Talks, travel, grants

Brachiopods

Mammals

Talks

- Evolution 2014: basic comparison between NA and European mammal survival
- GSA 2014: current fully Bayesian model of brachiopod survival
  - lots of positive feedback, ideas

Travel and grants

- AMNH: tooth measures for all notoungulate specimens identified to species level
- DDIG: applied; travel to Argentina; collaboration with Rick Madden

Current brachipod survival model

Target and developing survival model

Point/counting process of fossils in the record

(overdispersed) Poisson model of occurrence

Hierarchical genera in groups from Foote and Miller

Count of fossil occurrences per bin per genus for duration of observed geneus

How to model?

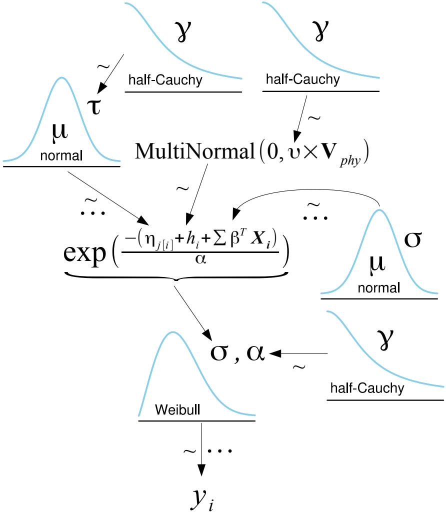
Death and Taxa: biological, temporal, and historical effects on mammal species duration

North American survival

- species duration as measure of survival
- traits
  - organismal: diet, locomotor categories
  - species: body size, bioprovince occupancy
- origination cohort
- phylogeny primarily based on taxonomy

- duration defined as number of 2My bins from FAD to LAD, inclusive
- fully Bayesian hierarchical model
- censoring approach
  - if still extant, right censored
  - if not extant and duration of only 1 bin, left censored

Model diagram



$y_i \sim \mathrm{Weibull}(\sigma, \alpha)$

$\eta_{j[i]} \sim \mathrm{Normal}(0, \tau)$

$\tau \sim \text{half-Cauchy}(2.5)$

$h_i \sim \mathrm{MultiNormal}(0, \Sigma)$

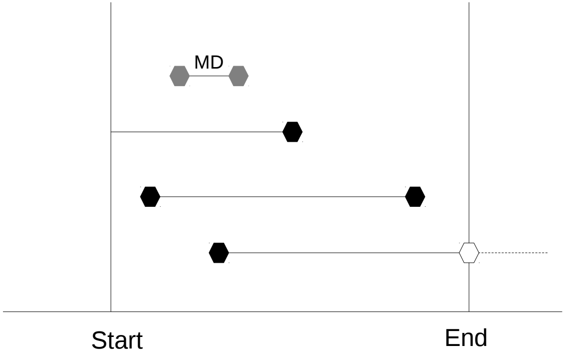
$\Sigma = \upsilon \times \mathbf{V}_{phy}$

$\upsilon \sim \text{half-Cauchy}(2.5)$

$\beta \sim \mathrm{Normal}(0, 10)$

$\alpha \sim \text{half-Cauchy}(2.5)$

Censoring



Probability with censoring

Right censored if not yet extinct

ccdf (1 - cdf) at observed duration given model

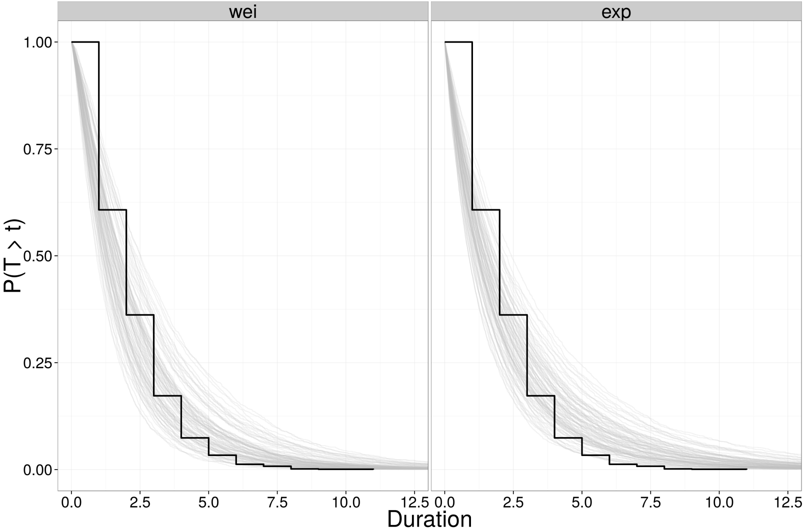
$$\Pr[T > T_i] = \int_{T_i}^{\infty} \mathrm{Weibull}(T_i|\alpha, \sigma)dy = 1 - F(T_i|\alpha, \sigma) \tag{1}$$

