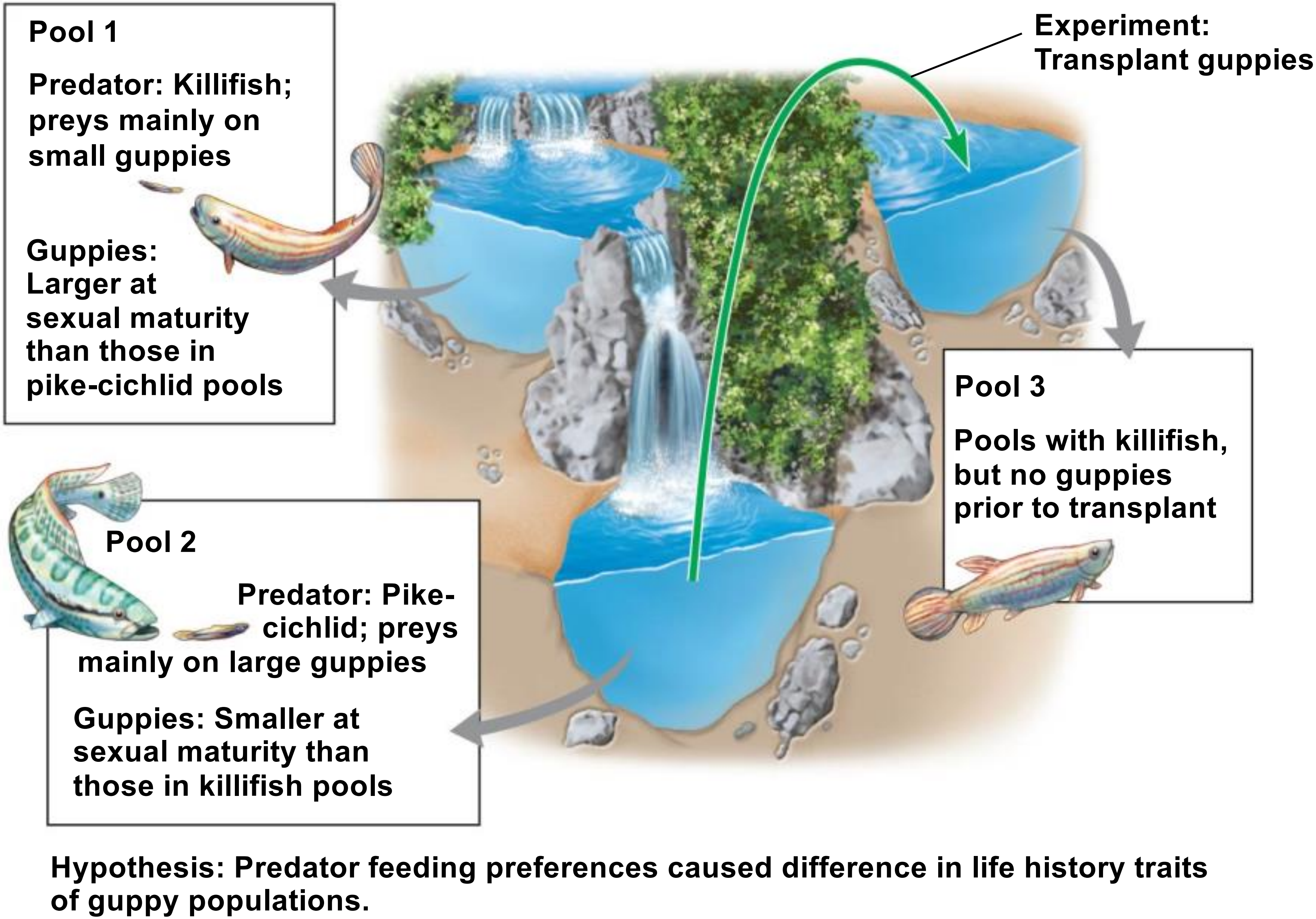
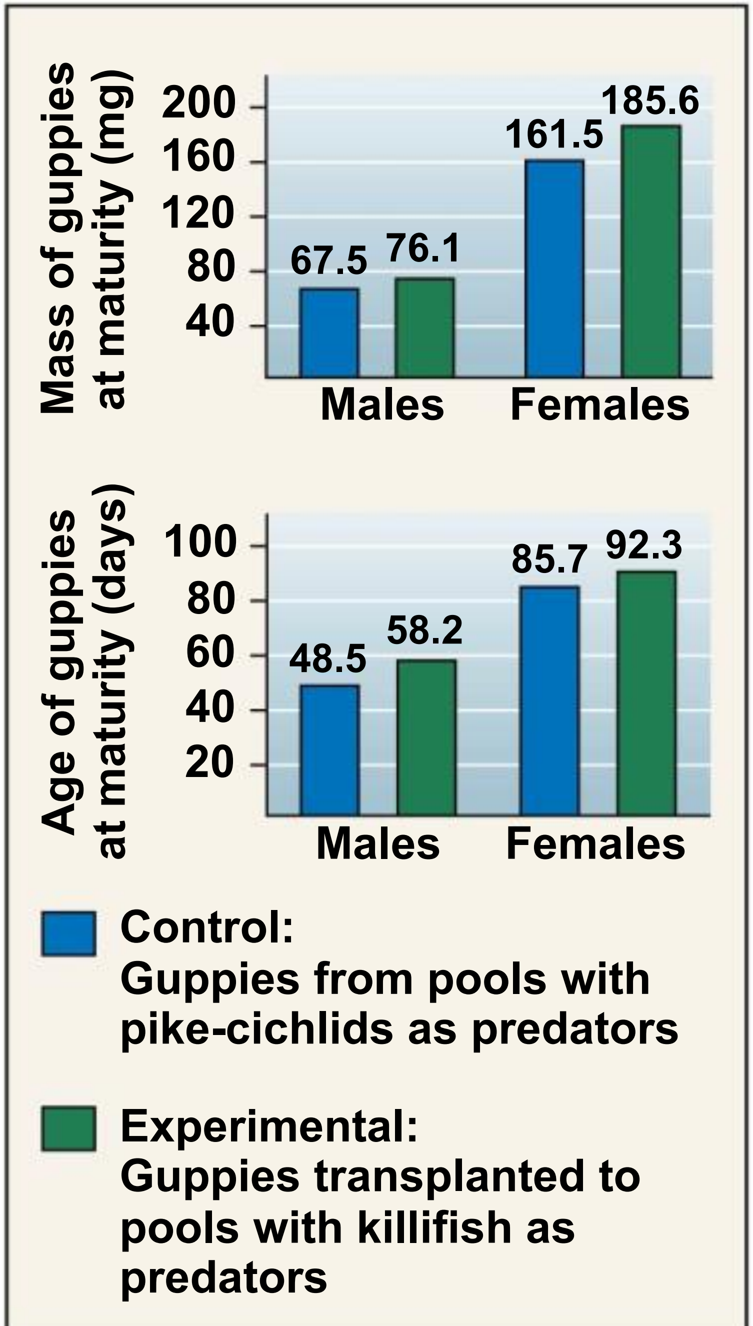


