Gambling with Australian brachiopods

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Gambler's Ruin

Definition

Given infinite time, all gambler's go bust.

Death of a taxon

Taxa as gamblers

All taxa, given infinite time, go extinct.

Foundation

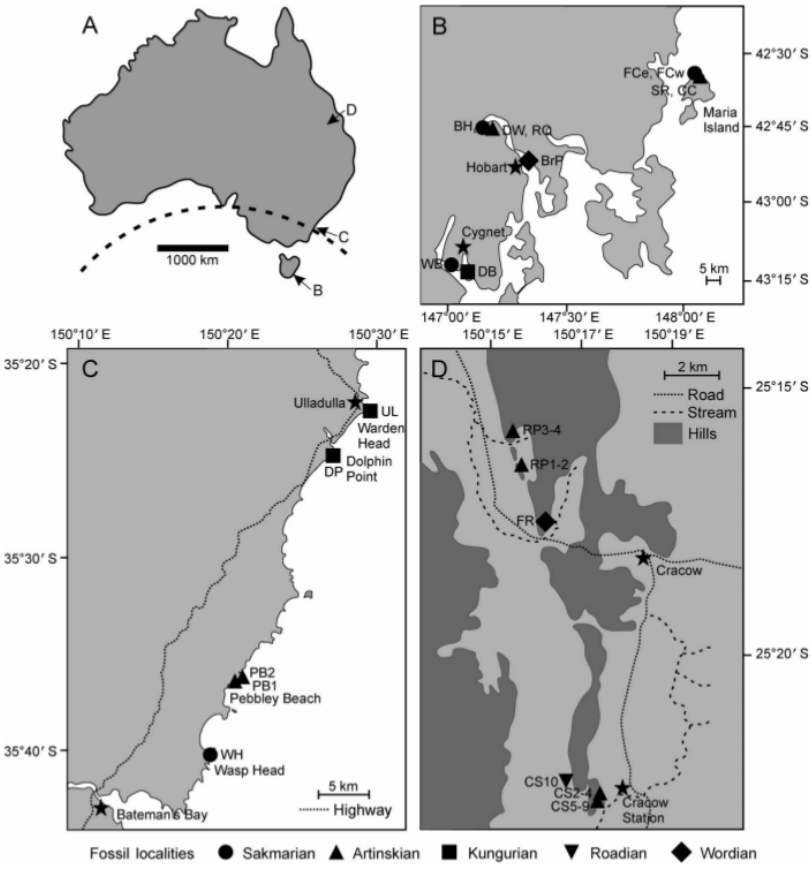
Question

Why do taxa go extinct at different rates?

Enter brachiopods

(Immersion Imagery, Shutterstock; Wikimedia)