Left censored if both extinct and only one stage

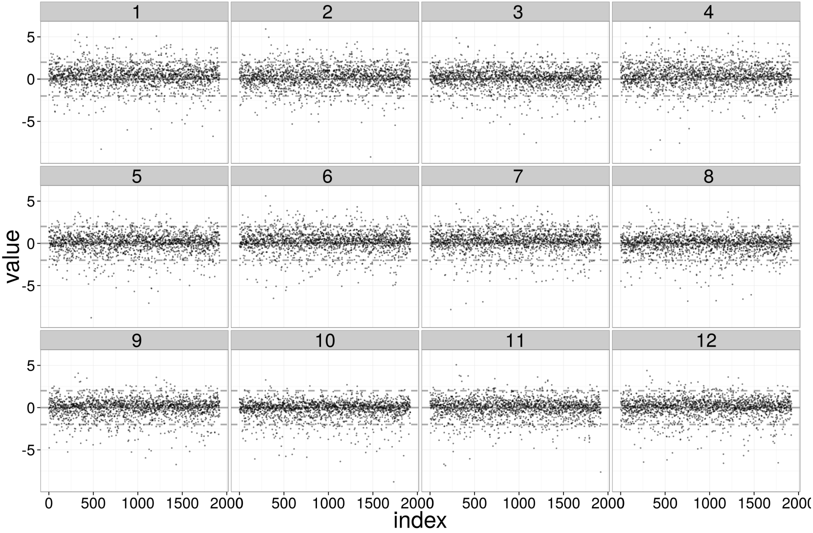
cdf at observed duration given model

$$\Pr[T < T_i] = \int_{-\infty}^{T_i} \mathrm{Weibull}(T_i|\alpha, \sigma)dy = F(T_i|\alpha, \sigma) \tag{2}$$

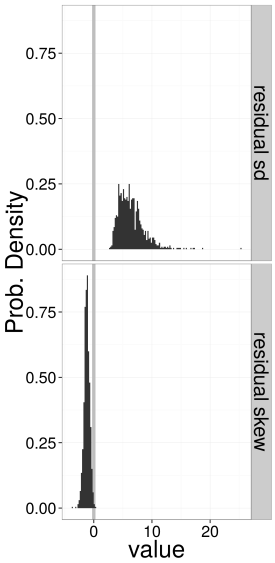
Posterior predictive checks: S(t)

