

Since last meeting

Current projects

Brachiopods

Mammals

Timeline

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## Since last meeting

- ▶ Evolution 2015 talk
- ▶ GSA 2015 talk
- ▶ Chapter 1 published (PNAS)
  - ▶ Effects of biotic traits on mammal species duration
- ▶ Chapter 2 submitted (Evolution)
  - ▶ Interplay between extinction intensity and selectivity in brachiopod extinction
  - ▶ Submitted early October, still in review?
- ▶ Did not submit DDIG

## Review of possible chapter 1

- ▶ Published in PNAS
- ▶ I took all of your comments very seriously and they really improved the paper.
  - ▶ Rick for forcing on the phylo (didn't do figure, but made me use it).
  - ▶ Ken and David for pushing about modern extinction risk.
  - ▶ Michael and Ken for helping me write it in english.
- ▶ Sorry I didn't send it to anyone except Michael and Ken.

## Review of possible chapter 2

- ▶ Submitted to Evolution
- ▶ What my patterns of extinction in Australia project eventually turned into.
  - ▶ Sorry about that.
  - ▶ Primarily drive by sample size issues.
- ▶ Sorry I didn't send it to anyone except michael and ken before submitting it.
  - ▶ This is actually a really good time to get all of your comments!

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# Regional patterns in the diversification of Paleozoic brachiopods

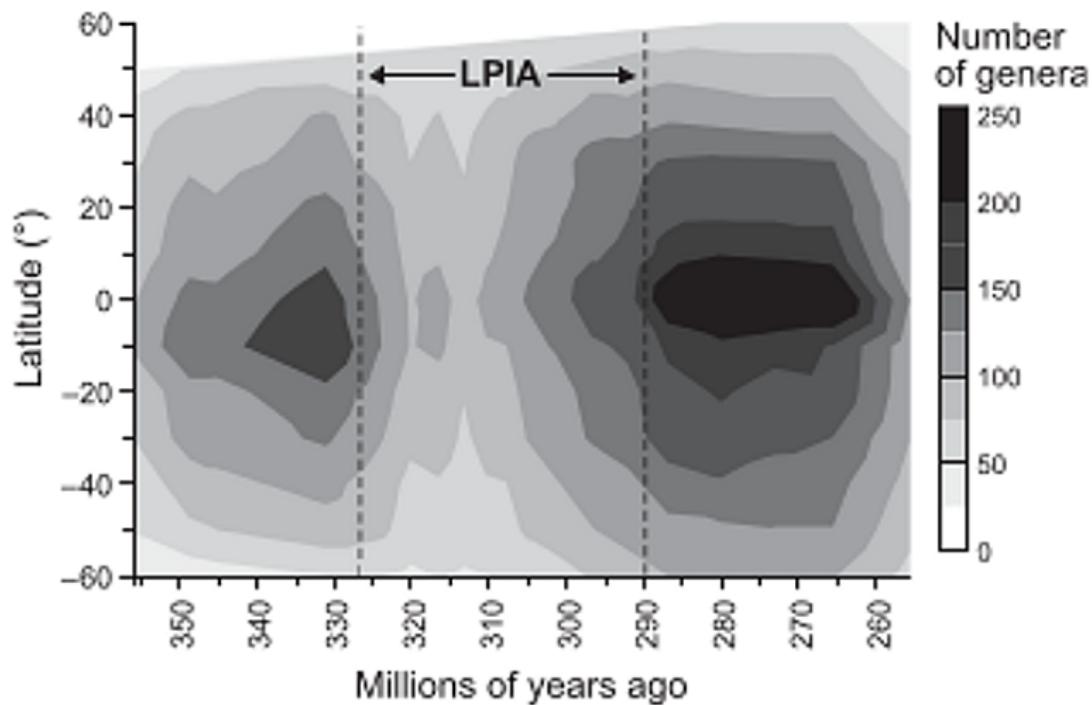
## Question

How does differential taxonomic gain and loss contribute to regional (e.g. latitudinal) diversity?

