Population growth

How can there be so many @&X!! mosquitoes?

Lecture outline

- Two models of population growth
- Little *r*
- Exponential population growth
- Logistic population growth
- Density-dependent regulation of populations

Modeling population growth

- Depends on how organisms reproduce
  - In a discrete, non-overlapping way, often called _______ growth
  - In a continuous, overlapping way
- Either way, populations only change in abundance because of four parameters…
- Nevertheless, we often assume a *closed* population, which means we ignore…

r

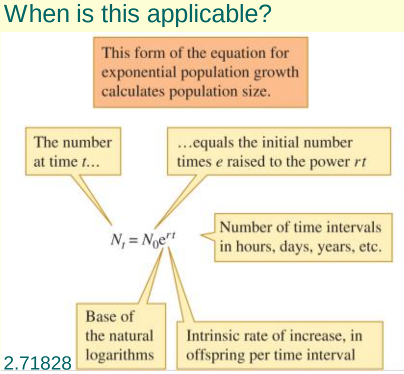
- At any moment in time, an individual's contribution to population growth is modelled as the per capita or intrinsic or instantaneous rate of increase
- *r* = ___________
  - *b* = ______ / ________
  - *d* = ______ / ________
- If *r* > 0, population is ?
- If *r* = 0, population is ?
- If *r* < 0, population is ?

Species	*r*	Doubling time
E. coli	58.7	17 min
Paramecium	1.59	10.5 hr
Tribolium	0.101	6.9 days
Rattus	0.015	46.8 days
Bos	0.001	1.9 yr
Nothofagus	0.000075	25.3 yr

From Gotelli

One equation for exponential growth

- When is this applicable?



Integrated form

= 2.71828

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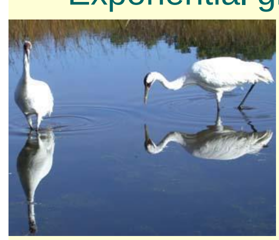
Fig. 11.4 bottom

Exponential growth in nature



Grus americana

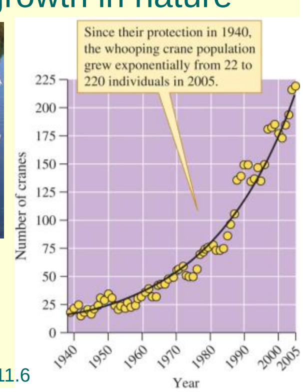
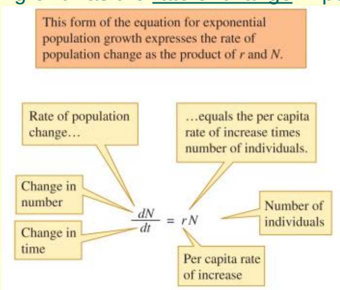


Fig. 11.6

A second exponential equation

- Instead of just looking at the total number of individuals, we can also express exponential growth as the rate of change in population size



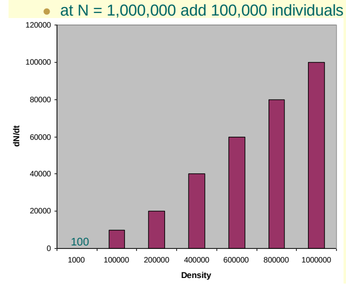
Differential form

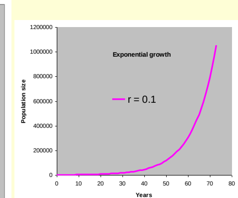
Fig. 11.4 top

Differential form in action

- $r = 0.1$
  - at N = 1,000, add 100 individuals each year
  - at N = 100,000 add 10,000 individuals each year
  - at N = 1,000,000 add 100,000 individuals each year

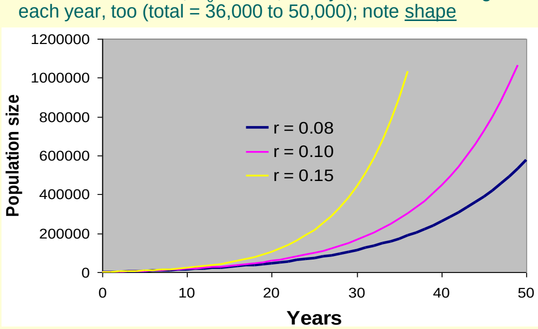
$$\frac{dN}{dt} = rN$$





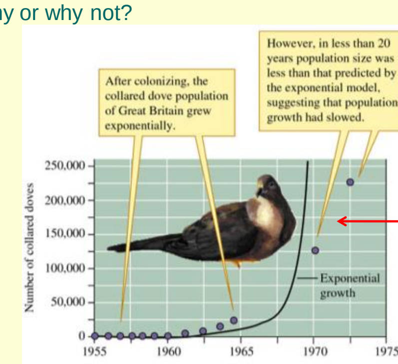
Importance of magnitude of *r*

- r = 0.08, 0.1,or 0.15; N_0 = 1000; t = 1 yr; 1000 new immigrants each year, too (total = 36,000 to 50,000); note shape



Is exponential growth always realistic?

