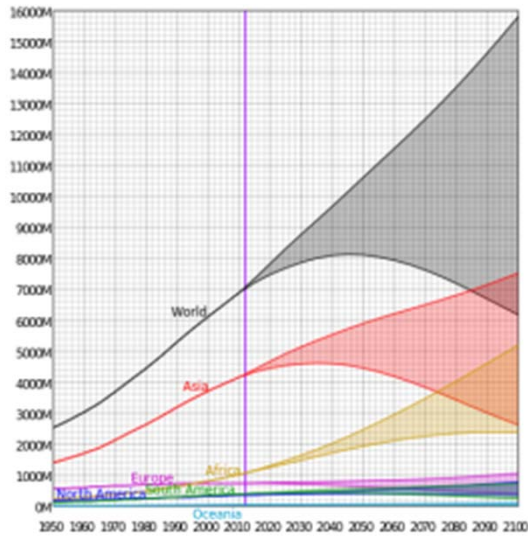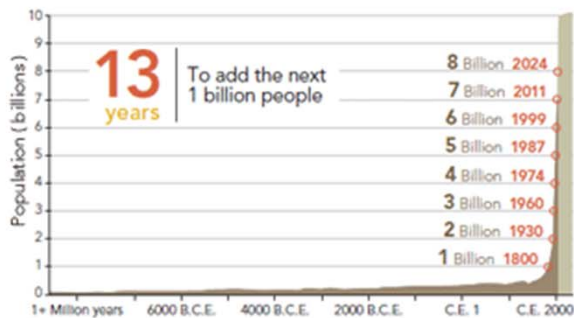# Population Growth: Carrying Capacity

Population growth rate and projections

Historic and Projected Population Growth

13 years To add the next 1 billion people

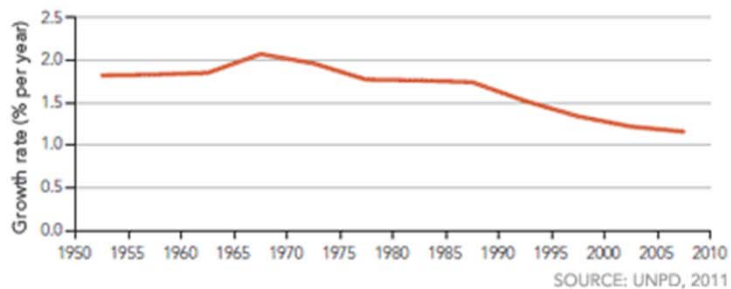|	
8 Billion	2024
7 Billion	2011
6 Billion	1999
5 Billion	1987
4 Billion	1974
3 Billion	1960
2 Billion	1930
1 Billion	1800

SOURCES: CARL HAUB, POPULATION REFERENCE BUREAU (PRB), 2010; U.N. POPULATION DIVISION (UNPD), 2011

World Population Growth, 1950–2050 (medium variant)

9.3 Billion

India
China
Africa
Other less developed countries
More developed countries
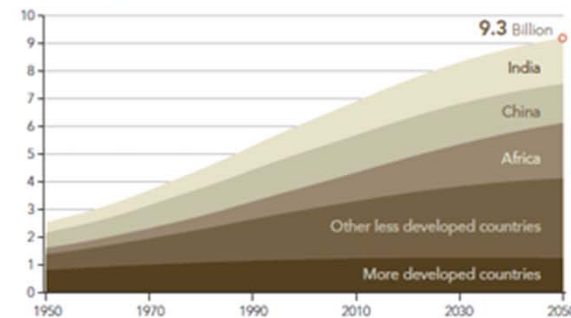
SOURCE: UNPD, 2011

Population Growth Rate, 1950–2010

Tipping point. The period of most rapid population growth is behind us. Since its peak in 1965–70, the growth rate has declined, falling roughly by half in 40 years as women have had fewer children.

SOURCE: UNPD, 2011

… but what if not enough resources?