## Motivation

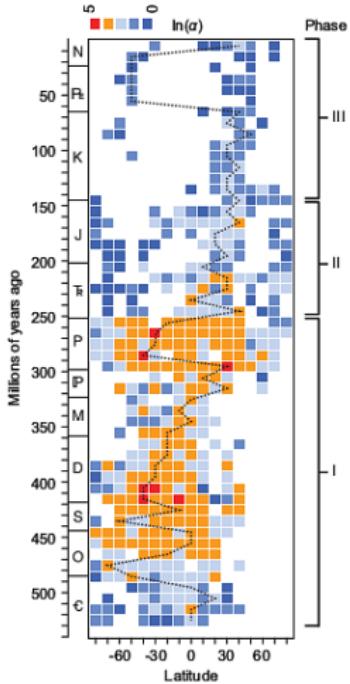
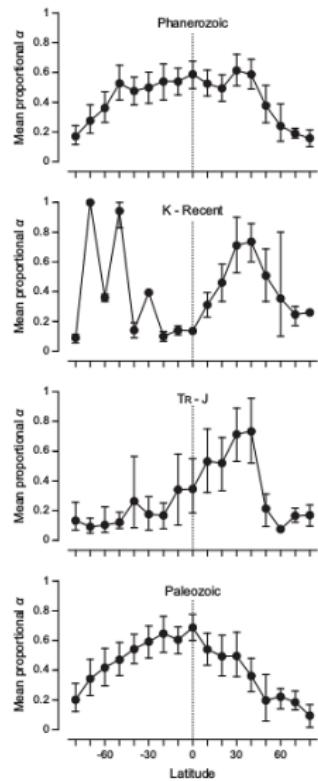
- ▶ latitudinal diversity gradients
  - ▶ through lense of a diversification process
- ▶ regional as opposed to global
  - ▶ variation within regions may not match global pattern  
(more biologically relevant?)
  - ▶ partial follow up to brachiopod survival work

# Brachiopod latitudinal diversity



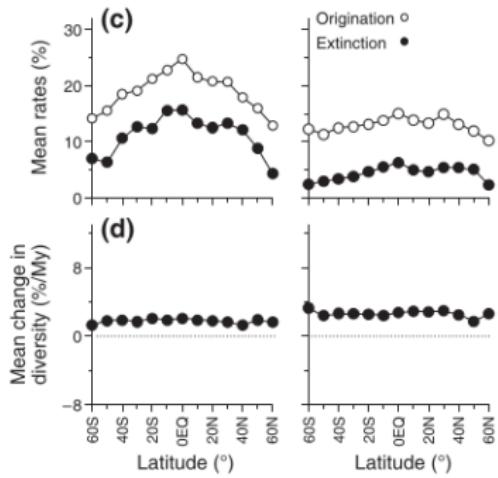
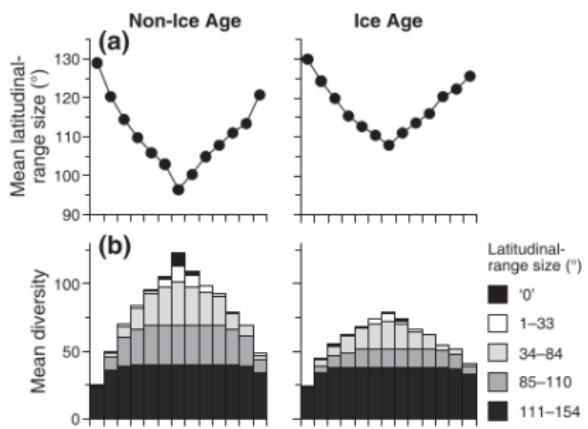
(Powell 2007 *G. Eco. Biogeo.*)

