Logistic Population Growth

Topics

The equation for logistic growth in discrete time

The definition of density-dependent growth

Basic properties of the model

Strange behavior of the (discrete time) model, such as damped oscillations and chaos

From Geometric to Logistic Growth

Geometric growth

$$N_{t+1} = N_t + N_t r$$

Logistic growth

$$N_{t+1} = N_t + N_t r_{max}\left(1 - \frac{N_t}{K}\right)$$

where

- r_{max} is the growth rate when N_t is close to 0.
- K is the carrying capacity

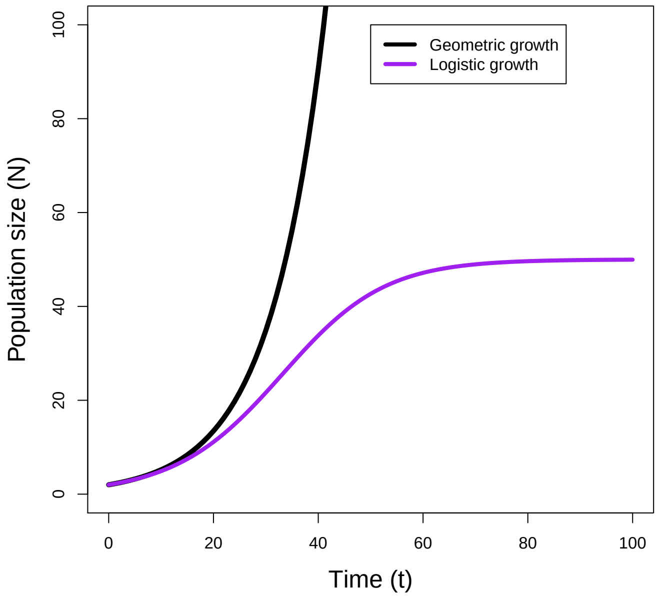
Density-dependent growth

Logistic growth is an example of **density-dependent growth**

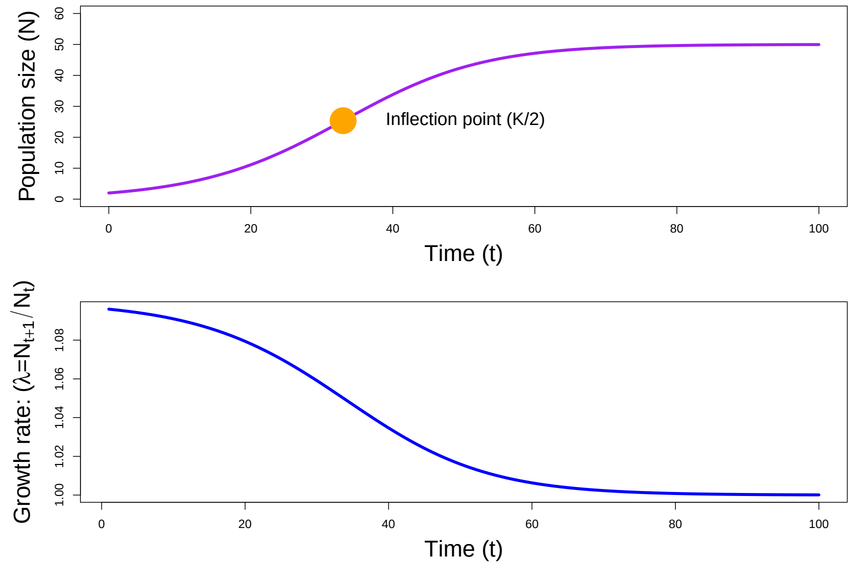
Definition: Population growth rate *is* affected by population size (N).

Implications: Resources are limited and there is a carrying capacity.