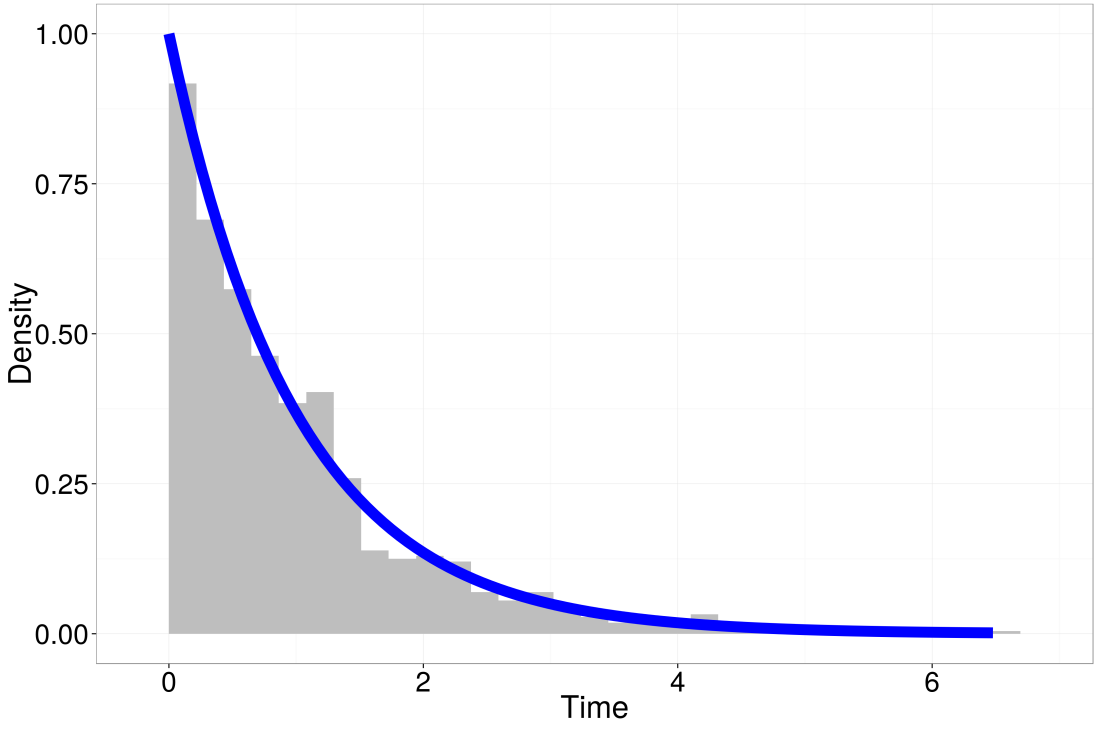
System details

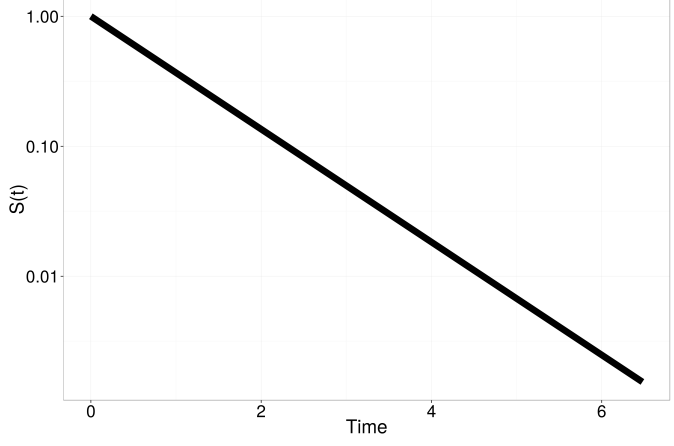


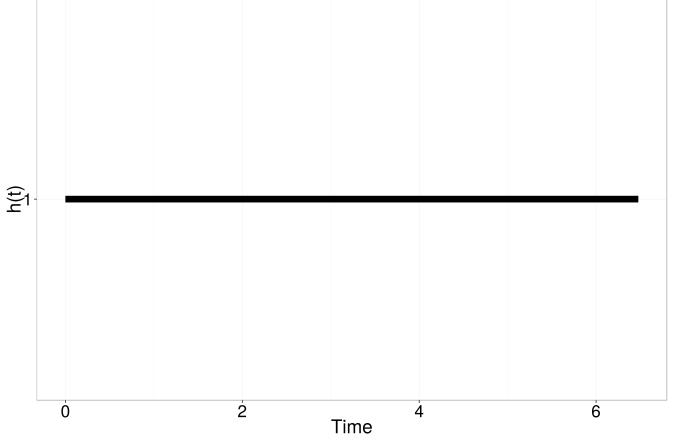
(Clapham and James 2008 *Palaios*)

- Australian Permian
  - range in/out taxa right censored
- predictors
  - substrate probability (fully Bayesian approach)
  - onshore/offshore
  - body size (Payne *et al.* 2014 *Proc. B*)
  - occupancy (see Vilhena *et al.* 2014 *Nature Com.*)