# Variation in bioversity gradient



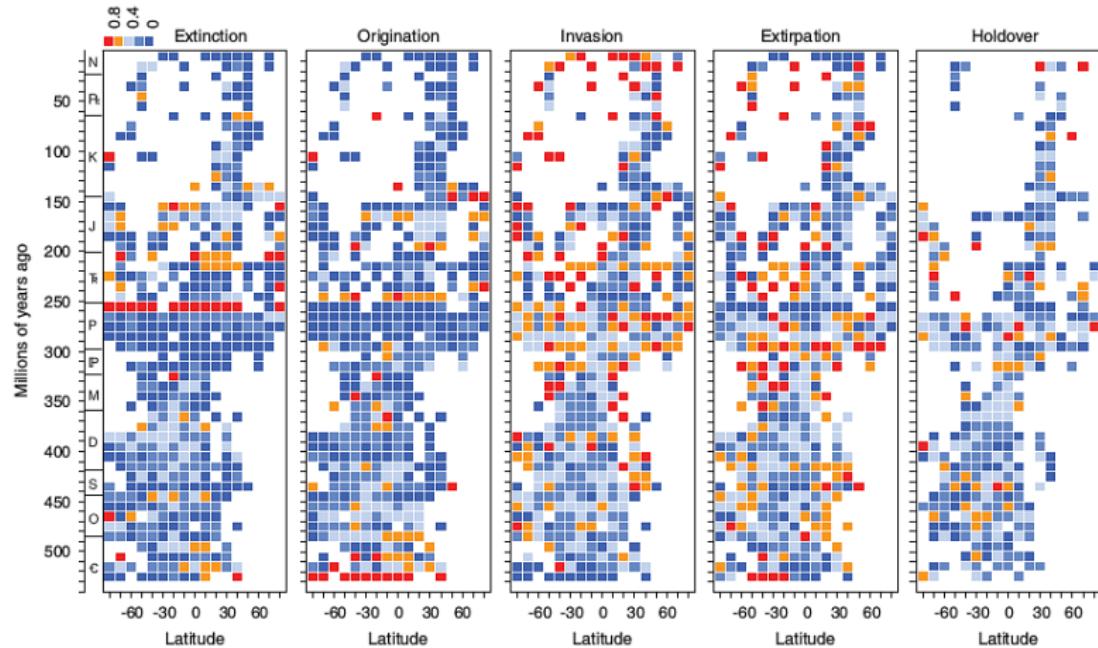
(Powell *et al* 2015 *Paleobio.*)

# “Modes” of latitudinal diversity



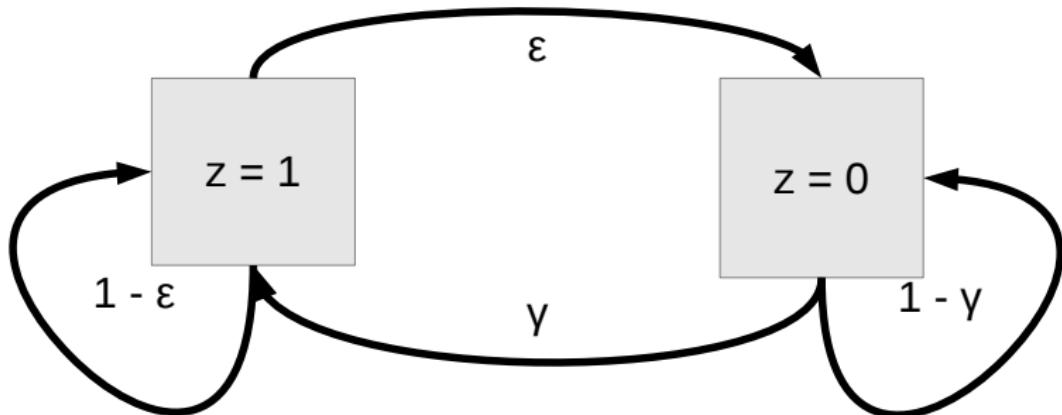
(Powell 2007 *G. Eco. Biogeo.*)

