Population Ecology

Population Dynamics

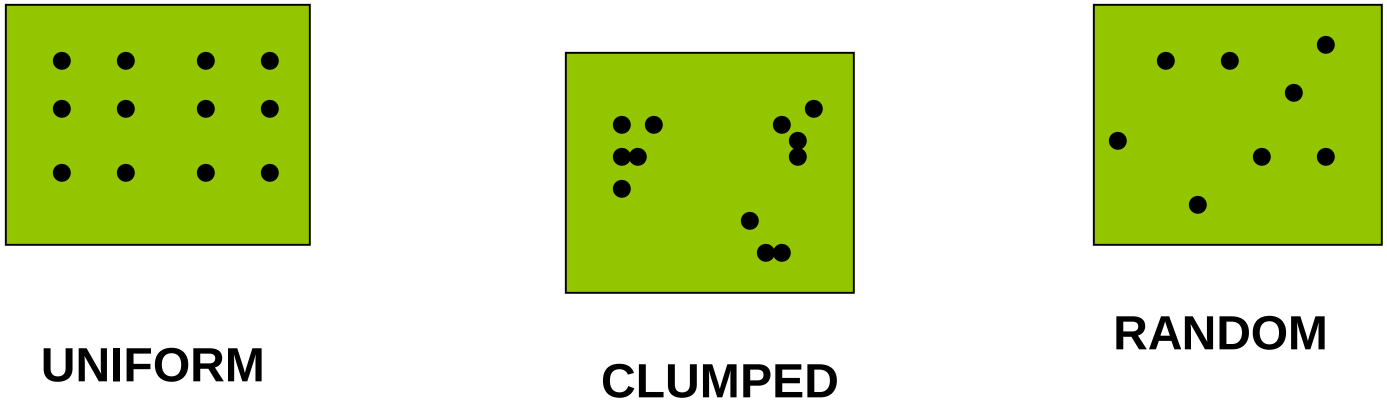
- Population:
  - All the individuals of a species that live together in an area
- Demography:
  - The statistical study of populations, allows predictions to be made about how a population will change

Population Characteristics

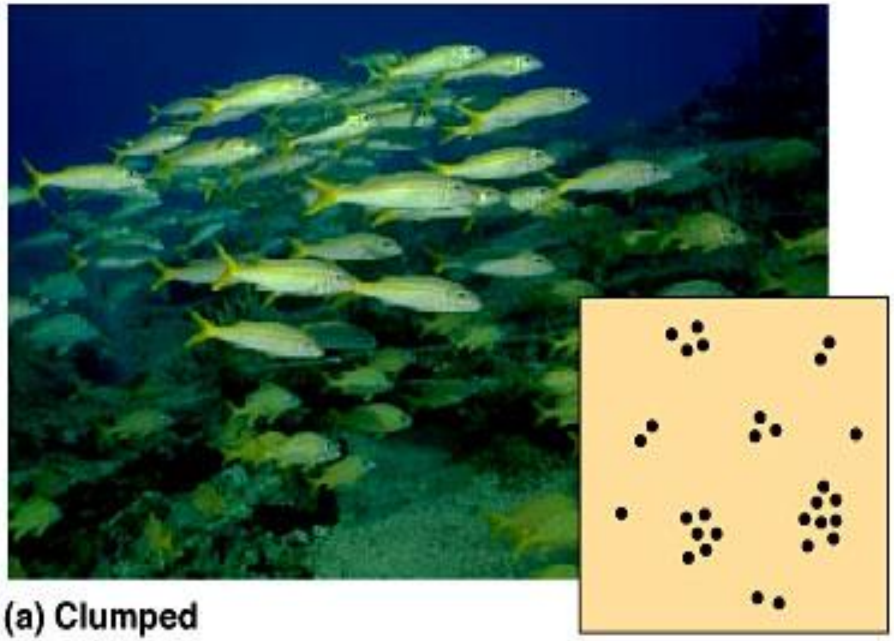
- Three Key Features of Populations
  - Size
  - Density
  - Dispersion