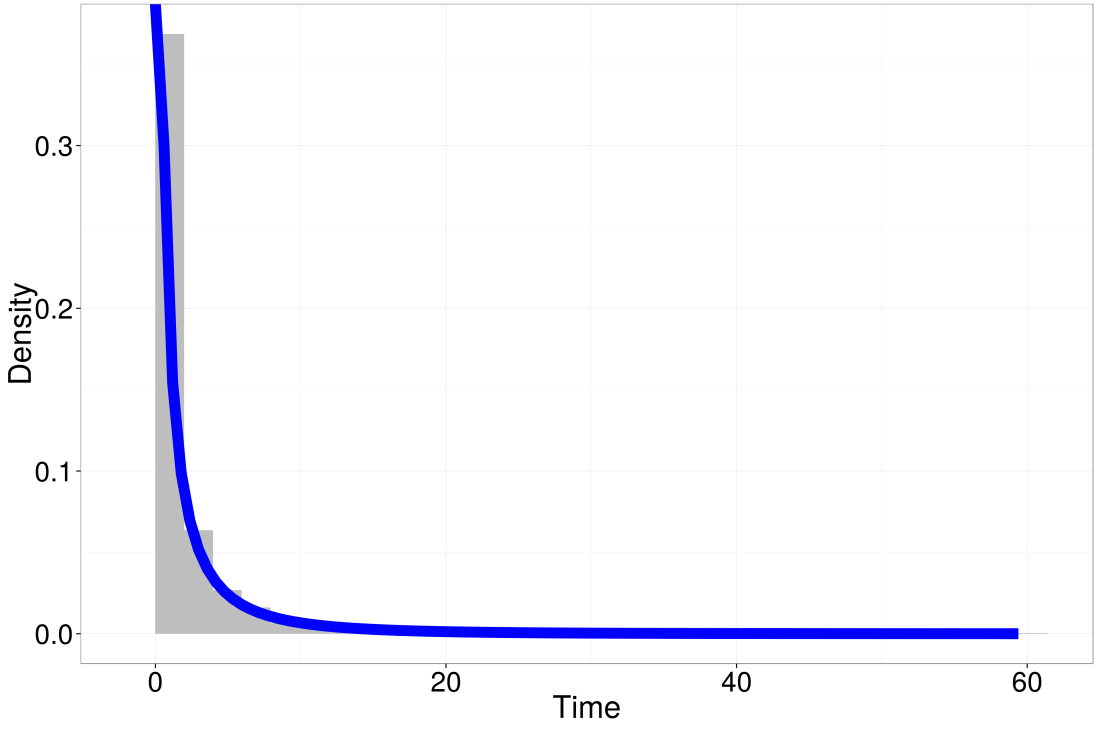
Survival analysis

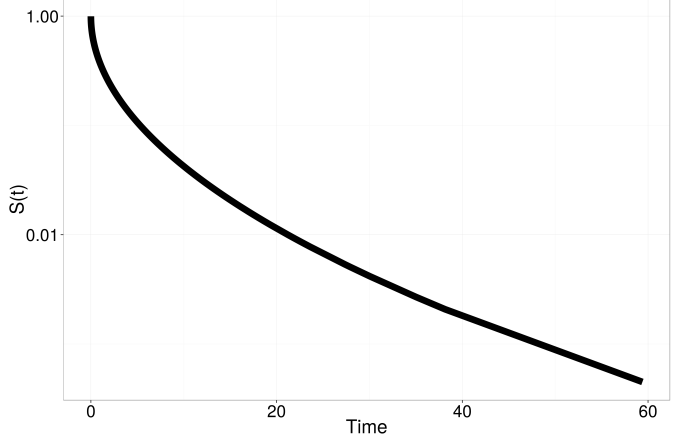


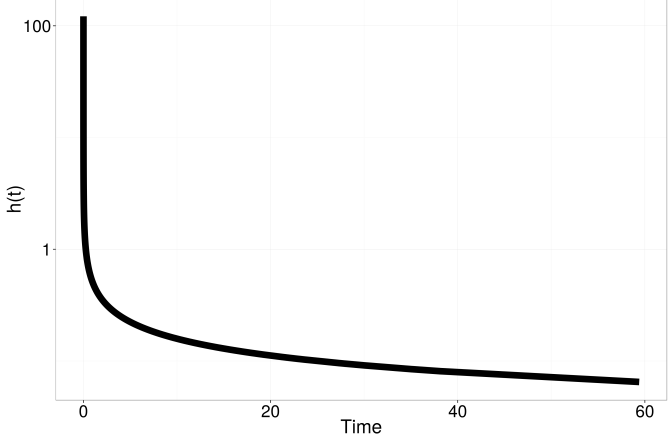




