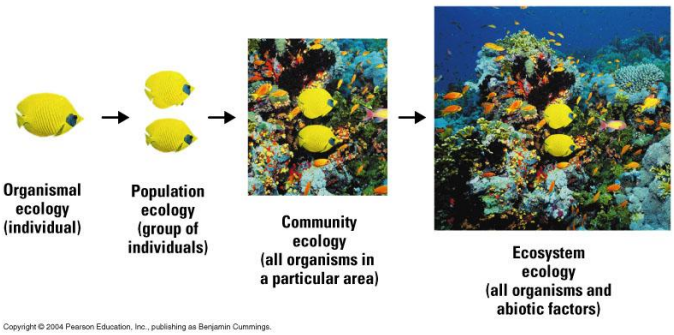
Population Ecology

- Science of Populations
- Applying this science to the human population
- Understanding the problems and solutions related to the human population

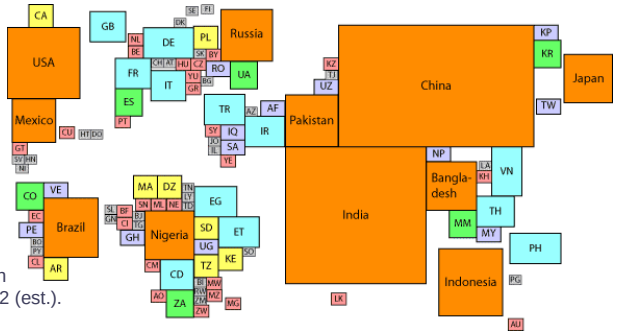
Population

group of individuals of same species living in an area



Population size

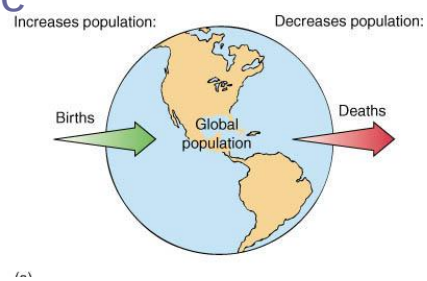
Number of individuals present
at a given time and in a given area

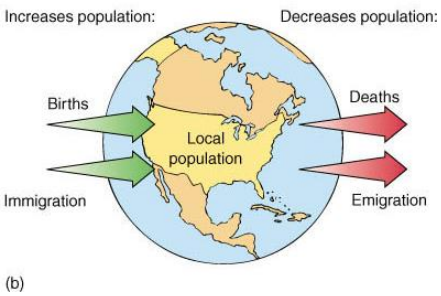


note: this graph only shows countries with
a population over 5 million on July 1, 2002 (est.).
The color indicates the size:
Orange means a country > 100 million
Blue means a country between 50 and 100 million
Green a country between 40 and 50 million
Yellow a country between 30 and 40 million
Lavender a country between 20 and 30 million
Pink a country between 10 and 20 million
Grey a country between 5 and 10 million.

The size of a population may change through time

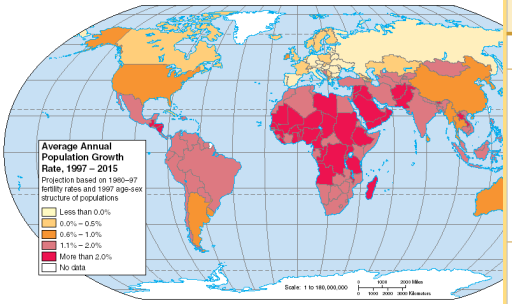
What will determine weather a population grows, shrinks, or remains stable?

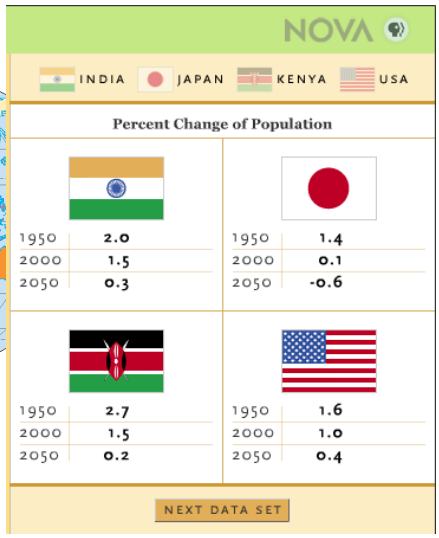




Annual Growth Rate: % of change

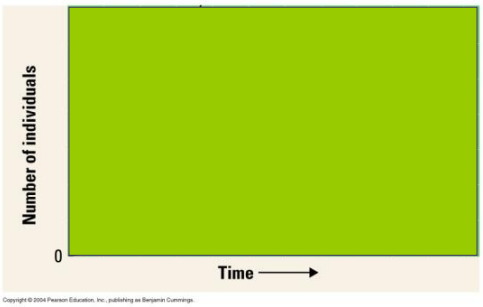
Which populations are growing, shrinking, or remain stable?