Size: number of individuals in an area

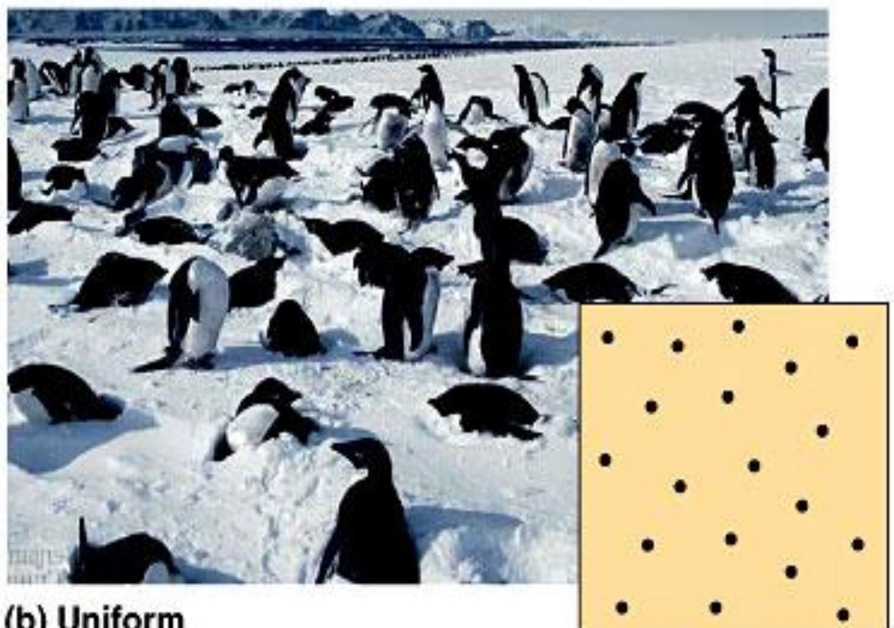
- **Population Density:** **measurement of population per unit area or unit volume**
- **Pop. Density = # of individuals ÷ unit of space**
- : **Dispersion:** Pattern of Spatial distribution or spacing of organisms



Population Dispersion



(a) Clumped



(b) Uniform

(c) Random

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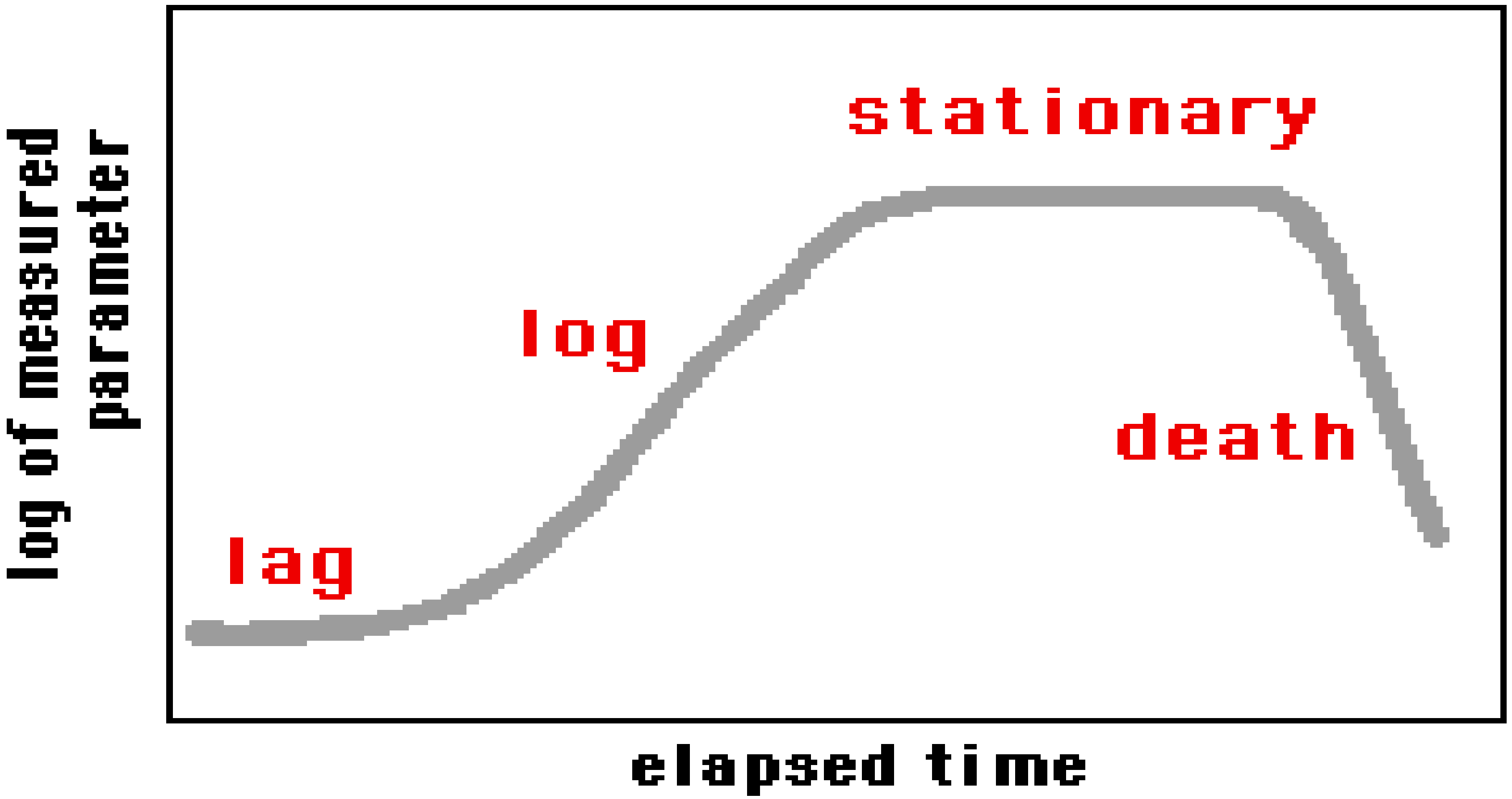
Principles of Population Growth