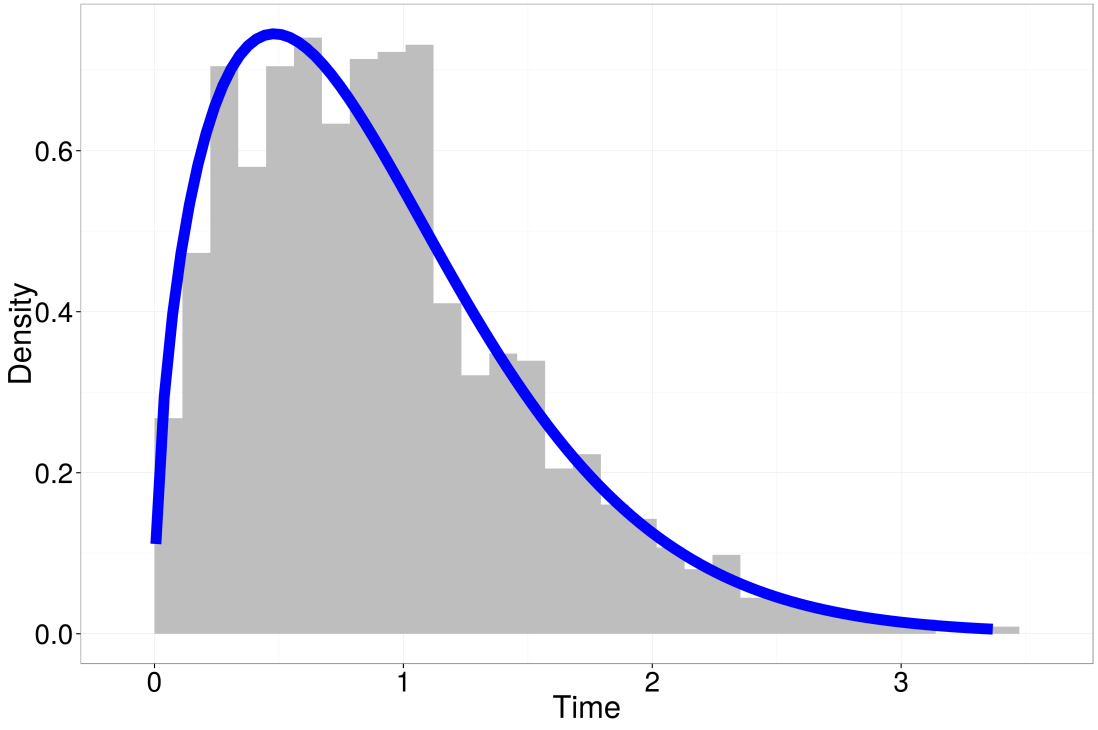
Survival analysis

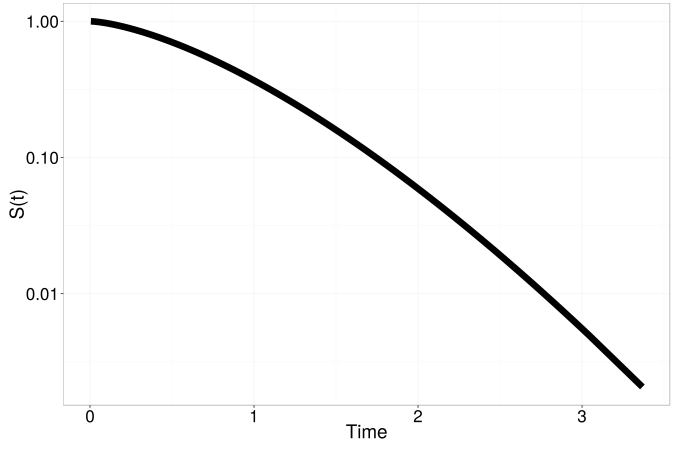


