Ecology

I. Definitions
II. Population Ecology
III. Community Ecology
IV. Ecosystem Ecology

I. Definitions

Ecology

- From the Greek words
  - Oikos – home
  - Logos – to study
- The study of home place
- Study of relationships between living things and their **environment**

Environment:

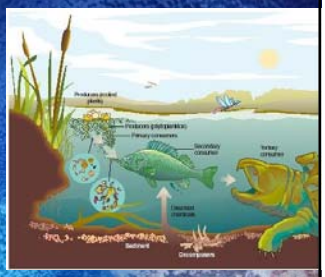
- **Includes:**
  - **Biotic (living) components**
  - **Abiotic (non-living) components**

Ecological Hierarchy

- A **population** is a group of individuals of a single species that simultaneously occupy the same general area.
  - The characteristics of populations are shaped by the interactions between individuals and their environment.
- A **community** is any assemblage of populations in an area or habitat.
  - Includes other individuals of the same species as well as populations of other species living in the same area which they interact.

Ecological Hierarchy

- An **ecosystem** consists of all the organisms living in a community as well as all the abiotic factors with which they interact
  - Microcosm to lakes to forests, etc.
  - Biosphere as global ecosystem made up of all the local ecosystems on Earth



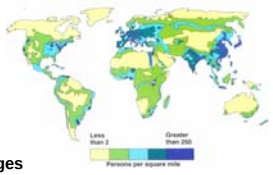
II. Population Ecology

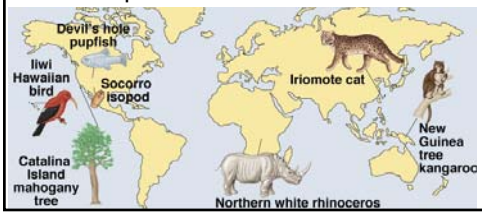
A **population** is a group of individuals of a single species that simultaneously occupy the same general area.

Population Ranges

- **Species are composed of populations**
- **Populations are dispersed across limited geographical ranges**
- **Some species have very narrow ranges (including endemics)**
- **Some species have very wide ranges**
- **Within their range, individuals can be spaced at random, in uniform, or in clumps**

Human Population Distribution on Earth

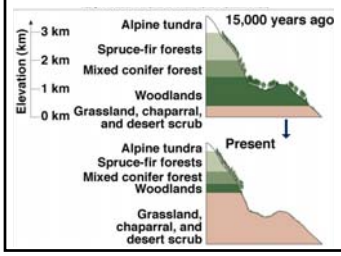


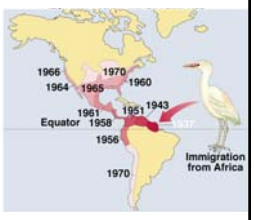


Range Expansions and Contractions

- Population ranges are not static
- This can be due to changing environmental conditions
- Or due to colonization of new habitat

Altitudinal shifts in population ranges in the mountains of SW North America





Range expansion of the cattle egret

Population Growth

A) Change in population size depends on:

1) Births

2) Deaths

3) Migration: (**Emigration**: # leaving, **Immigration**: # entering)

→ Change in size = (B - D) + (I - E)

What determines these changes?

1) Biotic potential-

- max rate a population can increase
- under ideal conditions

2) Environmental resistance-

- limits to population growth
- set by biotic / abiotic surroundings.

B) The rate of change in population size (growth rate):

(ignoring **migration**)

Need to know (for a time period):

births, # deaths, # in population

(birth rate – death rate = growth rate)

b - d = r

Example: (Population = 10,000)

(900 births /10,000) – (400 deaths /10,000) = 500/10,000

= 0.05 (5%) increase per person per year

C) # of individuals added to a population *within a certain time:*

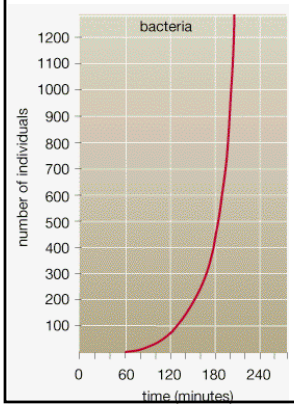
the **growth rate** (***r***)

is multiplied by the original population size (***N***)

rN = population growth within a given time period

0.05 x 10,000 = increase of 500 people/yr

How is Population Growth Regulated?



Full **Biotic potential**-->

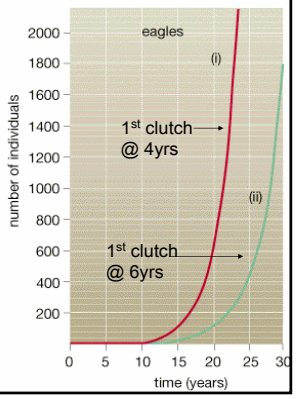
→ **Exponential growth**

→ **J-curve**

time (minutes)	number of bacteria
0	1
20	2
40	4
60	8
80	16
100	32
120	64
140	128
160	256
180	512
200	1024
220	2048

What Influences Biotic Potential?