Population growth curves

show change in population size over time



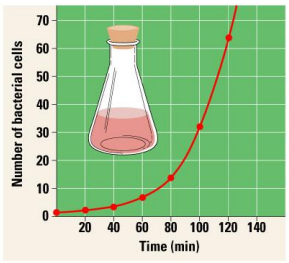
How does a population grow by a fixed growth rate?

Exponential growth is seen at a fixed percentage

- ***J-shaped curve***
- **Growth by a fixed *%*, rather than a fixed amount.**
- ***It takes less time to double the population***

Time	Number of Cells	
0 minutes	1	$= 2^0$
20	2	$= 2^1$
40	4	$= 2^2$
60	8	$= 2^3$
80	16	$= 2^4$
100	32	$= 2^5$
120 (= 2 hours)	64	$= 2^6$
3 hours	512	$= 2^9$
4 hours	4096	$= 2^{12}$
8 hours	16,777,216	$= 2^{24}$
12 hours	68,719,476,736	$= 2^{36}$

(a)



(b)

Analogy:
Similar to growth of money in a savings account

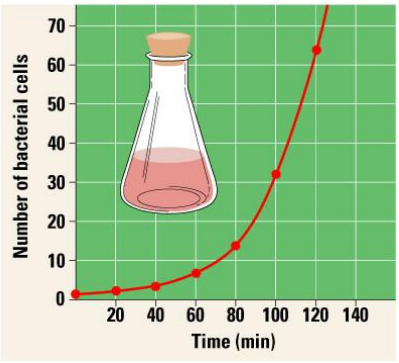
Under which environmental conditions, does exponential growth happen?

Table 5.2 Exponential Growth in a Savings Account with 5% Annual Compound Interest

Age (in years)	Principal
0 (birth)	$1,000
10	$1,629
20	$2,653
30	$4,322
40	$7,040
50	$11,467
60	$18,679
70	$30,426
80	$49,561

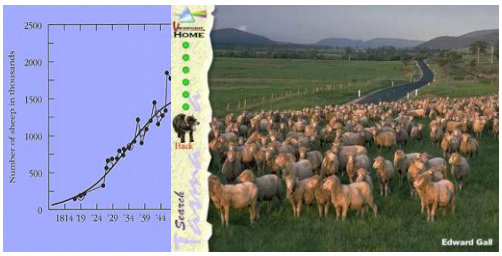
Under unlimited resources

populations grow exponentially



Endless amount of food, water, space, no predators or disease

Case: Sheep introduced in Tasmania



EARLY 1800's Sheep introduced into Tasmania, sheep had unlimited food resources
→ exponential growth in 2 decades, resulted in 2.5 million sheep

MID 1800's Decreased growth due to dwindling resources and disease

LATE 1800'a population stabilized at 1.6 million sheep

When resources are limited, can an exponential growth continue forever?

Populations can not grow infinitely

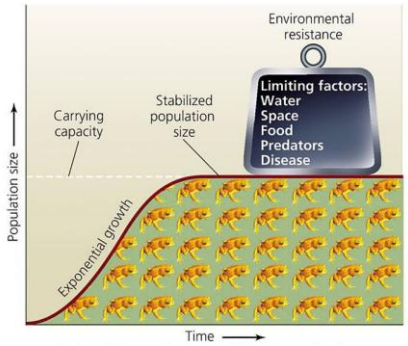
Why?

Resources are limited

and

They restrain exponential population growth,

slowing the growth rate down.

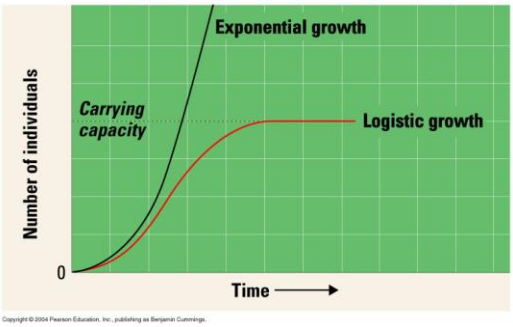


Logistic growth is seen under limited resources

- **First,**
  population grows exponentially

- **When resources dwindle,**
  growth slows close to zero

  Births = deaths



- **Population size stabilizes,**
  this is the maximum number of individuals
  of a given species that the environment can sustain.
  This size is called the CARRYING CAPACITY

- ***S-shaped curve***

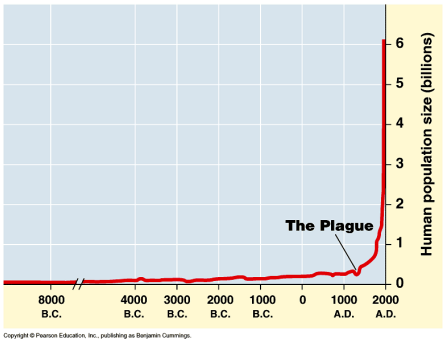
What was the carrying capacity of sheep in Tasmania?
Will the carrying capacity be the same for rabbits in Tasmania?