# Change in evenness + diversity

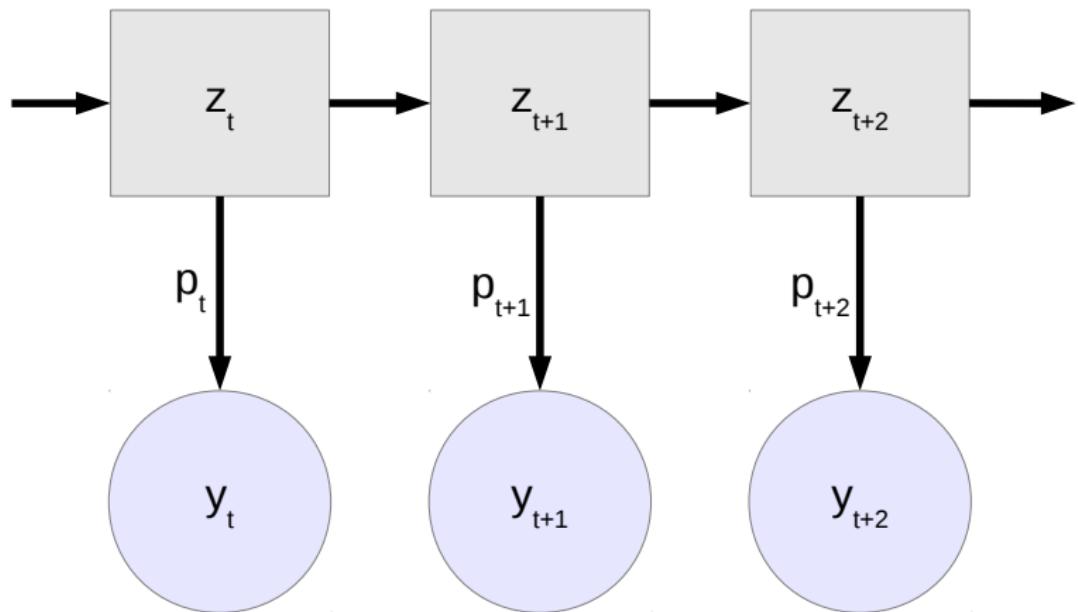


(Powell *et al* 2015 *Paleobio.*)