- Sex ratio
- Age of 1st reproduction
- Frequency of reproduction
- Average # of offspring produced each time
- Length of reproductive life
- Age structure
- Death rate

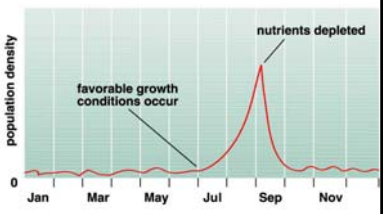


How is Population Growth Regulated?

A. Full Exponential growth is uncommon

1) Boom and bust population cycles

- Cyclic with predictable changes: rain, temp, nutrients
- Usually short-lived species

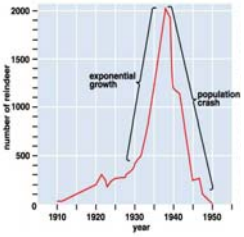


How is Population Growth Regulated?

A. Full Exponential growth is uncommon

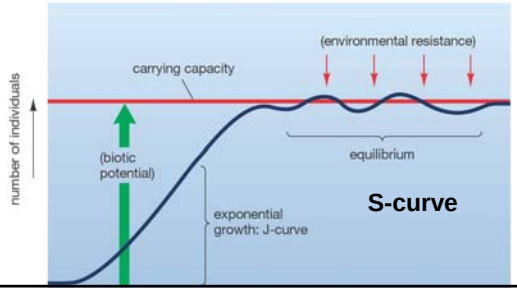
2) Introduced (exotic) species

- Escape predators, competitors?

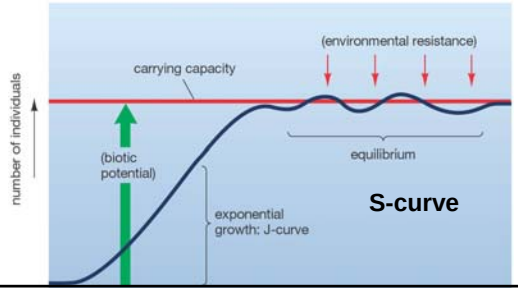


B. Why is exponential growth rare?

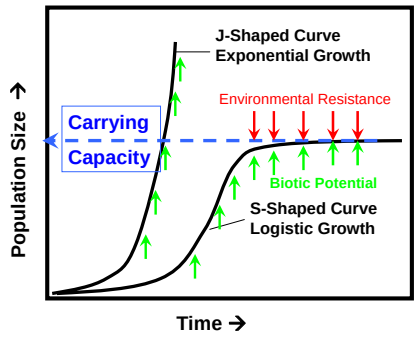
- An area can support only a certain population size **indefinitely = carrying capacity (K)**
- determined by: Resources and Environmental Resistance



- This is the **Logistic Growth Model** or the **Sigmoidal Growth Curve** (= S-curve)
- As a population approaches its carrying capacity, its rate of growth slows, b/c fewer resources remain
- Populations often grow to the carrying capacity of their environment



Population Growth Models



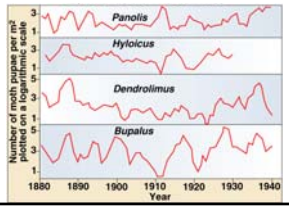
C. Environmental Resistance

1) Density independent effects:

→ **the rate of growth is limited by something other than population size**

e.g. weather, fires, human activities

→ **erratic population growth patterns; lack of sigmoidal growth curve**



Fluctuations in the number of pupae of four moth species from Germany.

C. Environmental Resistance

2) Density Dependent Factors:

→ **the rate of population growth is limited by population size itself**

→ **when populations approach their carrying capacity, competition for resources can be severe**

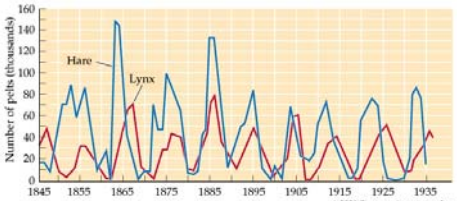
a) Predation

- **Predation** controls the size of the **prey** populations
- AND controls the size of the **predator** populations
- **Predators often focus on common prey**

Can result in out-of-phase population cycles

- Predators reduce prey #, reducing their food resource
- Predator population--> decreases
- With fewer predators--> prey population--> increases

Linked population cycles of the snowshoe hare and the northern lynx



b) Parasitism

- When one organism feeds on another organism without killing it.
- **Parasite, Host**
- **Examples:**
  ticks, intestinal worms: spread more easily in dense host populations.

c) Competition

- When population numbers increase, competition intensifies
- competition among members of **different** species = **interspecific competition**
- If among members of the **same** species = **intraspecific competition**

…Interactions and combinations…

→ **drought x parasites**

→ **parasites x harsh winters**

Population Doubling Time

• The time it takes a population to double its size at a given growth rate (*r*).