Figure 36.7-1



Data from D. N. Reznick and H. Bryga, Life-History Evolution in Guppies (*Poecilia reticulata*): 1. Phenotypic and genetic changes in an introduction experiment, *Evolution* 41: 1370–1385 (1987).

Figure 36.7-2

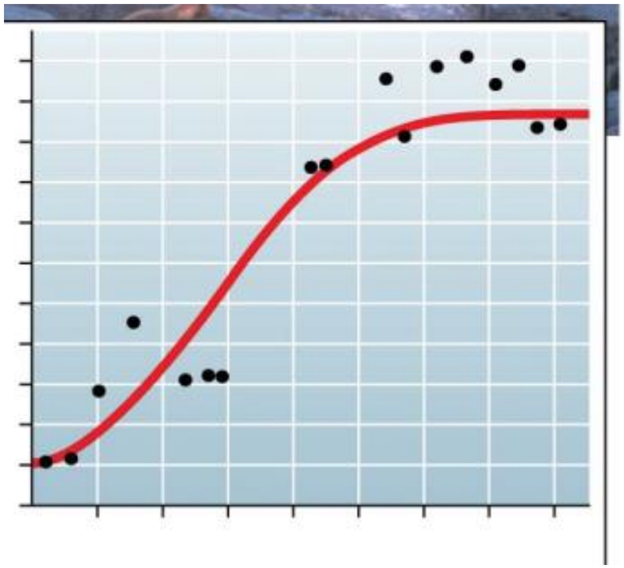


Eat larger guppies

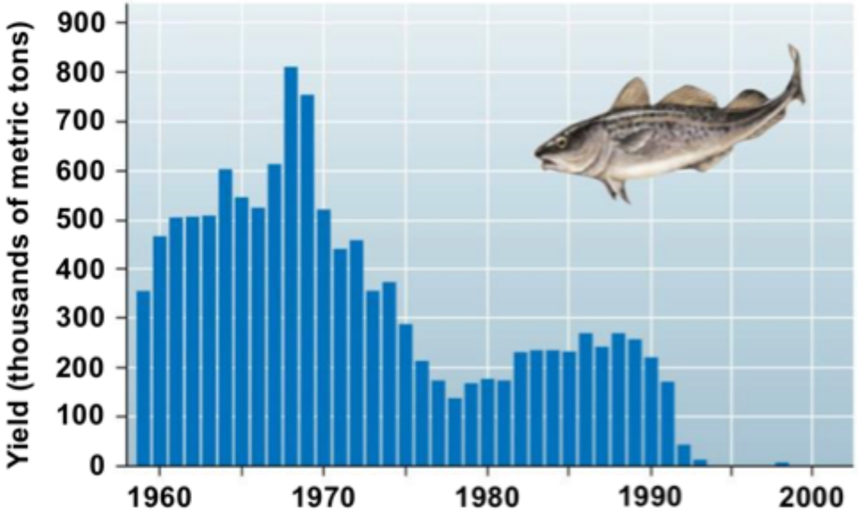
Eat smaller guppies

36.8 CONNECTION: Principles of population ecology have practical applications

- **Sustainable resource management** involves harvesting without damaging the resource.
