

## Topic 2 - Open vs Closed Populations Notes

- Populations can be classified two ways:
- Open - all 4 factors (immigration, emigration, birth, death) are involved
  - Ex.
- Closed - immigration and emigration don't exist. Food or waste doesn't enter/exit environment.
  - Ex.
- Growth Curves - are used to record changes in a population over time
  - Time is on x - axis
  - Number of individuals or pop density on y - axis
  - Best fit line passes through as many points as possible

### World Population Growth, 1750–2150

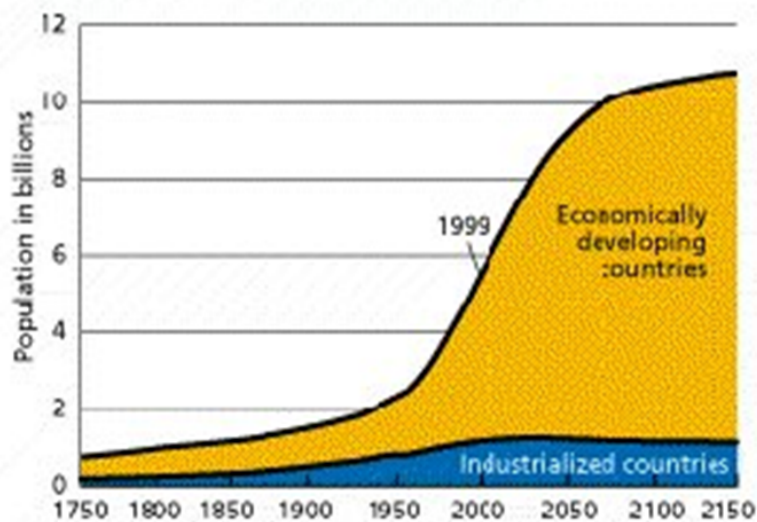
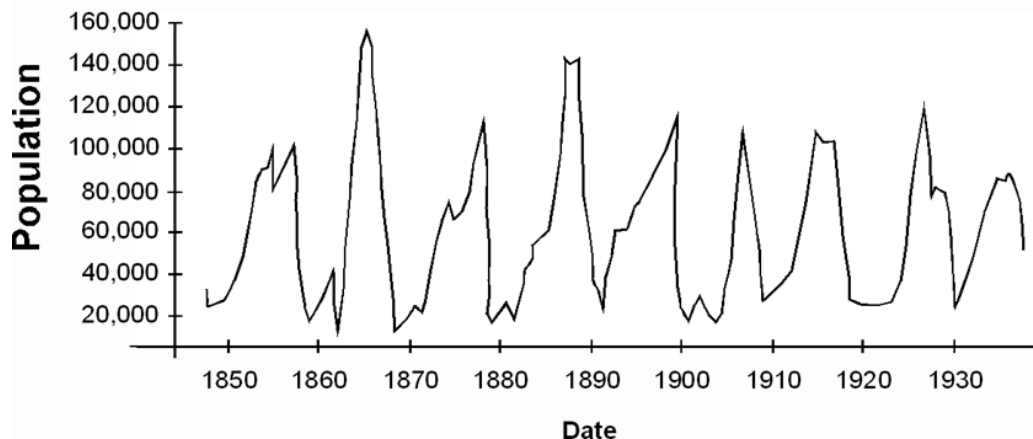
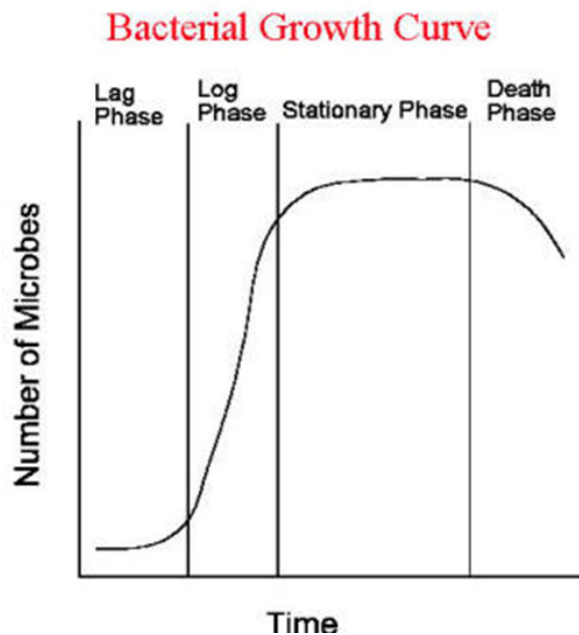