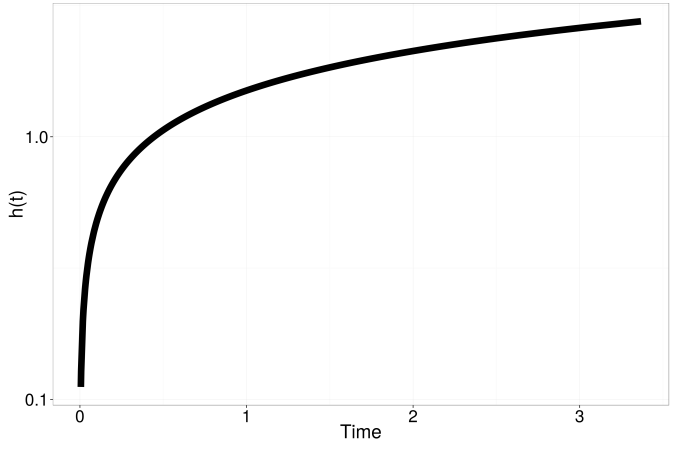




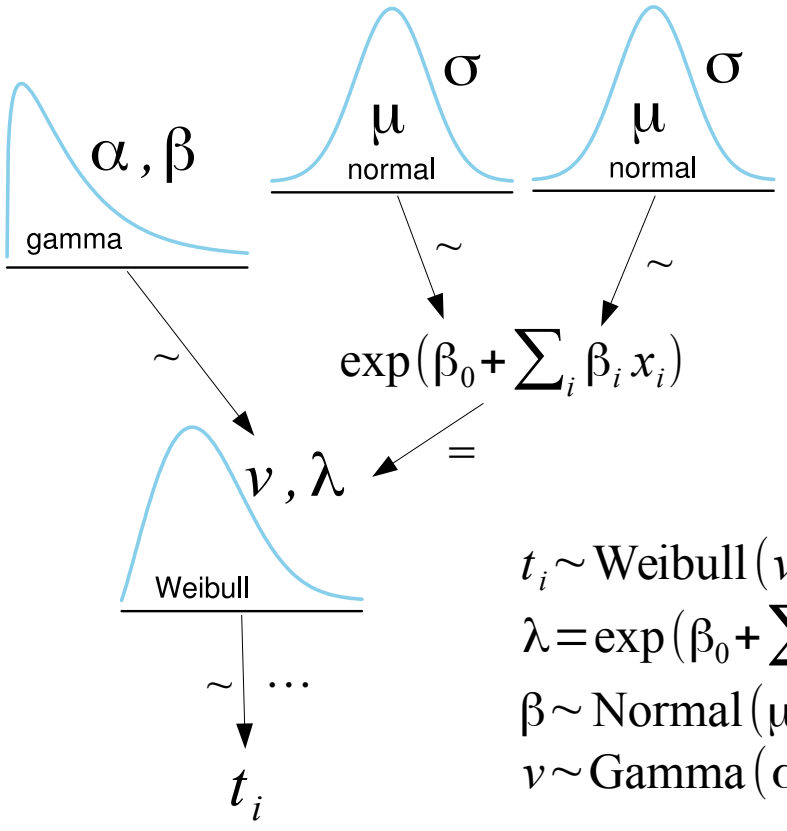
Survival analysis





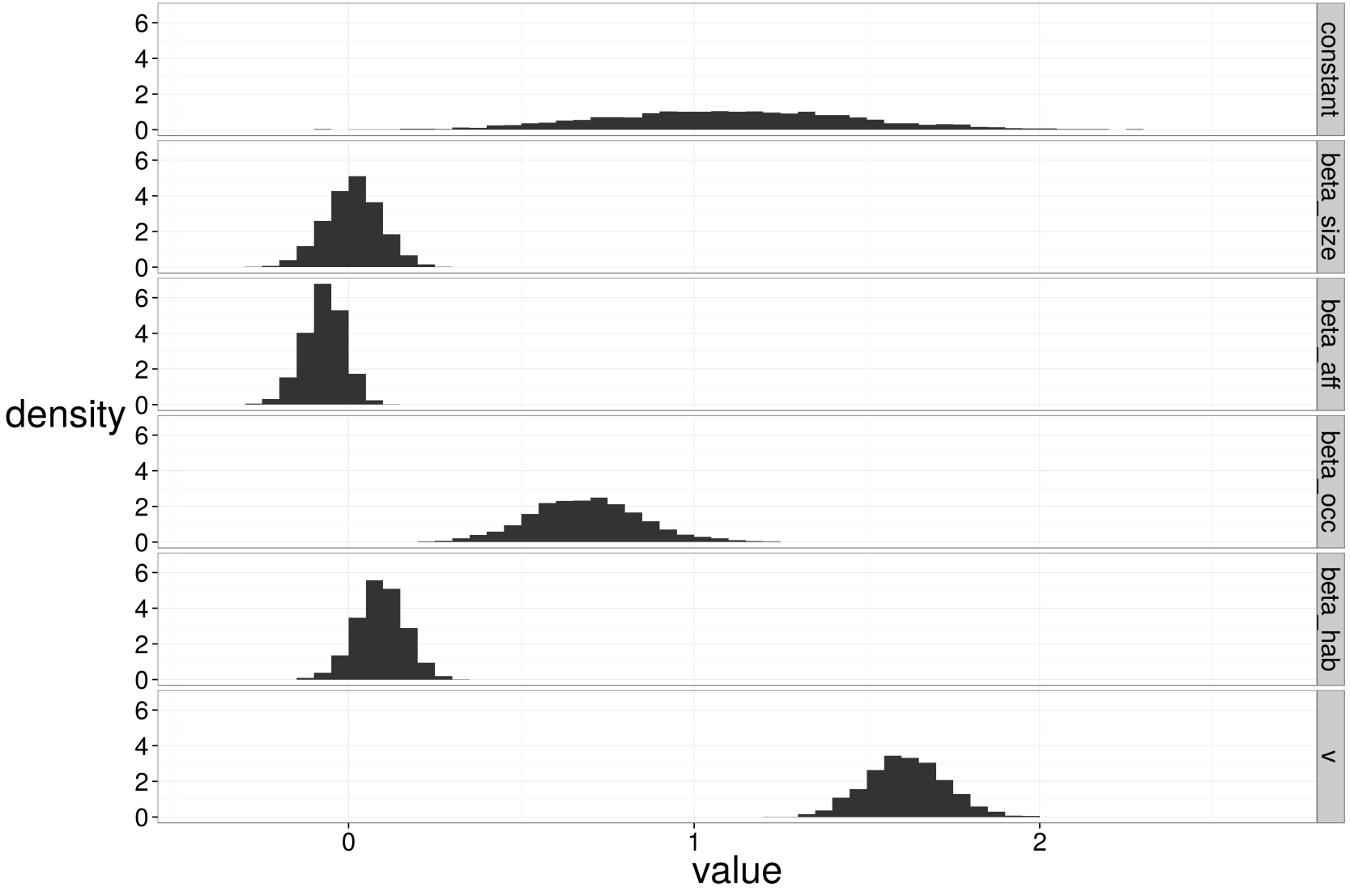