- Population growth rate: explains how fast a given population grows.
- Population growth measured in different ways:
  - Microorganisms- how fast population grows in tube or bottle
  - Plants/animals- how fast population grows in a new environment with plenty of resources

PHASES
of the population growth curve



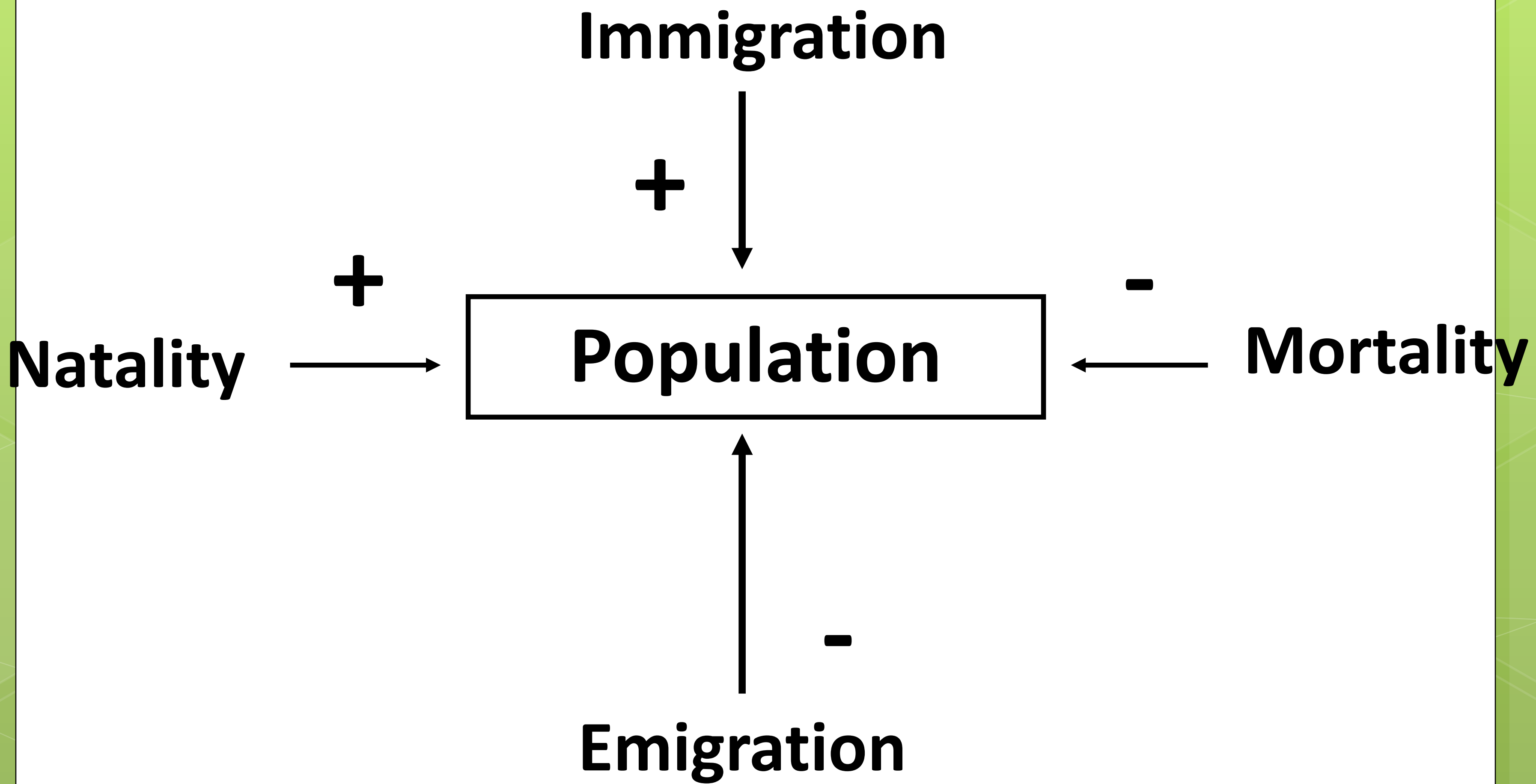
Key Features of Populations

- **Growth Rate:**
  - Birth Rate (natality) - Death Rate (mortality)
  - How many individuals are born vs. how many die
  - Birth rate (*b*) − death rate (*d*) = rate of natural increase (*r*)