- "Carrying Capacity" (K)- the total number of individuals that can be supported within a population

- How stop population growth at K?
  - Decrease birth rate
   - Doesn't happen
  - Increase death rate
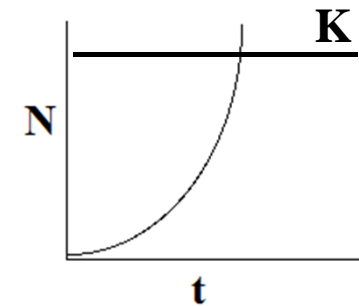
… but what if not enough resources?

- "Carrying Capacity" (K)- the total number of individuals that can be supported within a population (determined by environment)

- How stop population growth at K?
  - Decrease birth rate
   - Doesn't happen
  - Increase death rate
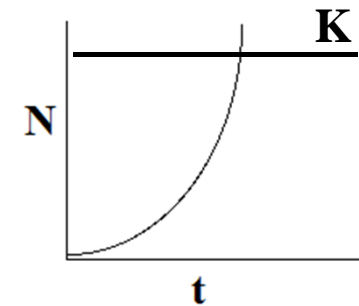
Human population growth impact...

- World population: >7 billion

- Most of growth increase is from medicine

- Technology has compensated and prevented/alleviated mass famines
  - But how long will it last???
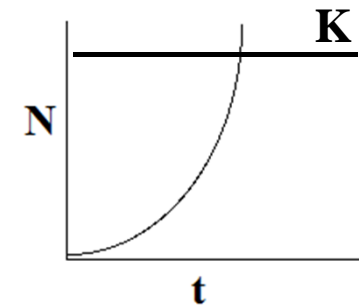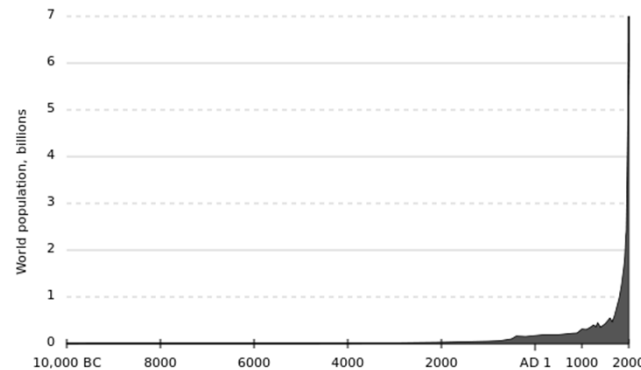
Why haven't we starved yet???

- **SO FAR**, food production increases faster than population increases
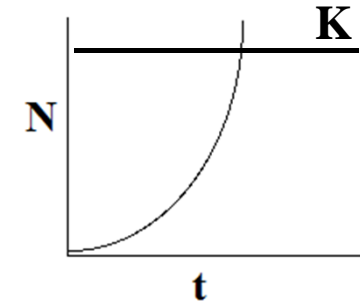   - Population increased ~2x
    - Food increased ~3x
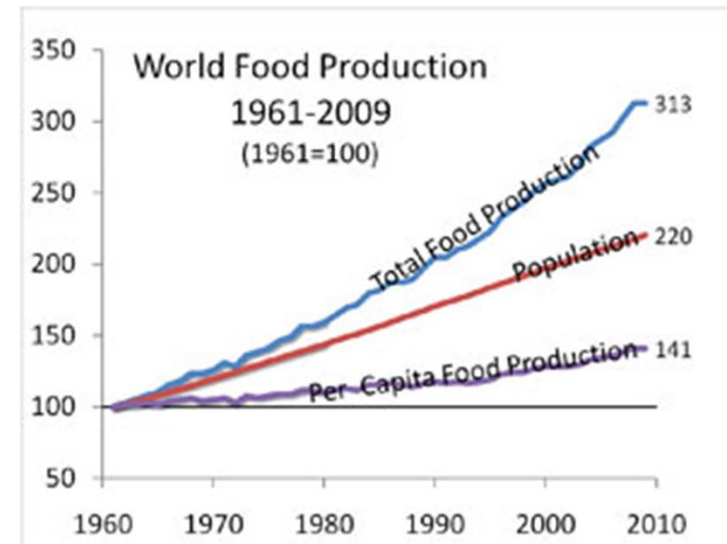
Problem to try:

$N_t = N_0 e^{rt}$, where N_t is the population at time t

N_0 is the population at time 0
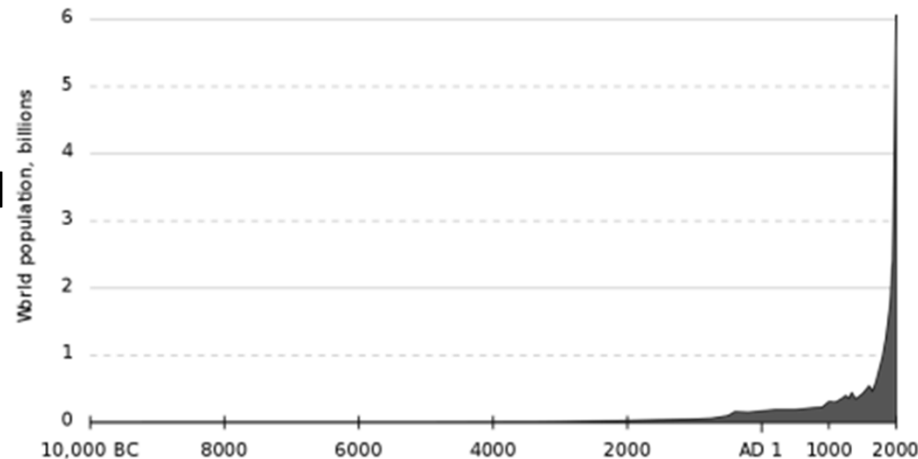
t = time *in years*, r = rate of increase

Current world population: 7 billion

Possible maximum "carrying capacity": 20 billion

r = 0.012

How many years 'til massive deaths?

Problem to try:
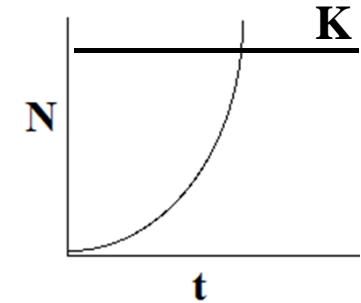
$$N_t = N_0 e^{rt}$$
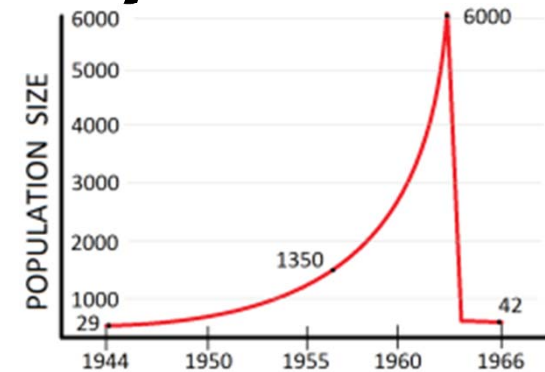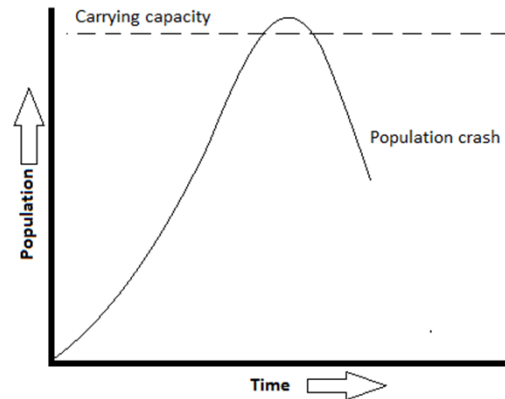
N_t = 20 billion

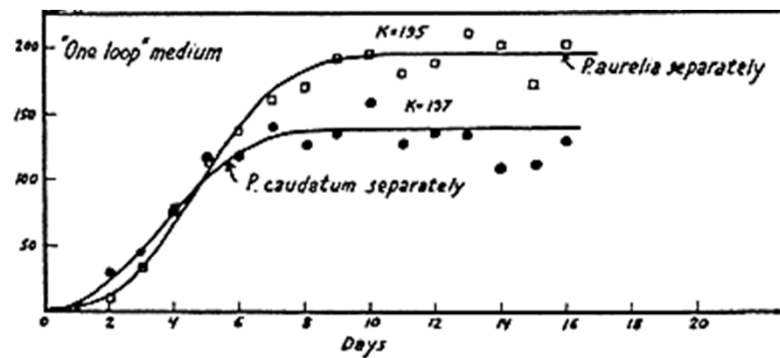N_0 = 7 billion

r = 0.012

20 billion = 7 billion $e^{0.012\,t}$

What happens when we exceed carrying capacity?