Bayesian model structure

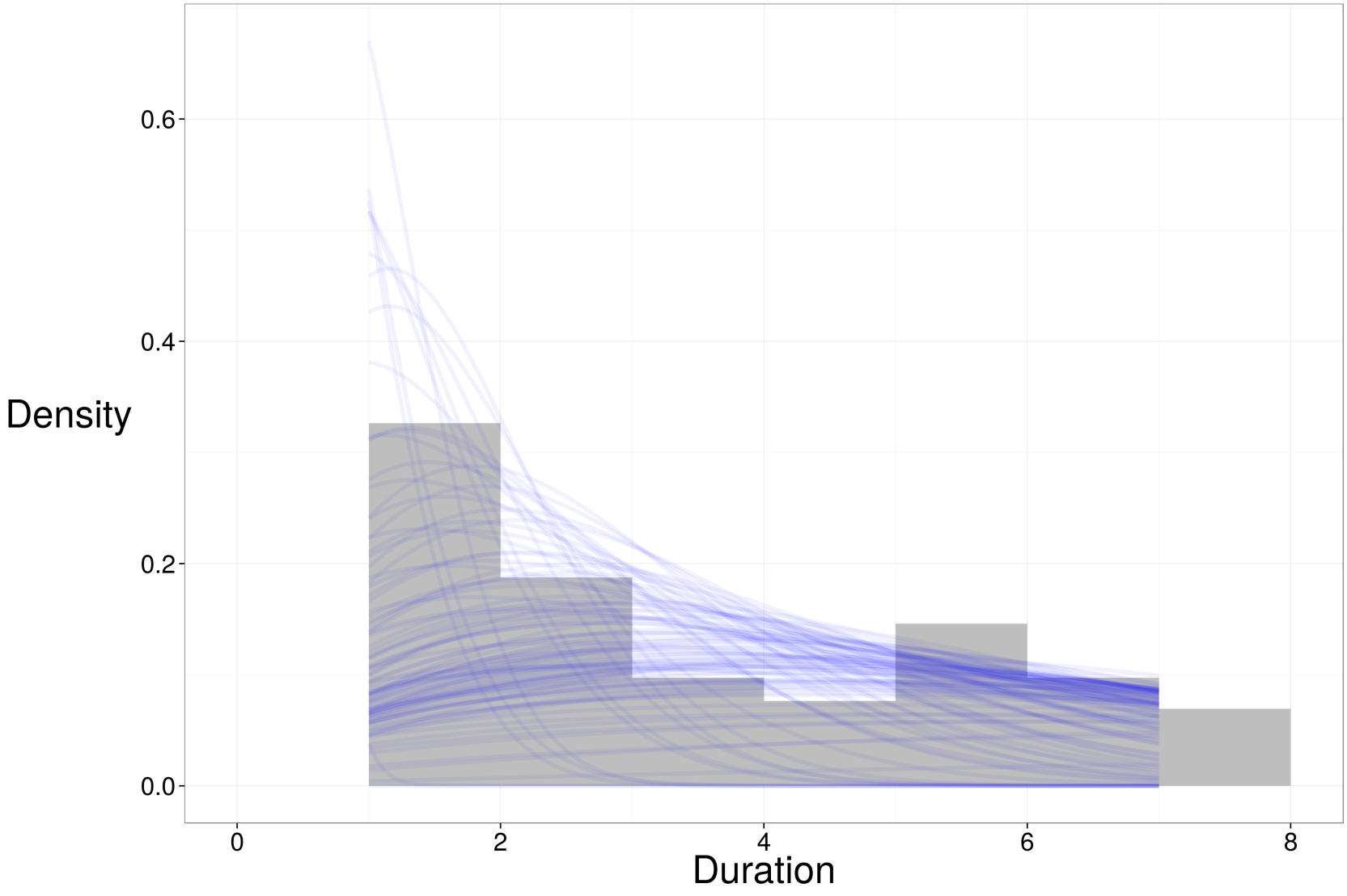


$$t_i \sim \text{Weibull}(\nu, \lambda)$$
$$\lambda = \exp(\beta_0 + \sum_i \beta_i x_i)$$
$$\beta \sim \text{Normal}(\mu, \sigma)$$
$$\nu \sim \text{Gamma}(\alpha, \beta)$$