Fig. 1.1 Population cycles of the snowshoe hare, based on pelts received by the Hudson Bay Company (after Kormondy, 1969)



## Closed Populations

- Bacteria, yeast and other micro-organisms are studied in closed systems because:
  - Easy to handle
  - Short life span allows many generation to be grown in a few days
  - A similar growth curve always results



- 4 phases can be identified in a closed pop growth curve:
  - Lag phase - a delay before a pop begins reproducing
  - Growth (log) phase - population is increasing at its fastest rate
    - Pop increase (I) = growth rate (R) x current pop (N)
  - Stationary phase - reached when natality equals mortality
    - Occurs b/c of shortage of nutrients, build-up of waste and lack of space
  - Death phase - when mortality is greater than natality
    - Occurs b/c nutrients have near run out and wastes build up

## Open Populations

- Naturally occurring populations

- All 4 factors are working

- Natality
- Mortality
- Immigration
- Emigration

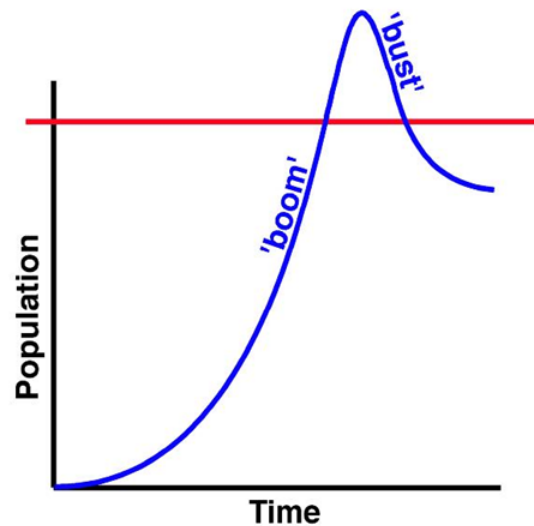
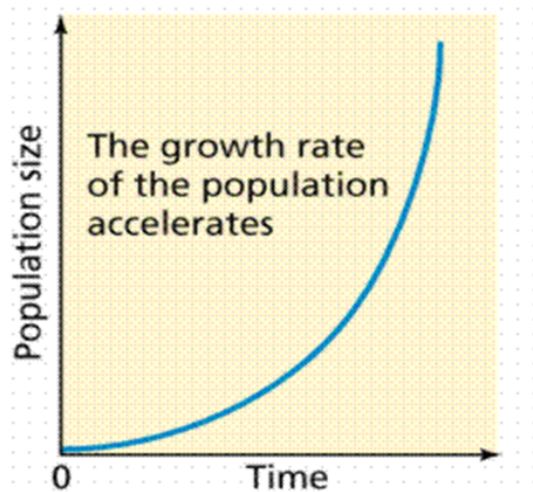
- J-shaped Population Curve

- A.k.a Exponential population growth

- Occur when rapid population growth is not restricted and resources are available

- i.e. Food and disease are not factors

- Typical of
  - Insect populations
  - Algae



- Resources will eventually run out
- Sharp decline in curve occurs b/c the carrying capacity (K) is suddenly exceeded by the rapidly growing pop
- Food availability is usually the most limiting factor

Carrying Capacity : The maximum number of individuals that the environment can support.