- In terms of population growth, this means maintaining a high population growth rate to replenish the population.
- According to the logistic growth model, the fastest growth rate: when the population size is at half the carrying capacity.



36.8 CONNECTION: Principles of population ecology have practical applications



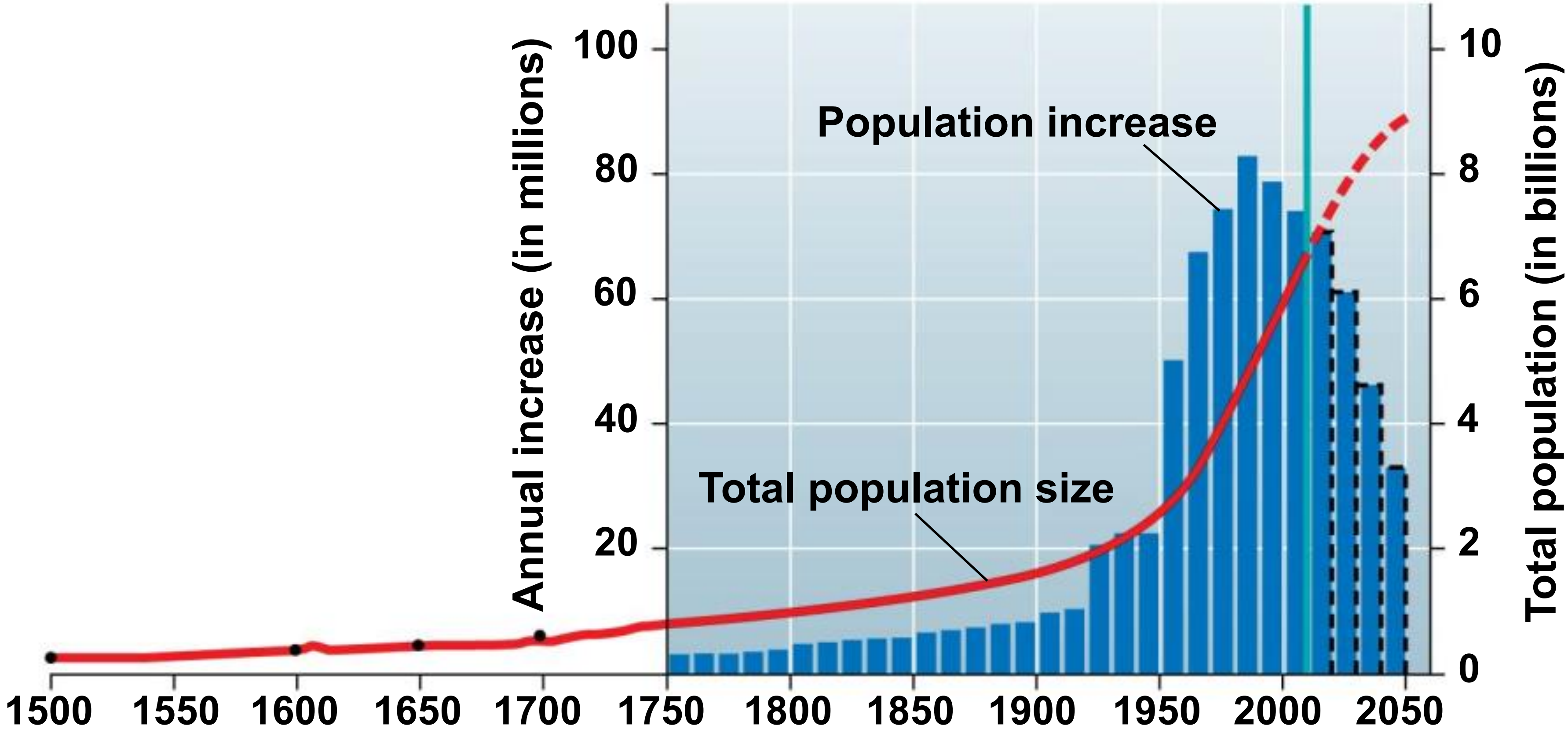
Data from Stock Assessment of Northern (2J3KL) Cod, *Science Advisory Report* 2011/041, Fisheries and Oceans Canada (2011).