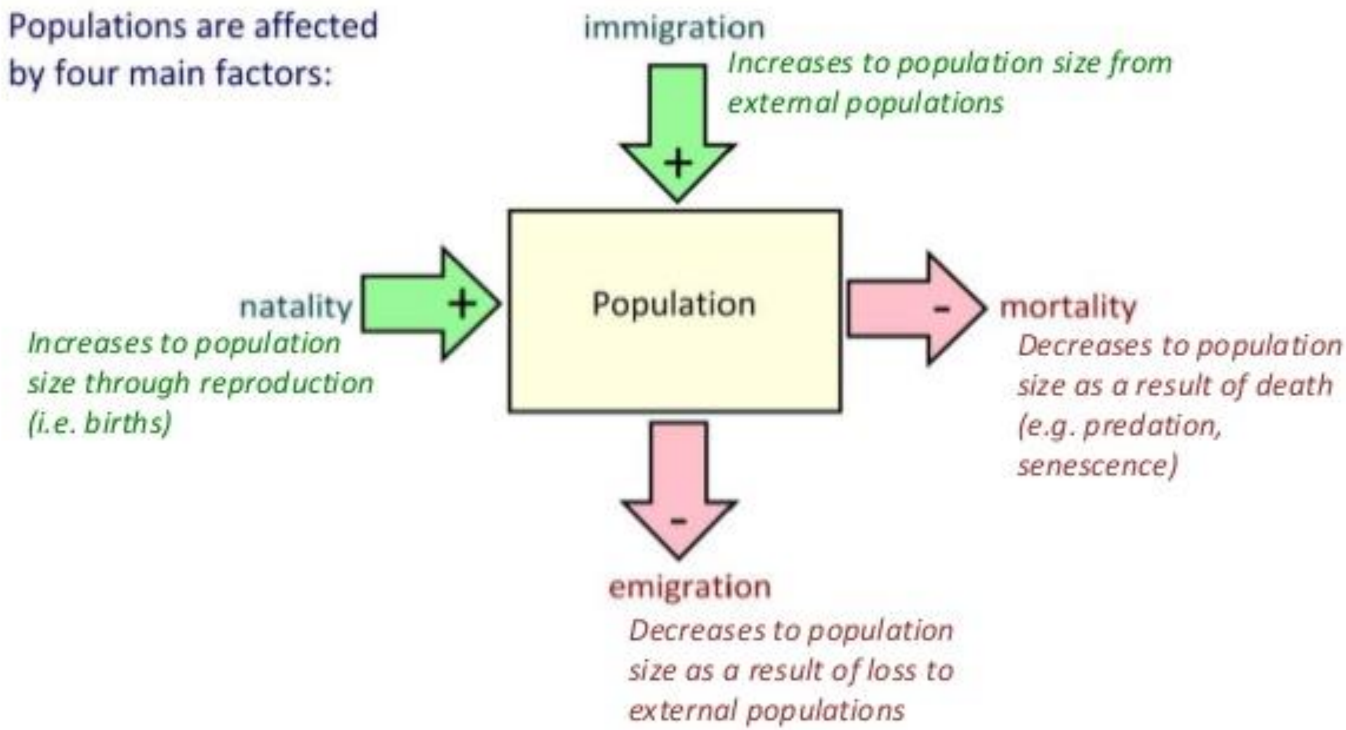
1. Immigration: movement of individuals into a population

