

Gambling with Australian brachiopods

Peter D Smits

Committee on Evolutionary Biology, University of Chicago

September 22, 2014

Foundation

Question

Why do taxa go extinct at different rates?

Common observation

Pattern

Species with large geographic ranges have a low extinction risk.

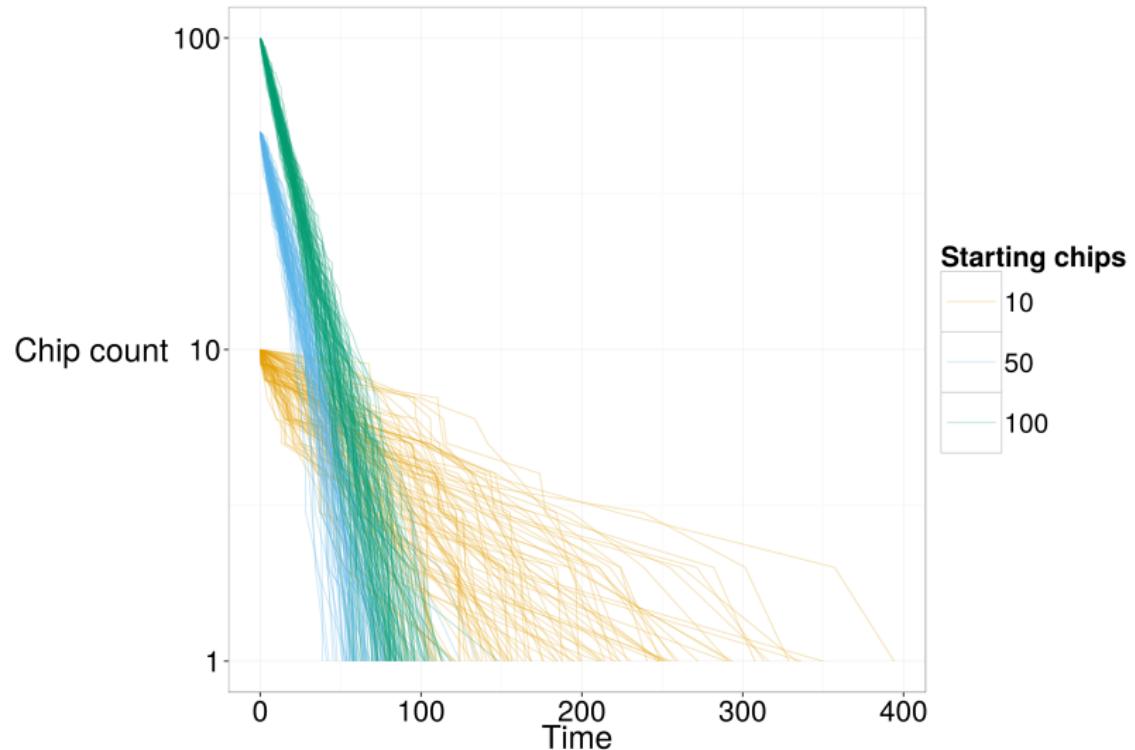
Expected given **purely random** extinction.