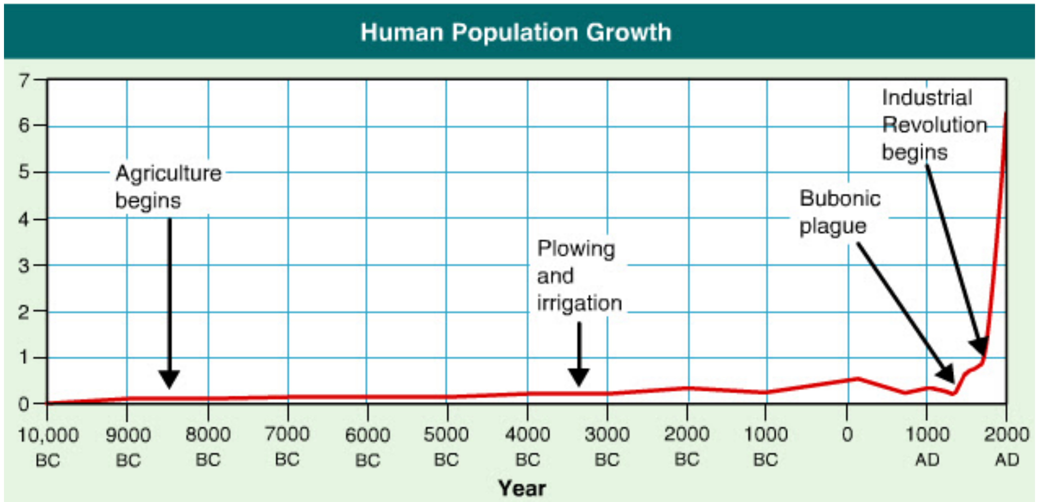
- The northern Atlantic cod
  - was overfished,
  - collapsed in 1992, and
  - still has not recovered.
- Resource managers may try to
  - provide additional habitat or
  - improve the quality of existing habitat to raise the carrying capacity and thus increase population growth.
  - https://www.youtube.com/watch?v=xWfqZggtM_w

- https://www.qsrmagazine.com/news/history-filet-o-fish
- “Since 1962, the Filet-O-Fish hasn’t changed much. … McDonald’s has used other varieties of fish, such as halibut and cod, but now uses wild-caught, sustainable Alaskan pollock.”
- Pollock: 黃線狹鱈 or 明太魚: 明太子