- Depends on two factors

- Biotic Potential
- Environmental Resistance

- Biotic potential - max # of offspring that can be produced by a species under ideal conditions

- Factors involved in determining Biotic potential
  - Offspring - max # of offspring per birth
  - Capacity for survival - chance offspring will reach reproductive age
  - Procreation - number of times per year organism reproduces
  - Maturity - age at which reproduction begins

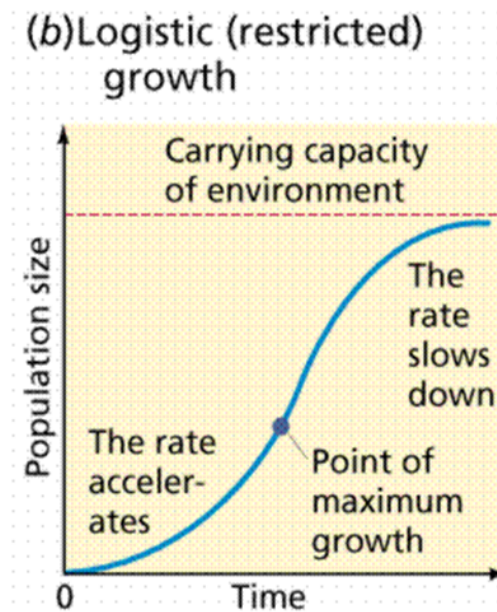
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- Environmental Resistance : Factors which tend to limit population growth

- A mixture of biotic and abiotic factors
- Examples
  - Climate affects food availability (tundra ex)
  - Number of predators
  - Nesting sites available

## S-shaped Population Curves (Logistic Growth)

- In most real populations food and disease become important as conditions become crowded.
- There is an upper limit to the number of individuals the environment can support.
- Ecologists refer to this as the "carrying capacity" of the environment. Pop in this kind of environment show what is known as logistic growth.



## Limiting Factors in Populations

- Law of the minimum - of all the essential factors required for growth, the one in the lowest [ ] is the controlling factor
- Shelford's law of tolerance - too much or too little of an essential factor can be harmful to an organism
  - Water, sunlight, nitrogen, phosphorous
- Density independent factors - factors that affect a population regardless of the pop density
  - Ex. Flood, fire, extreme temperatures
- Density dependent factors - factors arising from pop density that affect members of a population
  - Ex. Food supply, increased disease, increased predation

Topic 2 - Review Sheet

1. In many rural areas, stray cats are a problem as they may return to being wild (also known as feral). Feral cats that have not been spayed or neutered can reproduce, which may result in a population of feral cats. One pair of cats can produce 12 kittens in 1 year. If half these kittens are female, this increased population could potentially produce 84 kittens in the second year. In 5 years, the population could reach almost 33 000 feral cats.

- (a) Identify the kind of growth that is occurring.
- (b) Outline the conditions that would have to be in place for the population to achieve its biotic potential.
- (c) Describe 3 density dependent factors that might restrict the feral cats from reaching their biotic potential.

2. Scientists monitored the population size of a species newly introduced to an ecosystem. Their data are in Table 3.

- (a) Sketch a graph of the data. Identify the form of growth curve of the species.

Year	Population size	Year	Population size
1999	44	2003	301
2000	56	2004	275
2001	132	2005	321
2002	224	2006	298

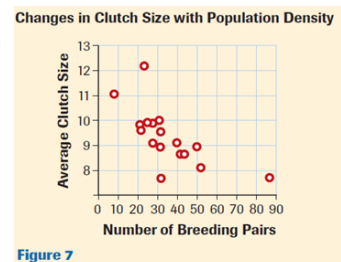
- (b) Use your graph to estimate the number of individuals in the whole population when it has reached the carrying capacity of the ecosystem ( $K$ ).