- **May see crash**

- **May see "leveling off"**

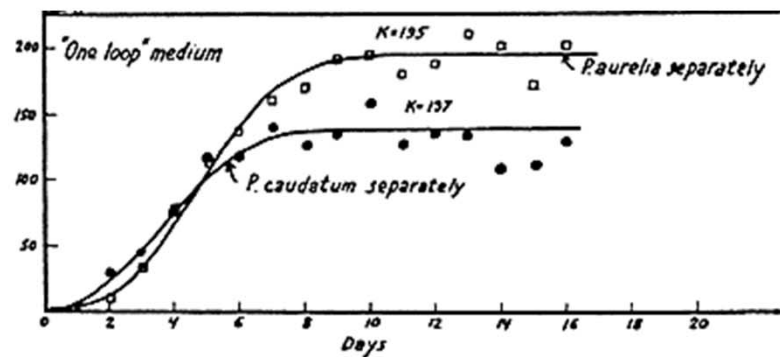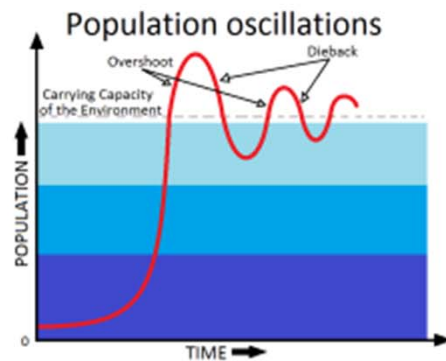

Assumed population of the St. Matthew Island reindeer herd. Actual counts are indicated on the population curve.
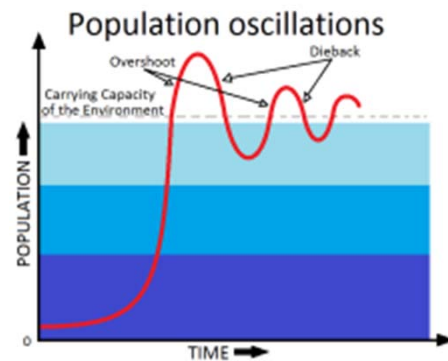
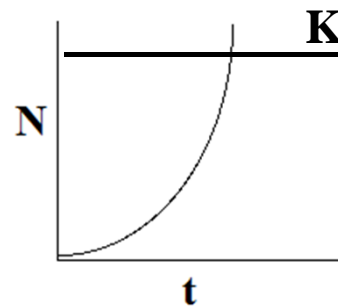# "Leveling off" at carrying capacity

- What causes this so-called "leveling off"?
  - Decrease in birth rate
  - **Increase in death rate**

- May see different outcomes in different places

- **May see "leveling off" (logistic model)**

If things are unchanged, at some point, human population growth will exceed our ability to support that growth.

What then?

Disturbing proposals

- **Ronald Fisher** (1930): "The most obvious requirement for a society capable of making evolutionary progress, in accordance with its current needs, is that reproduction should be somewhat more active among its more successful, than among its less successful members." (pages 257-258)

- Advocated "a moderate superiority of upper class fertility"...

- Will come back to this in "evolutionary applications & misapplications" lecture

How accurate is this math?

