

Extinction



- 1 INTRODUCTION
- 2 DETERMINISTIC MODELS
- 3 STOCHASTIC MODELS
- 4 ALLEE EFFECTS

EXTINCTION

- Many believe that humans are causing the 6th mass extinction event
- At least 1000 species have gone extinct over past 500 years
- Extinction rate unknown, but may be 100-1000 times higher than during the past 25 million years
- Almost 200 bird species have gone extinct since 1500
- Avian extinctions in GA: passenger pigeon, Bachman's warbler, ivory-billed woodpecker, Carolina parakeet



<https://vimeo.com/42592260>

CORRELATES OF EXTINCTION RISK

Species with high extinction risk often have:

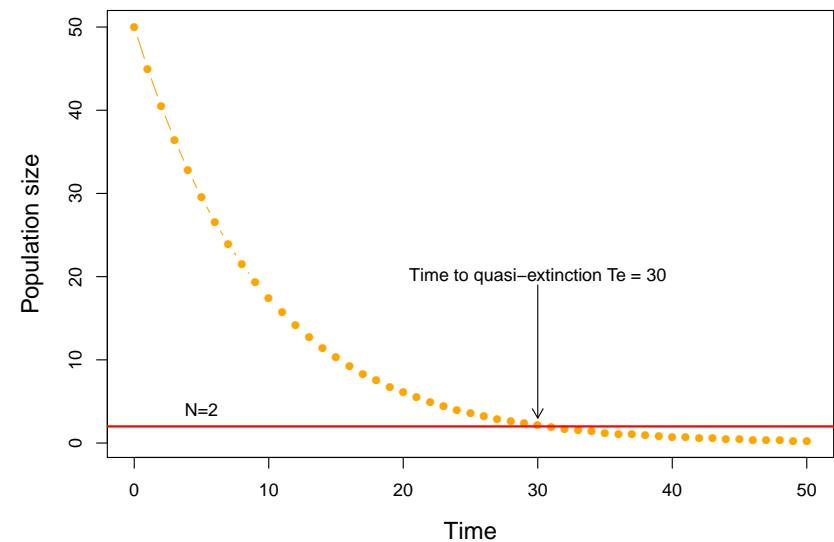
- Small range
- Low population size
- Limited dispersal ability
- Low population growth rate

For a model with no random variation, *time to extinction* can be calculated easily

But how should we define extinction?

Time to quasi-extinction (T_e) is the time it takes for a population to reach an extinction threshold beyond which it is doomed

Threshold usually based on genetic considerations, Allee effects, etc. . .



In addition to time to extinction (T_e), we are now interested in *extinction risk*

Extinction risk is the *probability* that a species goes extinct in some time period

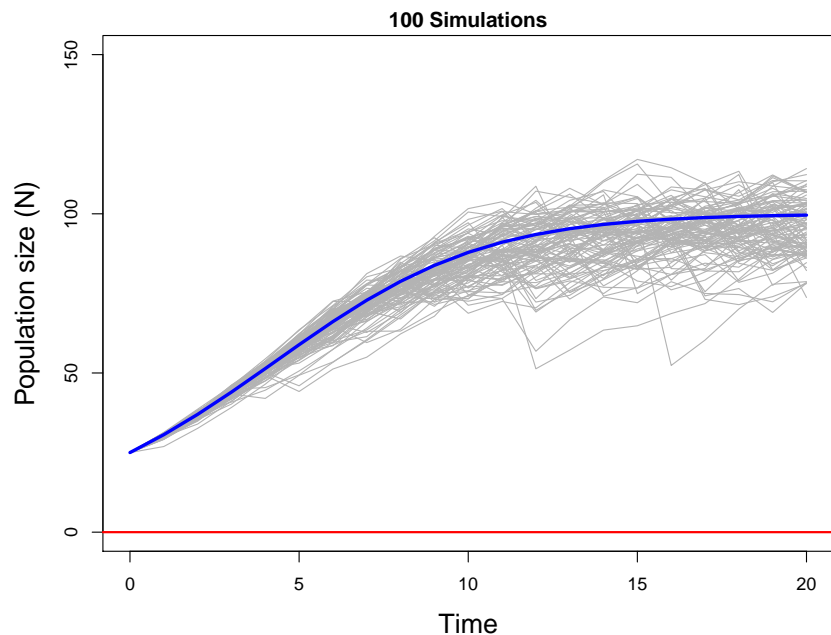
For a stochastic model, extinction risk can be calculated as the proportion of simulations in which the population goes extinct.