2. Emigration: movement of individuals out of a population

Factors That Affect Future Population Growth



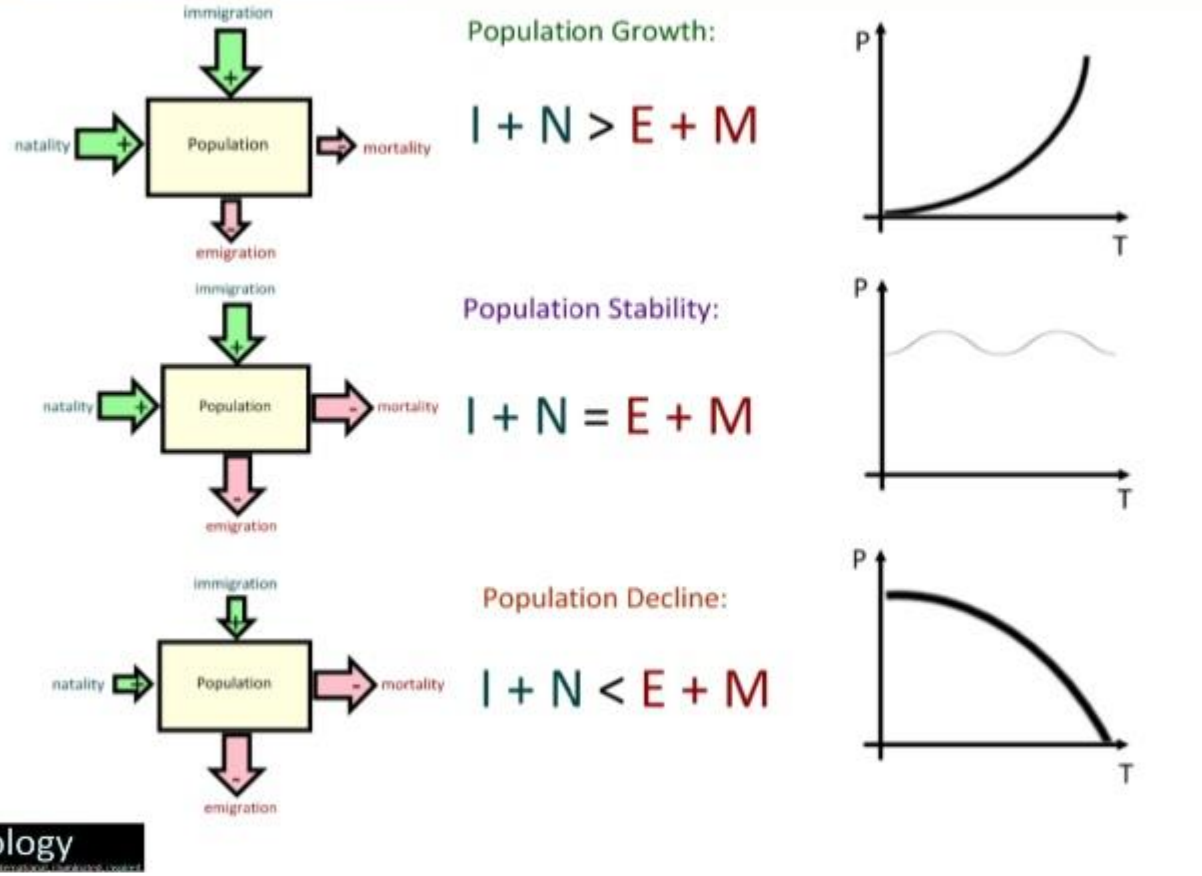
C.5.U4 The phases shown in the sigmoid curve can be explained by relative rates of natality, mortality, immigration and emigration.



Population Size = (**N**atality + **I**mmigration) - (**M**ortality + **E**mmigration)

http://www.slideshare.net/gurustip/populations-2174193

C.5.U4 The phases shown in the sigmoid curve can be explained by relative rates of natality, mortality, immigration and emigration.



Population Growth

- t = time
- N = population size (number of individuals)
- $\frac{dN}{dt}$ = rate of change in population size (ind/time)
- r = maximum/intrinsic growth rate (1/time)
  = fractional increase, per unit time, when resources are unlimited

How Do Populations Grow?

- Idealized models describe two kinds of population growth:

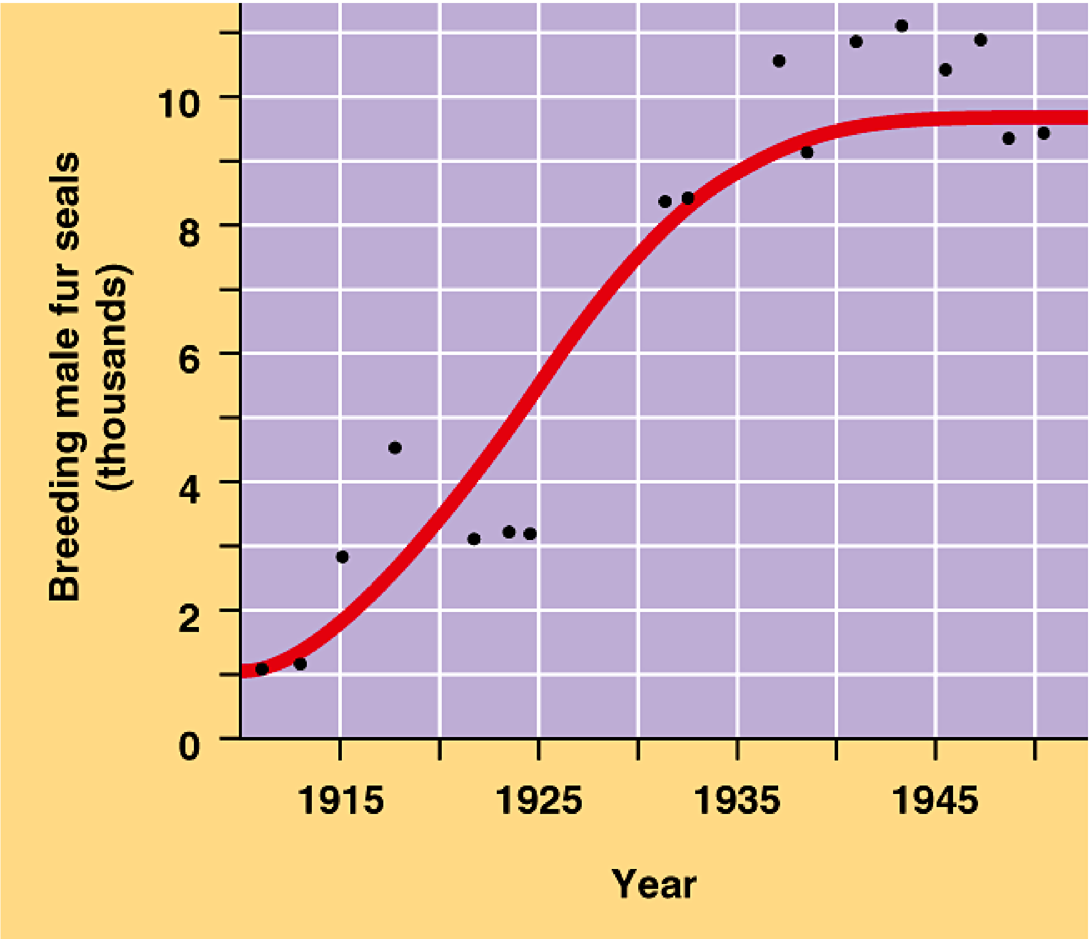
1. Exponential Growth

2. Logistic Growth

Population Growth

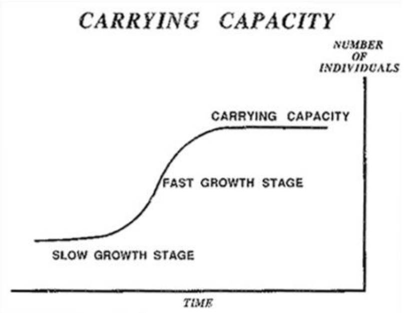
- Logistic growth
  - Assumes that density-dependent factors affect population
  - Growth rate should decline when the population size gets large
  - Symmetrical S-shaped curve with an upper asymptote

Logistic Growth Curve



"S"-shaped population growth pattern

- Also called "*k*" strategists
- Slow rate of reproduction, produce few offspring
- Elephants, bears, whales, redwood trees, cacti
- Live in stable environment
- Large, reproduce and mature slowly, long-lived
- Maintain population size near carrying capacity



Exponential Growth Curve

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	4,096	$= 2^{12}$
8 hours	16,777,216	$= 2^{24}$
12 hours	68,719,476,736	$= 2^{36}$

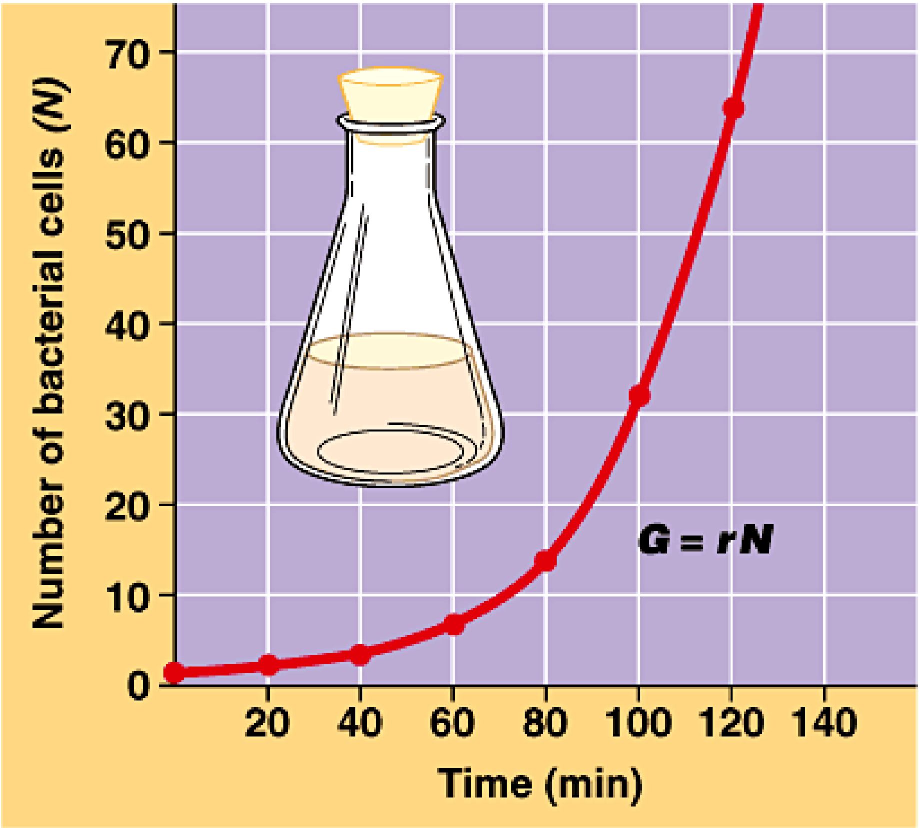
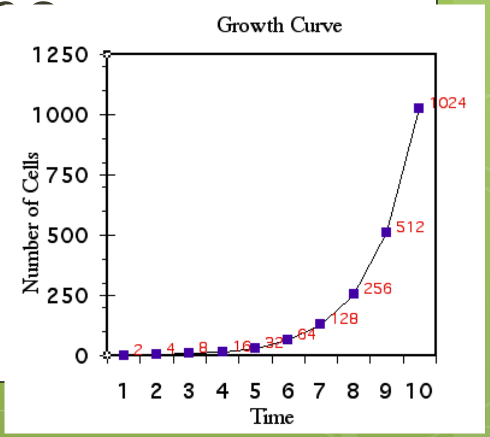


