

Previous Lecture

- *Populations are Structured*
- Basic descriptive attributes of populations:
 - Density (+estimation techniques; quadrat/mark-recapture)
 - Distribution
 - Dispersion (+estimation technique; index of dispersion):
- Practice Problem Video on Mark-Recapture on website.

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Lecture 2

All Populations Potentially Grow Exponentially

- A. Exponential population growth*
(Smith&Smith Chapter 9)
- B. Next: Exponential growth modified by age structure (next time; S&S Chap. 9)

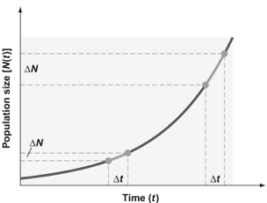
**Faite attention! Exponential growth theory is one of the most important concepts in all of Ecology!*
Biology science!

- A. Exponential population growth*
(Smith&Smith Chapter 9)
- B. Next: Exponential growth modified by
age structure (next time; S&S Chap. 9)

[illegible]

Exponential Growth

- ◆ The ‘Law of Exponential Growth’ is the
- ◆ Where does this law come from?



The graph illustrates exponential growth with Population size (N(t)) on the vertical axis and Time (t) on the horizontal axis. A curve starts at a low value and increases rapidly. Two points on the curve are highlighted, showing the change in population size (ΔN) and the change in time (Δt) over two different intervals. The slope of the curve increases as time progresses, indicating that the rate of growth is proportional to the current population size.

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Exponential Growth

- Individuals have some maximum birth rate (b)
- Individuals have some minimum death rate (d)
- The “per capita population growth rate”, r , is _____

Exponential Growth

- Total rate = per capita rate * capitas
- Population growth rate (dN/dt):

Exponential Growth

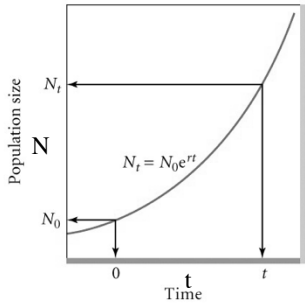
- This is an equation for a line, whose slope is r :

The graph shows a linear relationship between the population growth rate dN/dt (y-axis) and the population size $N(t)$ (x-axis). A straight line starts from the y-axis and extends upwards. A dashed right triangle is drawn under the line to indicate its slope, with the slope labeled as r .

Exponential Growth

→BUT, what kind of population growth (N vs. time) is predicted by this equation?

N vs. time



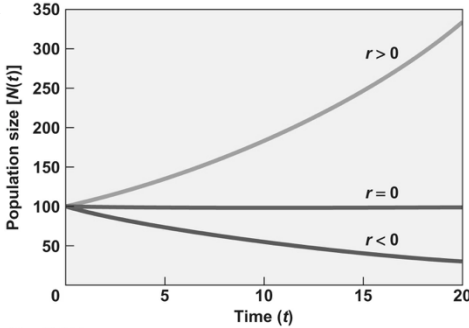




Fig. 9.3, S&S

Version 2 of the exponential growth equation replaces e^r with a different constant

Real World Exponential Growth



(a)



(b)

Fig. 9.6, S&S

Real World Exponential Growth

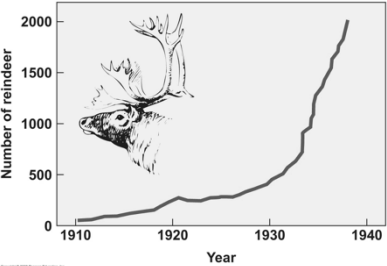
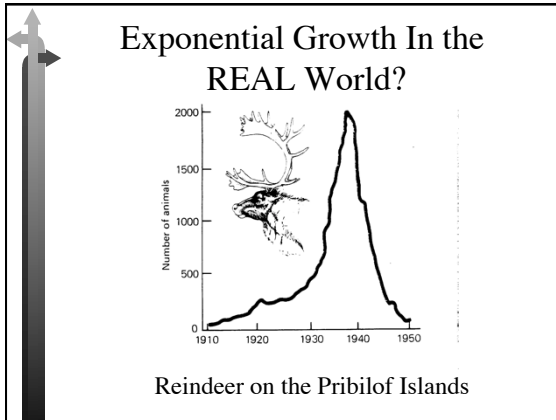
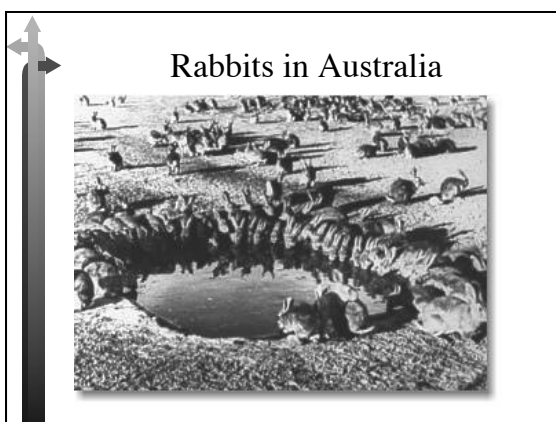


Fig. 9.5, S&S

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- Realized Exponential Growth
- ➔ Rabbits in Australia
 - ➔ Gypsy moth in North America
 - ➔ Locusts in Africa
 - ➔ Plague in Europe
 - ➔ Lemmings in the Arctic
 - ➔ Etc...



Gypsy Moth in North America



Locusts

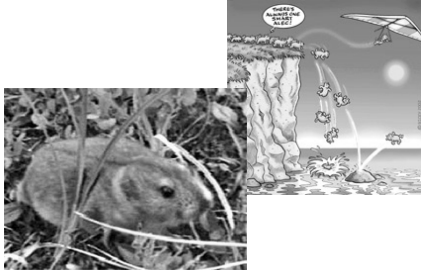


Plague



Bacterium: *Yersinia pestis* ('black death')

Lemmings



Sample Problem

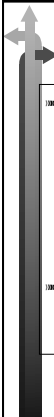
→ *E. coli* cells propagate by binary fission. They don't 'give birth' in the traditional sense. However, if the effective 'birth rate' of these cells is 6 cells/cell*hr, and death rate is 0, and the initial population consists of 100 cells, how long would it take to reach a population size of 4.92×10^{43} cells, enough to cover planet Earth 1 meter deep in bacteria?

→ SEE PRACTICE PROBLEM VIDEO 2!

Another sample problem!

→ If you wanted to leave \$1,000,000 to one grandchild in 60 years, how much would your initial investment have to be in order to accomplish this, assuming a 10% continuously compounded interest rate?

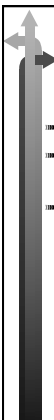
→ SEE PRACTICE PROBLEM VIDEO 2!



Another thought problem

→Facts: A penny is 19.05 mm in diameter. A penny is 1.52 mm thick. It is 384,400 km to the moon. I start stacking pennies in adjacent stacks (in a single row of stacks). The first stack has 1 penny, the second, 2, the third, 4, etc., doubling each time.

→How wide would row of penny stacks be when the last stack reaches to the moon?



Summary

→ All populations potentially grow exponentially

→ Exponential growth is a “compound interest” phenomenon

→ Occasional “outbursts” of exponential growth do occur in nature