Calculating extinction risk requires a specification of the time horizon of interest

$$N_{t+1} = N_t + N_t r_{max} (1 - N_t / K_t)$$

where

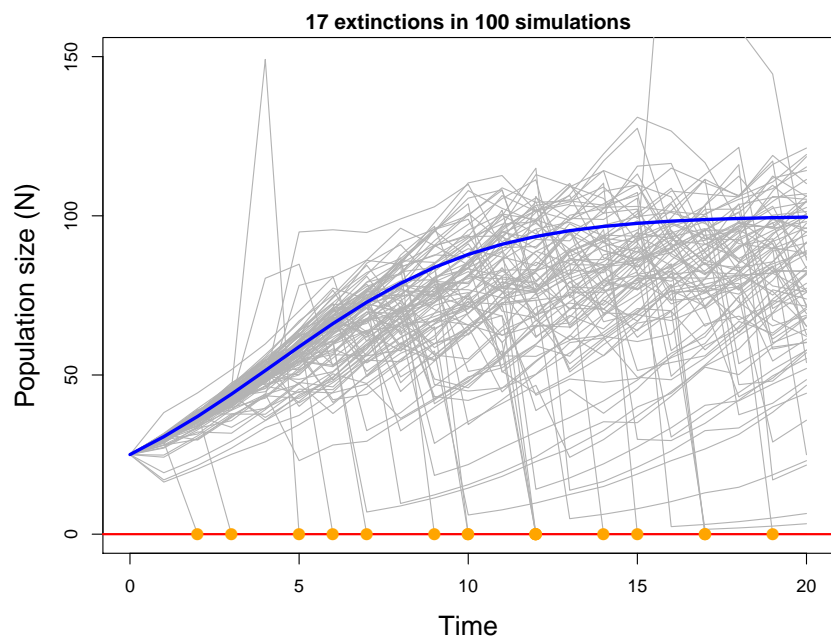
$$K_t \sim \text{Normal}(\bar{K}, \sigma_e^2)$$



Zero extinctions in 100 simulations, hence extinction risk is (approximately) zero over the 20 year time horizon

Assumptions

- We have the correct model
- We know the parameters with certainty



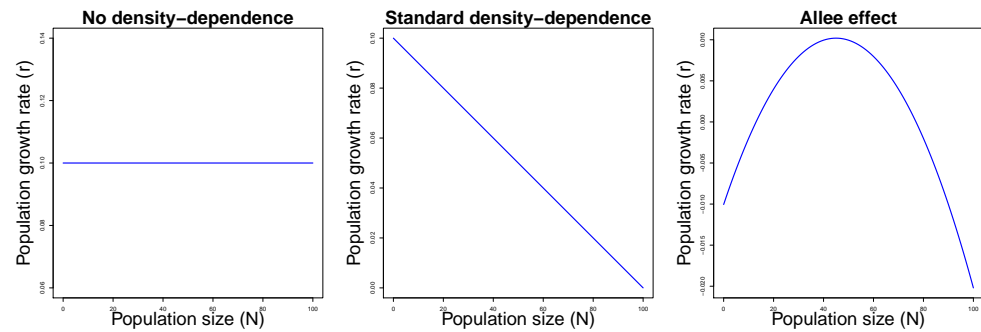
Normally, population growth rates increase as the population decreases (negative correlation)

The Allee effect is the phenomenon of positive correlation between population growth rates and population size

Mechanisms

- Finding a mate becomes difficult
- Social systems collapse
- Inbreeding depression
- etc...

Allee effects can greatly increase extinction risk for small populations



Humans have increased extinction rates dramatically

Models allow us to predict time to extinction and extinction risk

Models can be used to assess effects of management actions on extinction risk

ASSIGNMENT

Read pages 27–31 in Conroy and Carroll