Figure 35.3A

"J"-shaped population growth pattern

- Also called "r" strategists
- Mosquito, bacteria
- Reproduce very rapidly, produce many off spring in short period of time
- Environment unpredictable and change rapidly
- Small body size, mature rapidly, reproduce early, short life span
- Populations increase rapidly then declin



What Controls Population Size and Growth Rate (dN/dt)?

- **Density-dependent factors:**
  - **Intra-specific competition**
    - **food**
    - **Space**
  - **contagious disease**
  - **waste production**
  - Interspecific competition
  - Other species interactions?

Population Density:
# of individuals of a certain species in a given area

- **Density-independent factors:**
  - **disturbance, environmental conditions**
    - **hurricane**
    - **flood**
    - **colder than normal winter**

Factors Limiting Growth Rate

- Declining birth rate or increasing death rate are caused by several factors including:
  - Limited food supply
  - The buildup of toxic wastes
  - Increased disease
  - Predation

How Do You Affect Density?

1. Density-dependent factors: Biotic factors in the environment that have an increasing effect as population size increases (disease, competition, parasites)

2. Density-independent factors: Abiotic factors in the environment that affect populations regardless of their density (temperature, weather)

Density dependent regulation vs. density independent regulation

A. Density-dependent factor is one that intensifies as population increases in size. In large populations, density-dependent factors affect more individuals and have larger effect on each. These are biotic-factors.

Result: decreased birth and increased death rates.

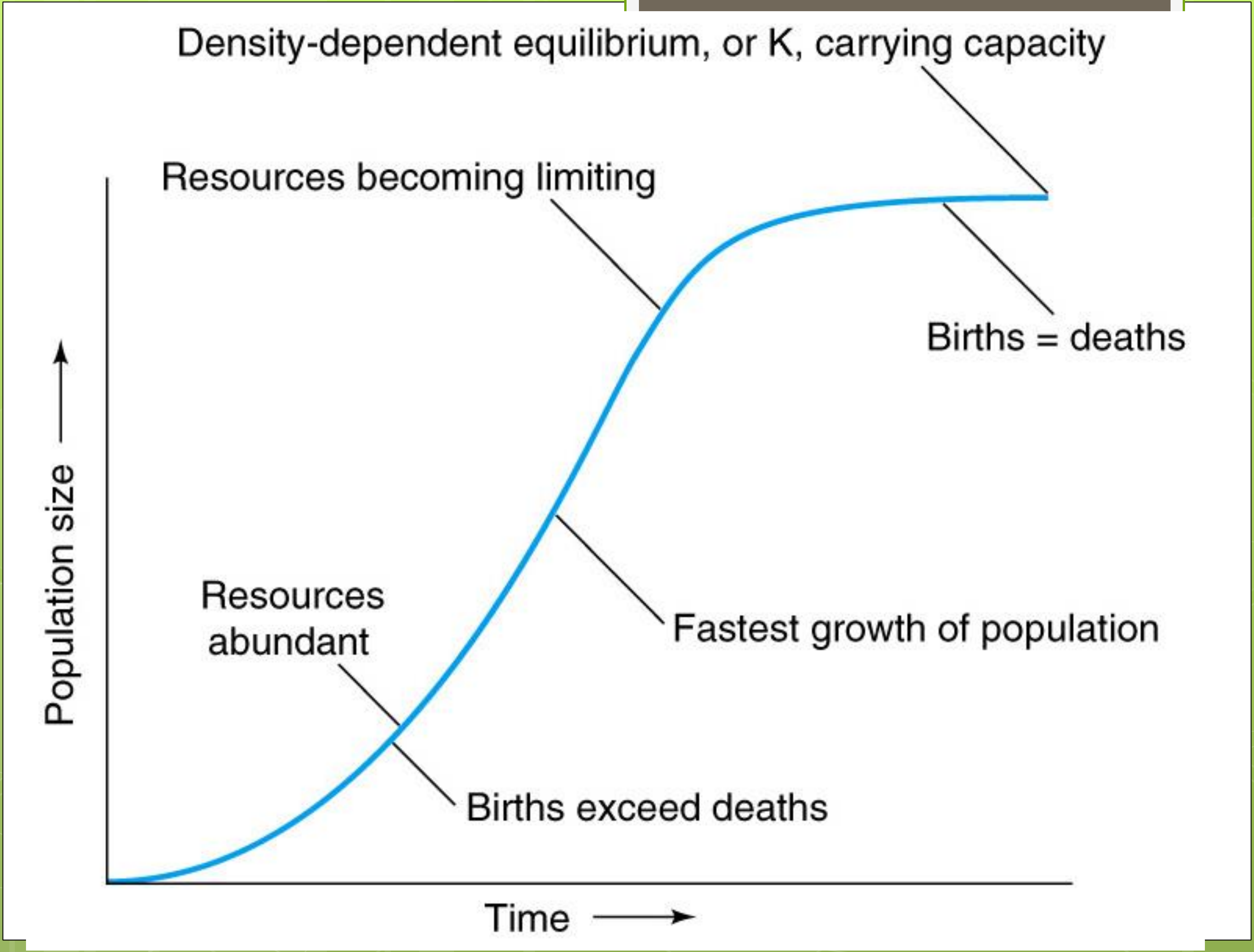
1. Density dependent factors result from either intraspecific or interspecific competition
2. Only density dependent factors can produce logistic type growth. Why? Because logistic growth is dependent upon a carrying capacity.