Doubling time = 69.3 /(*r*)

With *r* as a percentage

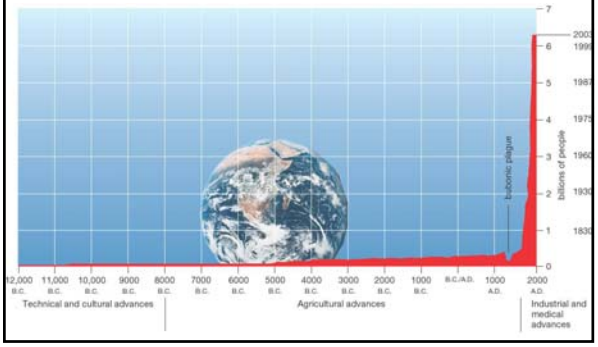
For example, if (*r*) = 0.05 = 5%

The doubling time = 69.3/5 = 13.86 yrs

Exponential Growth and the Human population

A. Cultural, Agricultural, & Industrial-medical revolutions...

- have humans overcome environmental resistance???



World Population growth

Time unit	Births	Deaths	Natural increase
Year	130,013,274	56,130,242	73,883,032
Month	10,834,440	4,677,520	6,156,919
Day	356,201	153,781	202,419
Hour	14,842	6,408	8,434
Minute	247	107	141
Second	4.1	1.8	2.3

US Census Bureau, 2005

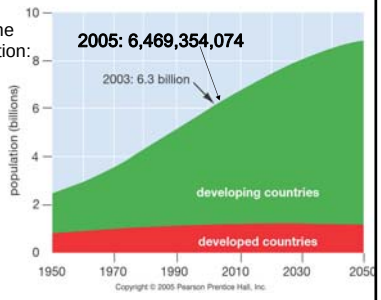
At our current world growth rate of 1.4% annual growth, our population will double every 39 years!!!

B. Developed vs. Developing Countries

In developed countries the industrial-medical revolution:

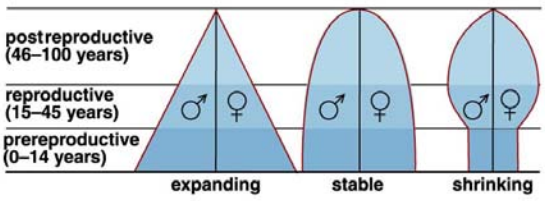
- Decreased death rate
- Reduced birth rates
- Stabilized growth

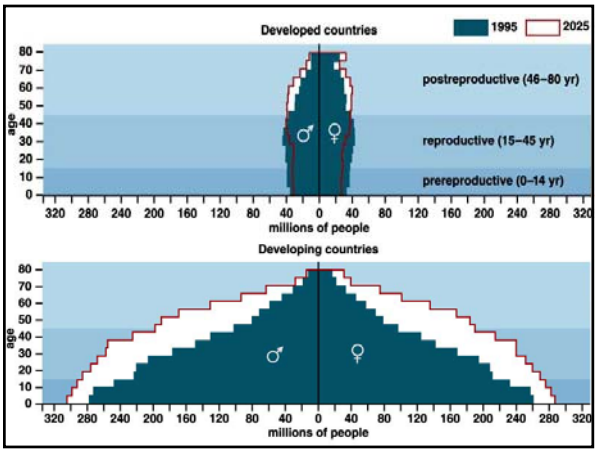
- In developing countries
- Decreased death rate
- Birth rates still high
- Why?
  - –Education
  - –Access to Contraceptives
  - –Tradition



C. Using age structure to predict growth

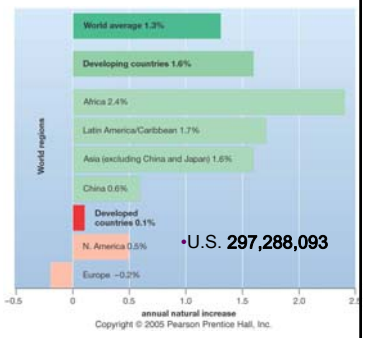
- **Age structure:** distribution of males and females in certain age groups
- **Replacement level fertility**





D. United States

- Fastest growing developed country
- 5% of the world's population
  - Accounts for 25% of global energy use
- People in developing countries→ smaller "ecological footprint"



•U.S. 297,288,093

How big is your ecological footprint?

Take the ecological footprint quiz:

http://www.earthday.net/footprint/index.asp

Turn in questions from course webpage next time.

What are the consequences?

- Does the earth have a carrying capacity?
- 3 billion? 46 billion?
- ~ 800 million chronically undernourished.
- Food, and food production will likely be the limiting factor.