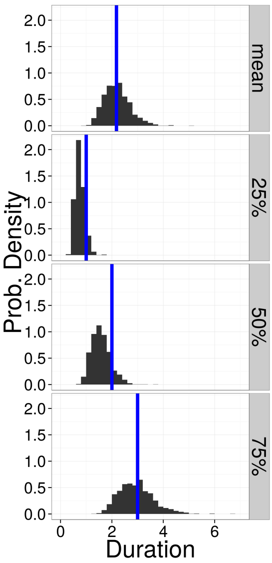


Posterior predictive checks: stnd. residuals

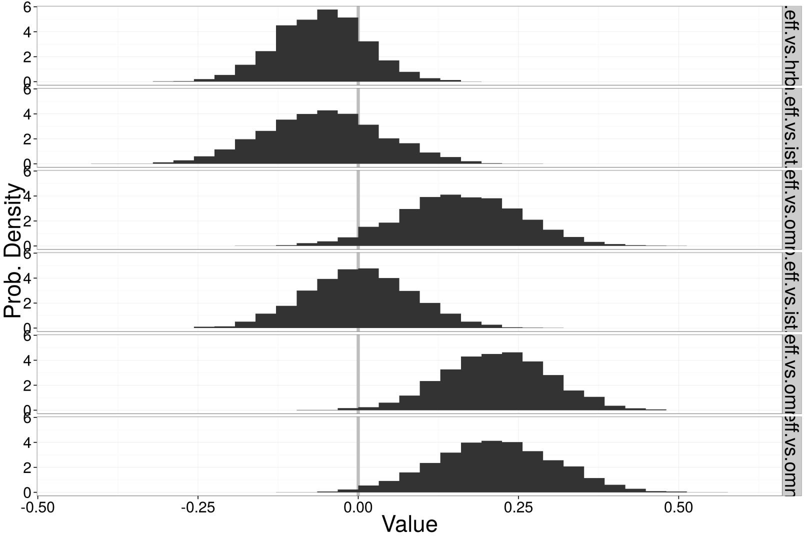


Posterior predictive checks: residuals and mean

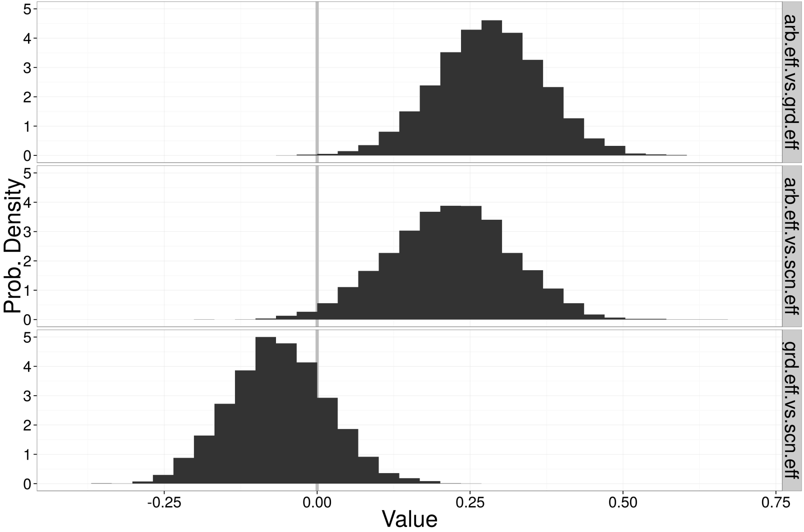




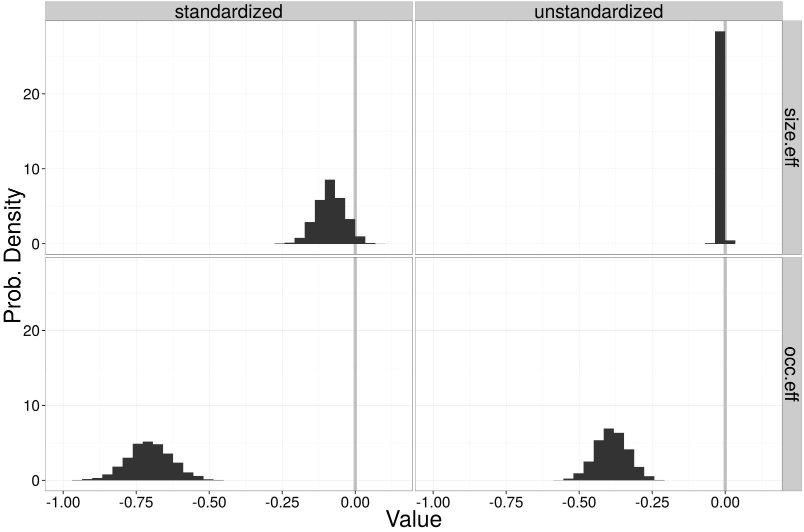
Pairwise differences of β, dietary category



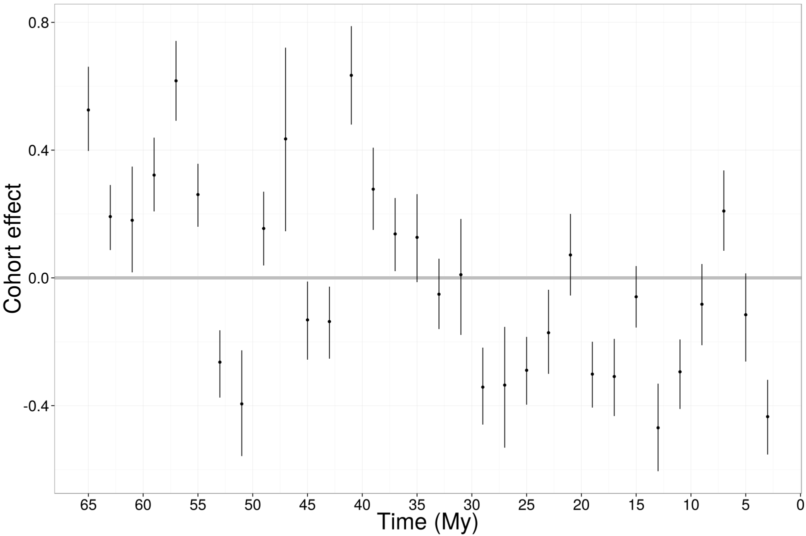
Pairwise differences of β, locomotor category