- Assumes constancy
  - Assumes intrinsic rate of increase doesn't change*
  - Assumes constant "age-structure"

    Rapid Growth   Slow Growth/Stable
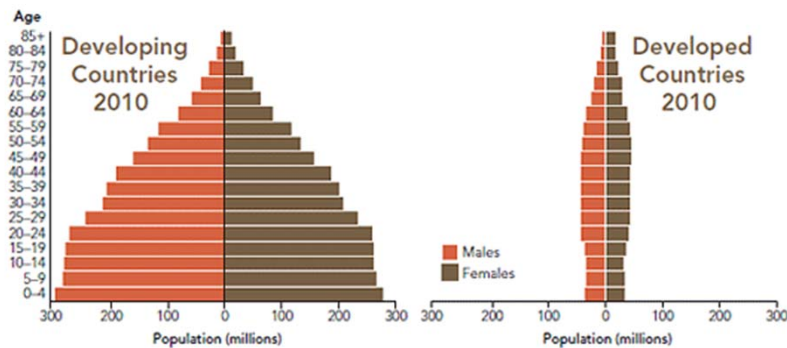
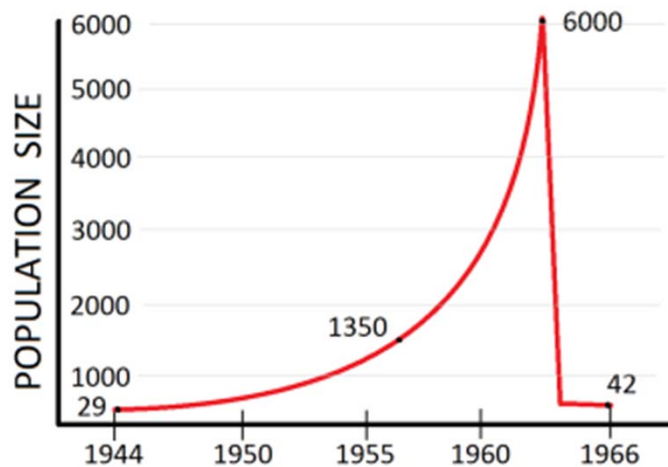# How accurate is this math?

- Carrying capacity can change
    - Innovations in farming, etc.
    - Depletion of non- or less-renewable resources
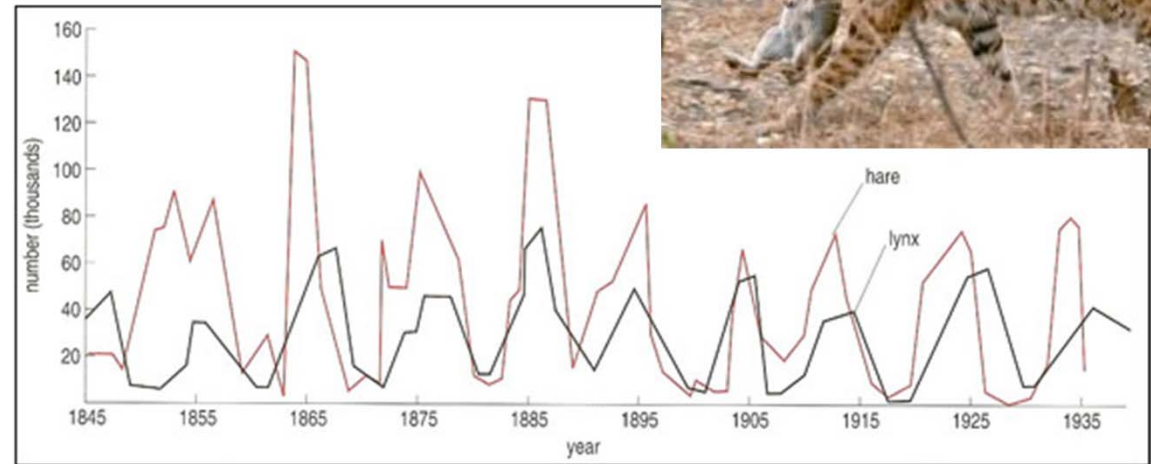   - Other changes in environment

How accurate is this math?

- Some species exhibit booms & busts

Assumed population of the St. Matthew Island reindeer herd. Actual counts are indicated on the population curve.

The math isn't perfect… but it's a starting point.

**Informative for particular circumstances
or for generating predictions.**

Image Credits, Unit 9-3