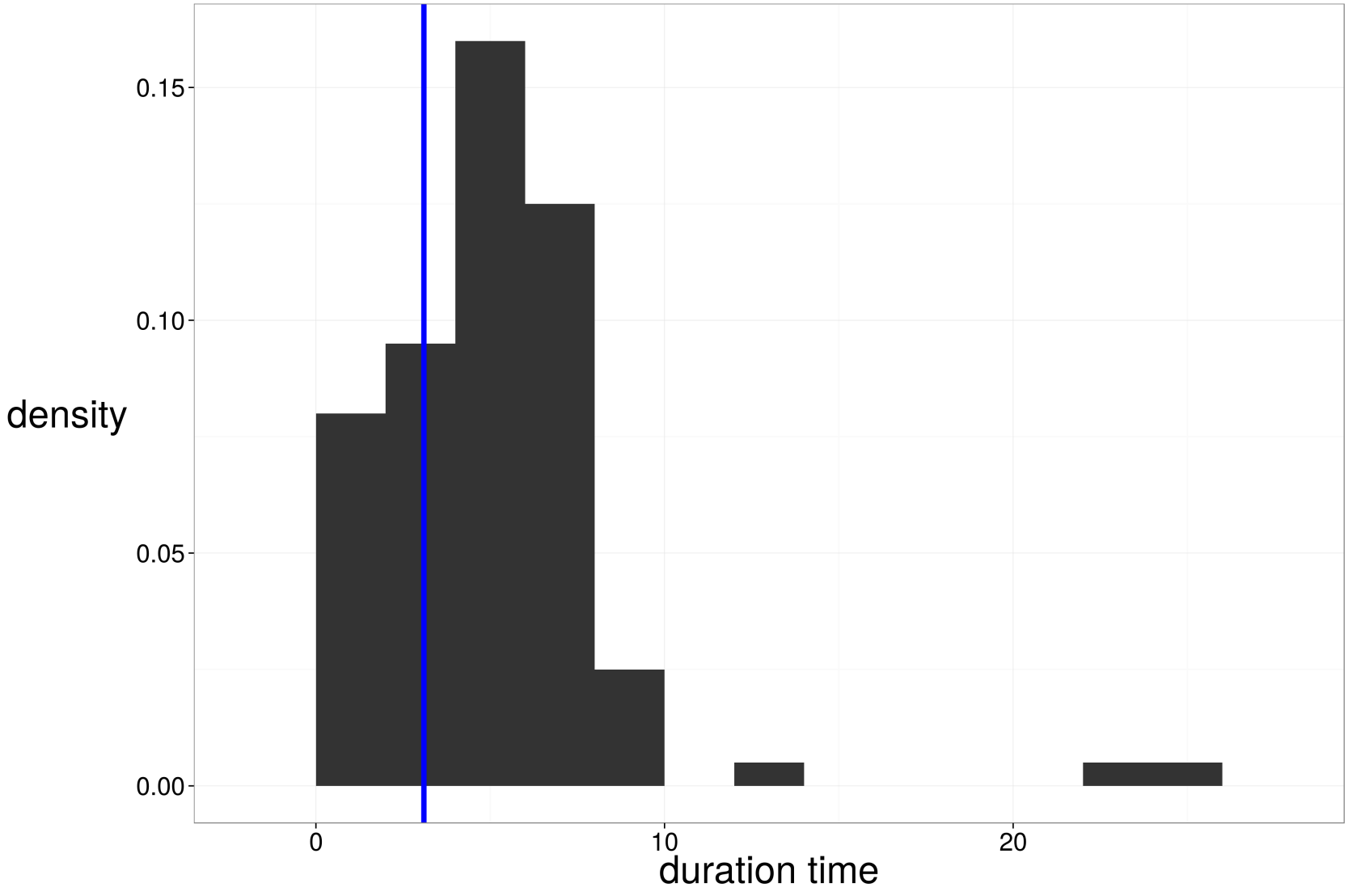
Parameter marginal posteriors



Durations



Posterior predictive check: mean duration



State of knowledge

Conclusions

Extinction is age-dependent ($v > 1$).

Occupancy has largest effects.

Nonlinearity or heterogeneous variance in size, affinity, habitat.

Overall, current model has problems at the tails.

Improvements

- Data
  - New Zealand (FRED)
  - improved paleoenvironment reconstructions
  - affixing strategy information
- Model
  - robust priors (t-distribution)
  - difference likelihood (log-logistic, generalized gamma)
  - substrate, habitat as distributions (fully hierarchical model) or just make categorical?
  - effect of sampling

Acknowledgements

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

The Field Museum

Fossilworks

The Paleobiology Database
revealing the history of life