- Why or why not?

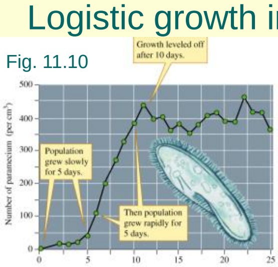


Why?

Fig. 11.7

Logistic growth in the lab and field

Fig. 11.10



Paramecium caudatum in the lab
Gause (1934)

Northern elephant seal in CA

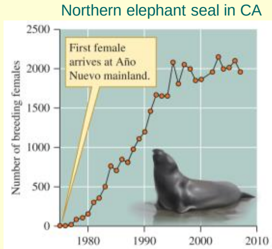


Fig. 11.12

Logistic growth

- Shape?

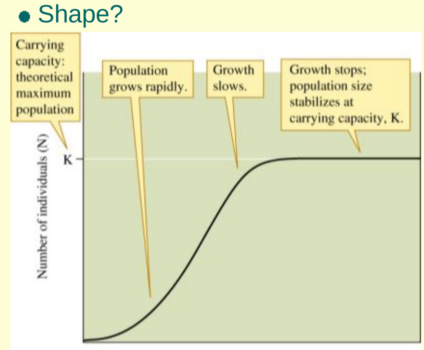


Fig. 11.8

What is K?

- Medium ground finch

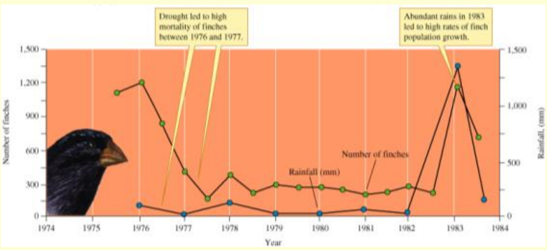


Fig. 11.17

Logistic growth

- Shape?

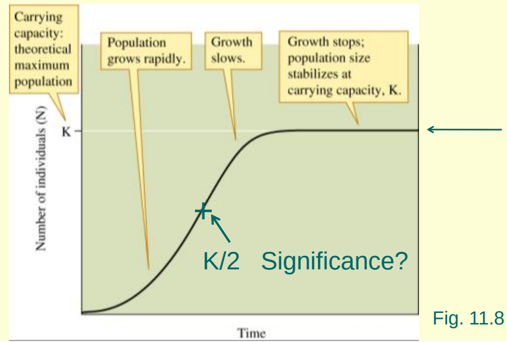
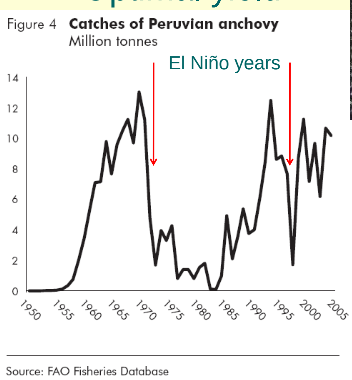


Fig. 11.8

Optimal yield



Hannesson 2008

Logistic growth equation

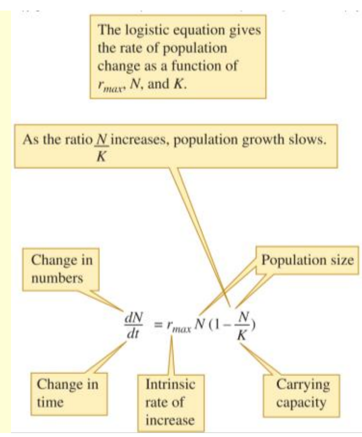


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Fig. 11.13

Population **regulation**

- K is thought to be an equilibrium density and is maintained by **density-dependent regulation**
  - As population size changes, birth and death rates change, too
- So, for a population to be regulated at this equilibrium, it must be controlled by **density-dependent** factors

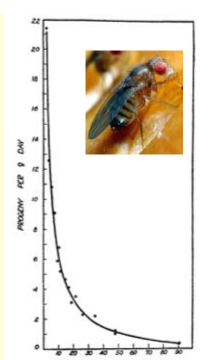

Fig. 10. Showing Changes in Rate of Reproduction of Drosophila with Increasing Density of the Mated Population

The circles give the observations and the smooth curve is the graph of the logarithmic equation discussed in the text.

Pearl (1927)

What are some factors *affecting* population size?

Which ones are "density dependent" factors?

Which ones are "density independent"?