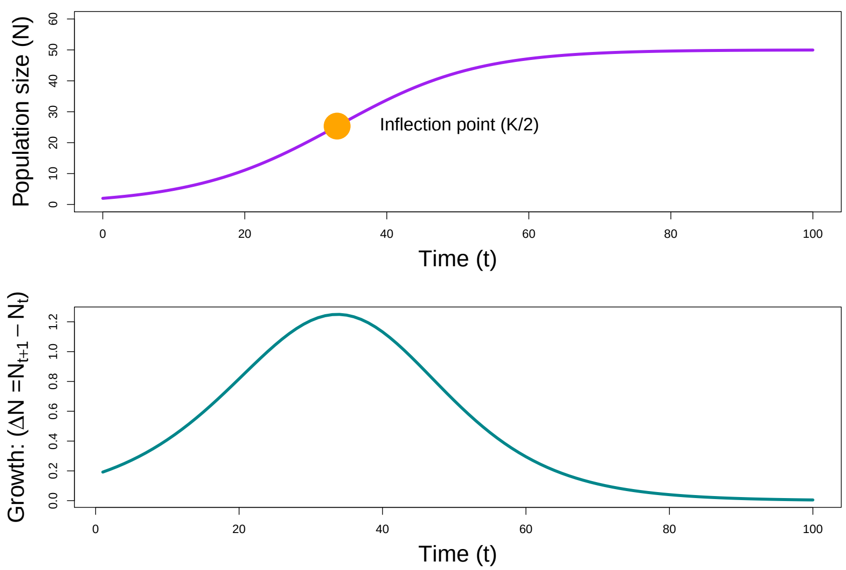
Graphical depiction



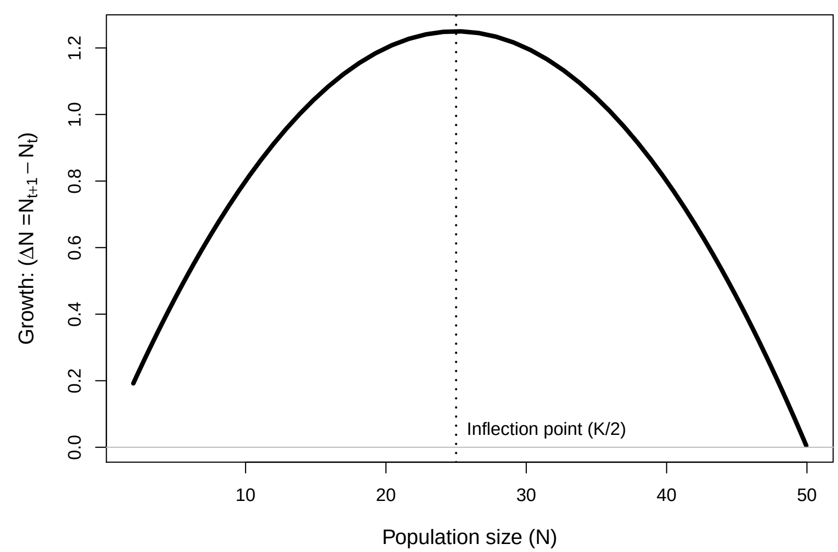
Growth rate ($\lambda_t = N_{t+1}/N_t$)



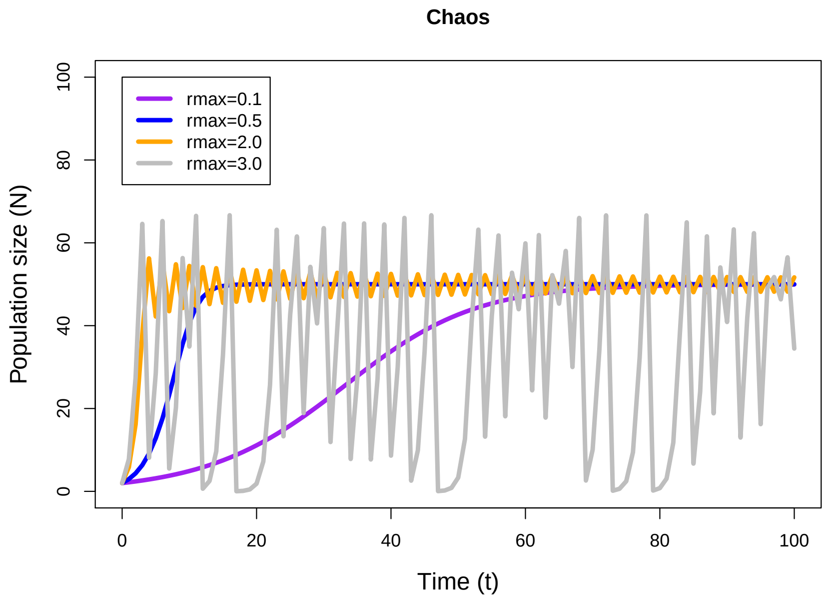
Growth ($\Delta_t = N_{t+1} - N_t$)



Growth ($\Delta_t = N_{t+1} - N_t$) as a function of N



What happens when we change r_{max}?



Definitions

Overcompensation

Density-dependent response in which populations over- or under-shoot carrying capacity rather than approach it gradually

Chaos

Highly variable dynamics that are extremely sensitive to small changes in parameters

Assumptions of basic model

- K and r_{max} are constant
- No sex or age effects or other sources of individual heterogeneity
- No time lags
- No stochasticity

Summary and assignment

Summary

- Logistic growth is a form of density-dependent growth
- Growth rate ($\lambda_t = N_{t+1}/N_t$) declines as N approaches K
- Growth ($\Delta_t = N_{t+1} - N_t$) peaks at $K/2$ (the inflection point)
- The model isn't mechanistic in the sense that it doesn't include birth, mortality, and movement processes.
- But it does allow for complex dynamics that resemble patterns seen in nature.

Assignment

Read pages 32–36 in Conroy and Carroll