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.

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!
Exponential Growth

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

Total rate = per capita rate \( \times \) capitas

Population growth rate (\( \frac{dN}{dt} \)):

This is an equation for a line, whose slope is \( r \):
Exponential Growth

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

\[ N_t = N_0 e^{rt} \]

Figure 9.3, S&S
Version 2 of the exponential growth equation replaces $e^r$ with a different constant.

Real World Exponential Growth

Fig. 9.5, S&S

Fig. 9.6, S&S
Exponential Growth In the REAL World?

Reindeer on the Pribilof Islands

Realized Exponential Growth

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

Rabbits in Australia
Gypsy Moth in North America

Locusts

Plague

Bacterium: *Yersinia pestis* (‘black death’)

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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 $4.92 \times 10^{43}$ 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