Let's apply
what we have learned
to the human population!

It took 1.5 million years to reach the 1st billion

2 billion (123 years later)

4 billion in 1974 (44 years later)



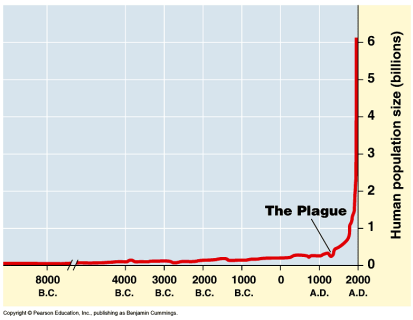
Is this an exponential or logistic growth?

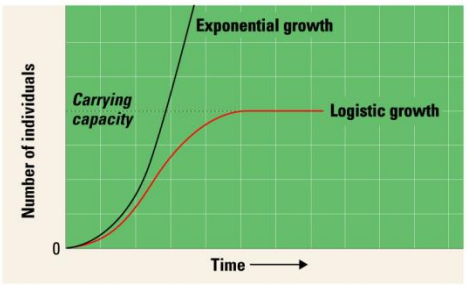
Questions to consider

What is the future like?

Can we keep this exponential growth?

What does population ecology tell us?





What is the carrying capacity for humans?

Estimates range between 4 billion to 16 billion

The variation is due to different levels of consumption of resources

Carrying capacity will be determined

not only by the number of individuals

but

the amount of resources each one consumes

Resource	MDC	US	LDC
% of population	19	5	80
Daily water use/person	676 g	1512 g	333 g
Energy use/person	31.1 b	59.4 b	3.8 b
Persons per motor vehicle	2	1.3	38

Ecological Footprint

- **Tool to measure amount of earth surface (land and water) that an individual requires**

Ecological footprint

- **Size of land depends on: level of consumption, which includes**
  land needed to provide for all resources a person needs AND
  land needed to dispose of all waste produced by a person

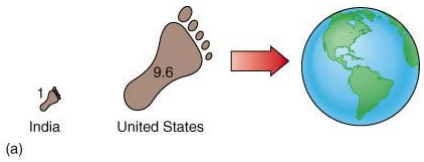
Ecological Footprints vary between countries

Residents of some countries use more land
Why?

An average person in the US requires 9.7 ha =

How does Ecological Footprint and Carrying Capacity relate to each other?

The size of the Ecological Footprint for each of us will determine the Earth's carrying capacity for humans



What can be done?

Sustainable development

use of goods and services to satisfy human needs and
improve quality of life

While

Minimizing use of resources
so that they are available for the future use

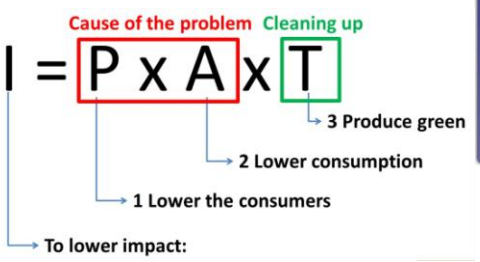
Find win-win solutions
for the human condition and for earth's environment

Several Changes to Sustainability

- **Redefine quality of life**
- **Industry: mimic natural systems by making processes circular**
- **Base our decisions on long-term thinking**
- **Promote research and education**

  produce responsible technology

  I = P × A × T



Several Changes to Sustainability

Sustainable development involves industry

AND the consumer:

- **Vote with our ballots**
- **Vote with our wallets**

Company	Revenue Net Sales in millions of dollars:	Percent of Revenue Allocated to:		
		Profit: (Net Income)	Marketing/ Advertising/ Administration	Research and Development (R&D)
Merck and Co., Inc	$40,363	17%	15%	6%
Pfizer Inc.	29,574	13%	39%	15%
Bristol-Myers Squibb Company	18,216	26%	30%	11%
Pharmacia Corporation	18,144	4%	37%	15%

What are companies trying to get you to buy?
cheaper vs. quality
disposable vs. reusable
more packaging vs. less packaging