The Human Population

Figure 36.9a

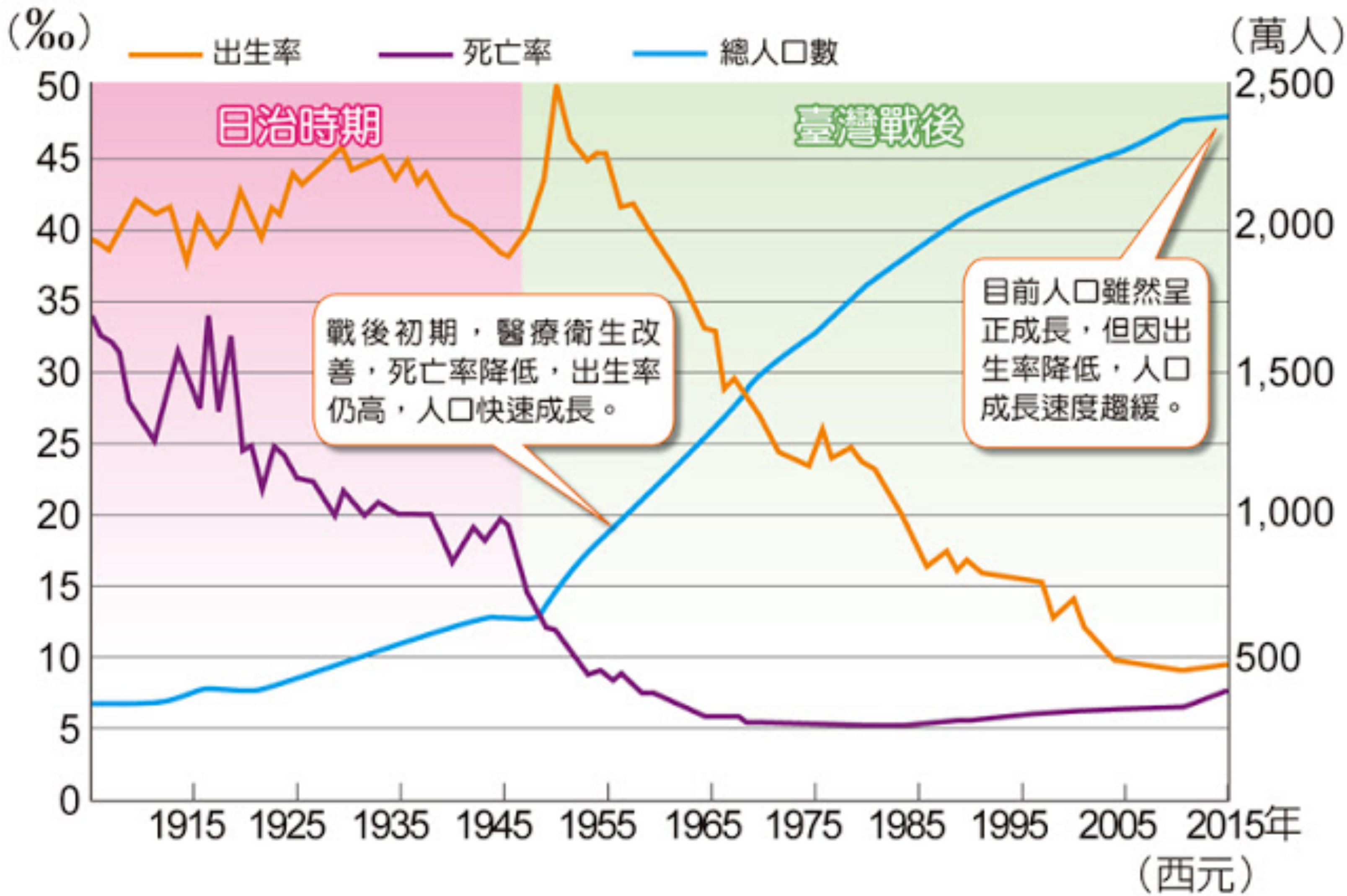




https://socratic.org/questions/throughout-most-of-human-history-did-human-population-size-skyrocket-remain-at-c

36.9 The human population continues to increase, but the growth rate is slowing

- The **demographic transition** is a shift from zero population growth, in which birth rates and death rates are high but roughly equal, to zero population growth, characterized by low but roughly equal birth and death rates.



http://lovegeo.blogspot.tw/2017/12/l1.html