Other traits



Cohort effect



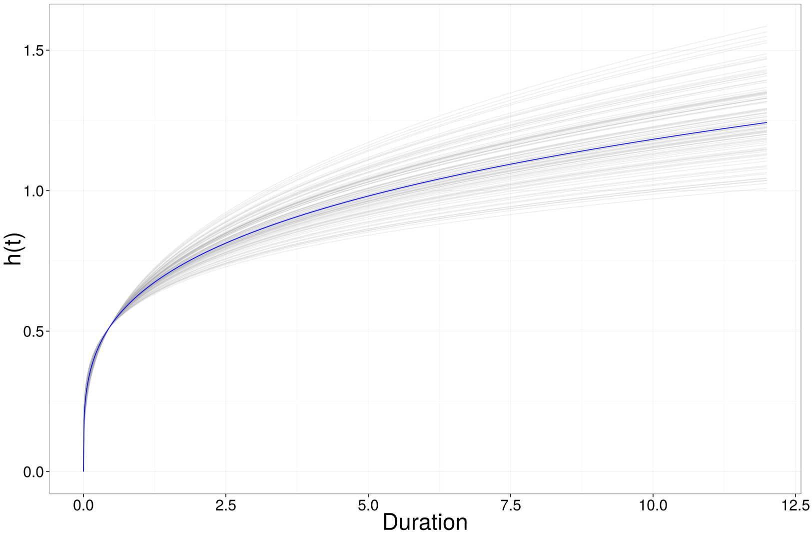
Partial pooling: cohort

Phylogenetic effect

Phylogenetic heritability *sensu* Lynch '91

note: actually just a special case of partial pooling.

Hazard curvature



Meaning

Results

- comparable probabilistic statements of trait, temporal, and historical effects
- decreasing cohort survival risk over Cenozoic
- $h(t)$ not constant over t, increases slowly
- model generally fits; no systematic biases in residuals

Interpretation

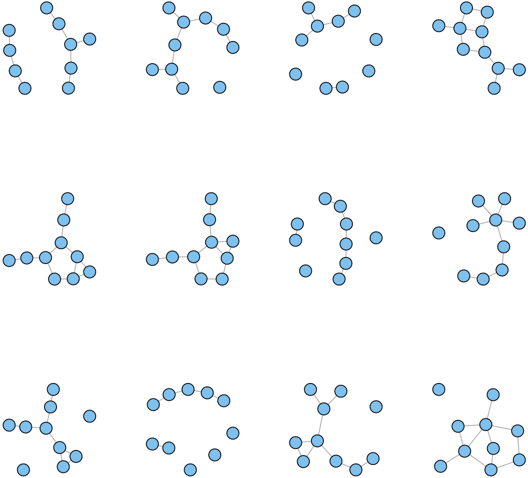
- older lineages out-competed by younger (Wagner and Estabrook '14 *PNAS*)
- increasing extinction with group age (Quental and Marshall '13 *Science*)
- background extinction and the blurring of Raup's modes of extinction
- relative effect of each covariate, levels of selection(?)

A model of biological, spatial, and phylogenic effects on Cenozoic mammal co-occurrence

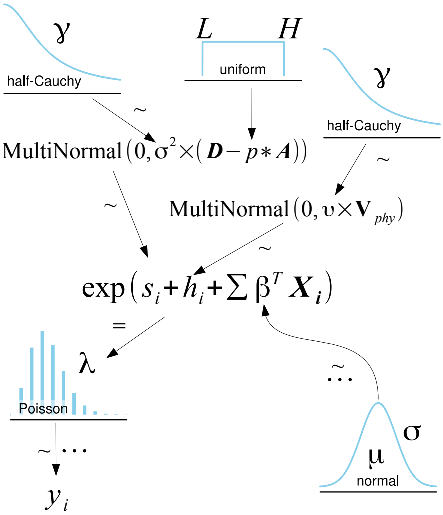
Biogeographic network

Species adjacency

Erdos-Renyi graph $G(n, p)$



Model diagram



$y_i \sim \mathrm{Poisson}(\lambda)$

$s_i \sim \mathrm{MultiNormal}(0, \Sigma_s)$

$\Sigma_s = \sigma^2 * (\boldsymbol{D} - p * \boldsymbol{A})$

$\sqrt{(\sigma^2)} \sim \text{half-Cauchy}(2.5)$

$p \sim \mathrm{Uniform}(0, 1)$

$h_i \sim \mathrm{MultiNormal}(0, \Sigma_p)$

$\Sigma_p = \upsilon \times \mathbf{V}_{phy}$

$\upsilon \sim \text{half-Cauchy}(2.5)$

$\beta \sim \mathrm{Normal}(0, 10)$