Gambler's Ruin

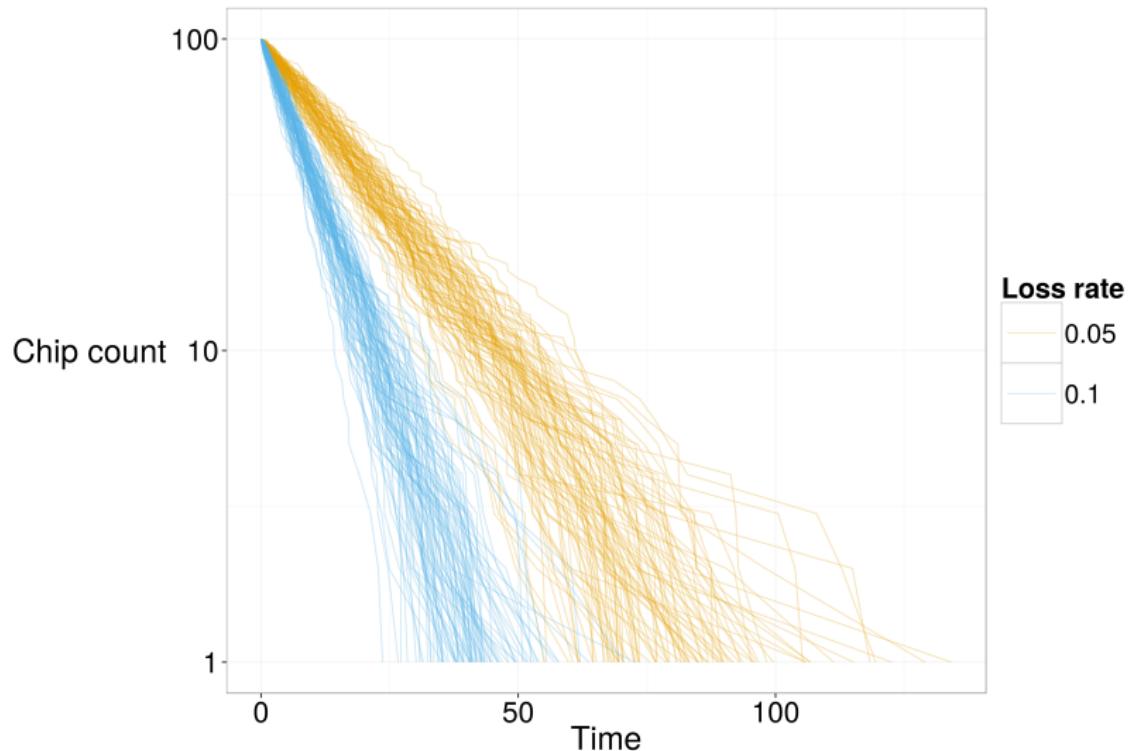
Definition

Given infinite time, all gambler's go bust.

Same rates



Different rates

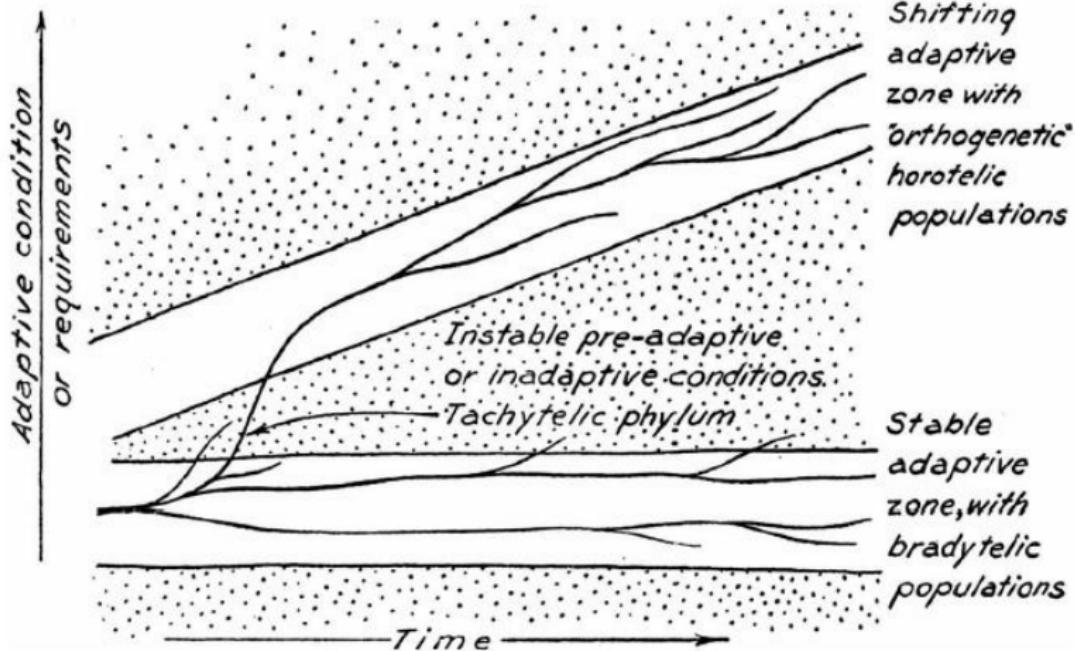


Mechanism

Problem

Impossible to distinguish **random** from **selection** without more information.

Adaptive zones



(Simpson 1944 Tempo and Mode)

Enter brachiopods

Permian

Australia and New Zealand (pbdb + fred)

substrate affinity

paleoenvironment affinity

Brachiopods, environmental preference, and extinction

Question

Do interactions involved in environmental preference predict differential survival?

Formalization of Van Valen

Law of Constant Extinction

$$T \sim \text{Exp}(\lambda)$$
$$\sim \text{Weibull}(\lambda, k = 1)$$

T : survival time

λ : expected number of extinctions per unit time

k : time proportionality

Bayesian framework

- better capture uncertainty
- continuous model development
- interpretability

Affinity is a distribution, not a scalar

e.g. $\text{Pr}(\text{taxon carbonate draw} \mid \text{all taxon draw})$ has uncertainty.

Improved prior e.g. substrate affinity:

$$\begin{aligned} (\theta_{\text{carb}} \mid \text{rocks}) &\sim \text{Bin}(\text{carb} \mid \text{rocks}, \theta_{\text{carb}}) \text{Beta}(\alpha, \beta) \\ &\sim \text{Beta}(\text{carb} + \alpha, \text{rocks} - \text{carb} + \beta) \end{aligned}$$

Estimate affinity as part of model.

Propagate uncertainty.

Acknowledgements

- ▶ Advising
 - ▶ Kenneth D. Angielczyk,
Michael J. Foote
 - ▶ P. David Polly,
Richard H. Ree
- ▶ Discussion and advice
 - ▶ David Bapst, Megan
Boatright, Ben Frable,
Marites Villarosa Garcia,
Kathleen Ritterbush,
Darcy Ross, Liz Sander,
Carl Simpson



The Field
Museum