3. Classify the following scenarios as density-dependent or density-independent:

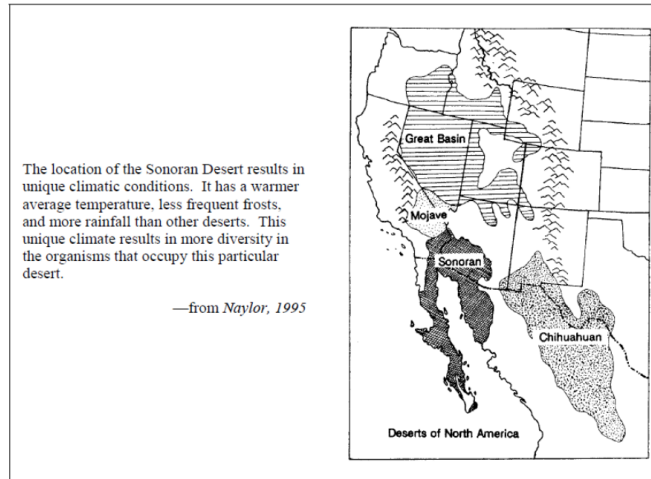
- (a) A forest fire destroys a great deal of habitat in Jasper National Park.
- (b) Many aquatic organisms die as a result of adverse weather conditions during the breeding season.
- (c) A young aggressive hawk invades the geographic range of established hawks, driving weaker birds from the geographic range.

4. Study the graph in Figure 7 which shows a population of the great tit, a European bird similar to the chickadee. The graph illustrates population density versus clutch size (the number of eggs to be hatched at one time).

- (a) Is this a case of density-dependent or density independent regulation? Explain your answer



Use the following information to answer the next two questions.



The factors that contribute most to the relatively great diversity of organisms in the Sonoran Desert as compared with that in other deserts are

- A. biotic factors that increase the biotic potential
- B. abiotic factors that reduce reproductive isolation
- C. abiotic factors that reduce environmental resistance
- D. biotic factors that increase the carrying capacity of the area

In the Sonoran Desert, all the populations of all the organisms occupying that desert represent

- A. a habitat
- B. a community
- C. a geographic range
- D. an ecological niche

Use the following information to answer the next four questions.

In Canada, to manage the harvest of fish, government departments issue quotas based on population estimates. Problems in salmon and cod fisheries have drawn attention to problems in the calculation of the estimates. Quotas based on these estimates have led to overharvesting and have driven the cod fishery into disaster.

The carrying capacity for northern cod in Canada's Atlantic region may be described as the

- A. harvest quota that permits sustainable yield
- B. harvest quota that matches the natural mortality of the cod
- C. decline on a growth curve that shows the population size dropping
- D. plateau on a growth curve that shows the population size has reached a limit

The Atlantic cod moratorium was a government-enforced period of no fishing.

The original two-year moratorium has been extended. Which of the following measures would be **most useful** when predicting the size of the cod population two years in the future?

- A. Cod lifespan and natality rate
- B. Cod biotic potential and future fishing quotas
- C. Migration patterns and predator population size
- D. Present population size and present population growth rate

When fisheries' quotas were set too high, it may have been because assumptions were made by government regulators that led them to expect cod stocks to grow rapidly after harvest. One such assumption could have been that cod

- A. have low fecundity and high mortality
- B. are relatively *r*-selected with a high biotic potential
- C. have high competition and density independent natality
- D. are relatively *K*-selected in regions of high environmental resistance

Terms and Descriptions Related to Populations		
Term	Effect of Small Population	Result of Rebuilt Population
1 Carrying capacity	4 Increased mutation rate	7 Hardy-Weinberg equilibrium
2 Chaos theory	5 Chance loss of genes	8 Secondary succession to a different climax community
3 Genetic drift	6 Increased intraspecific competition	9 Reduced genetic variability

Drastic reduction of a population raises the concern that a rebuilt population may show significant differences from the original population. Identify the term, effect, and result, as numbered above, that describe this concern.

Answer: \_\_\_\_\_  
                     Term                    Effect                    Result

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)