B. Density independent factors – the occurrence and magnitude of effect is uncorrelated with population size. These are abiotic factors. Most result from climate and weather or presence of a harmful pollutant.

1. Example: drought will reduce growth , but obvious that occurrence of drought is not related to population size.
2. Can be important in population regulation because, if density-independent factors occur often enough, may prevent growth ever approaching K.

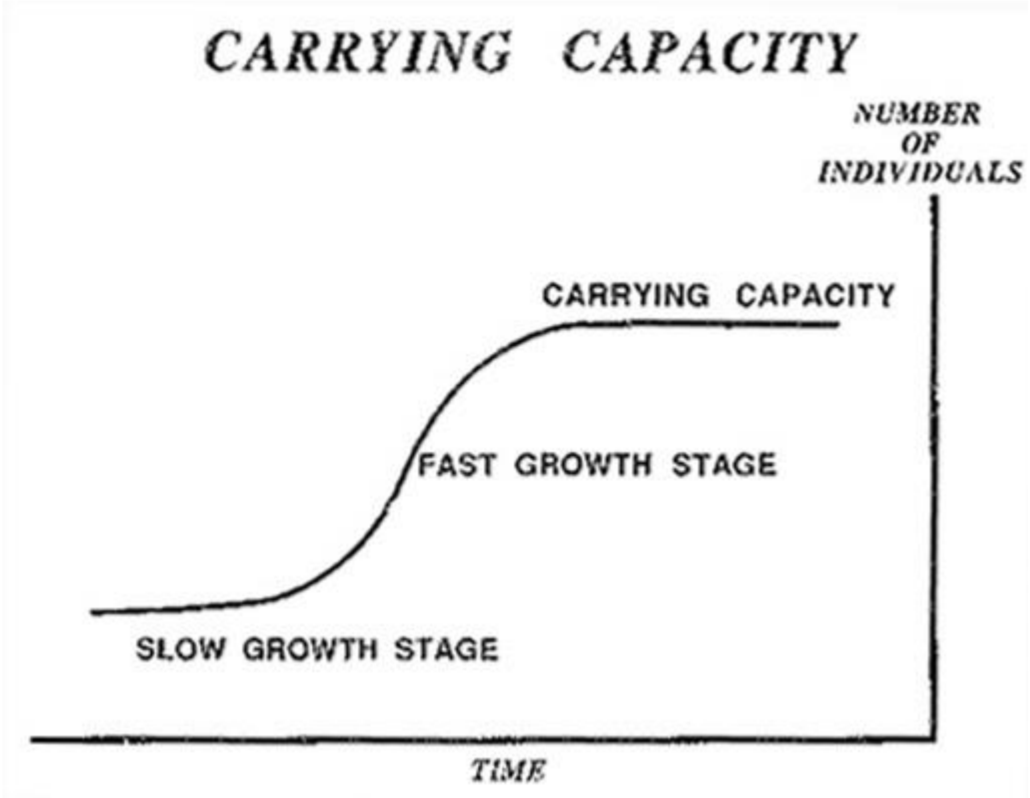
***Example:* Thrips, small insects, livein Australia, eat pollen and flowers of rose family.**

Number of Thrips determined by number of flowers, which is determined by weather or seasons.


Density-dependent equilibrium, or K, carrying capacity
Resources becoming limiting
Births = deaths
Resources
abundant
Fastest growth of population
Births exceed deaths
Population size
Time

Carrying Capacity

- **Carrying Capacity (k):**
  - The maximum population size that can be supported by the available resources
  - There can only be as many organisms as the environmental resources can support


CARRYING CAPACITY
NUMBER OF INDIVIDUALS
CARRYING CAPACITY
FAST GROWTH STAGE
SLOW GROWTH STAGE
TIME