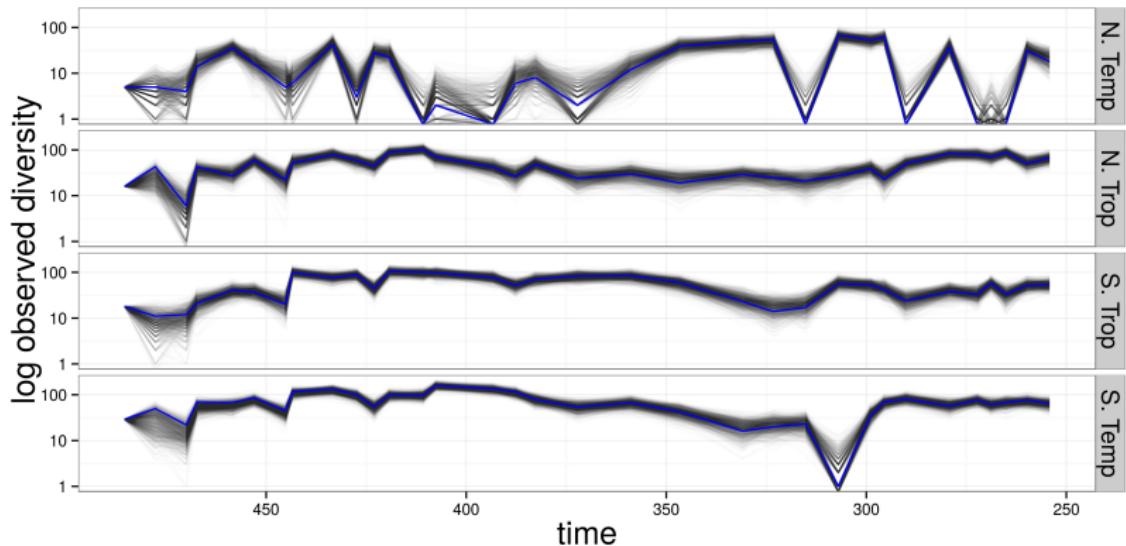
## Model structure: Markov model



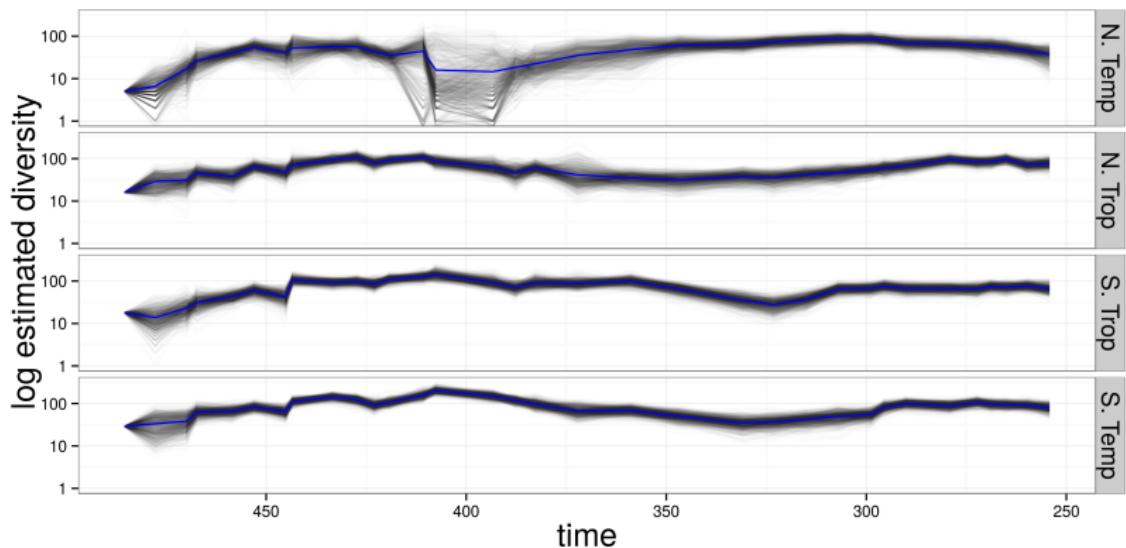
## Model structure: hidden state



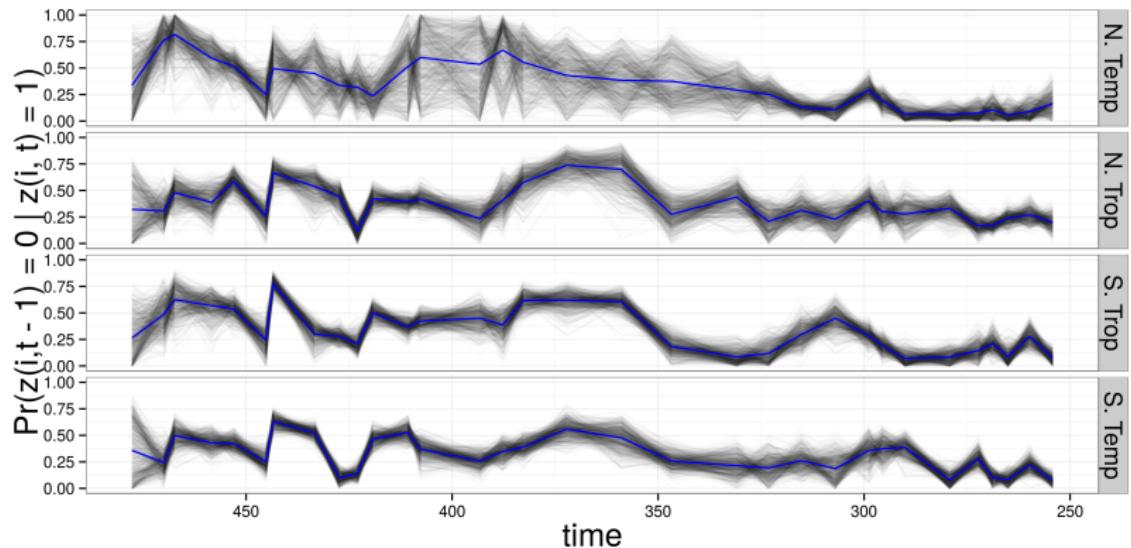
# Observed diversity



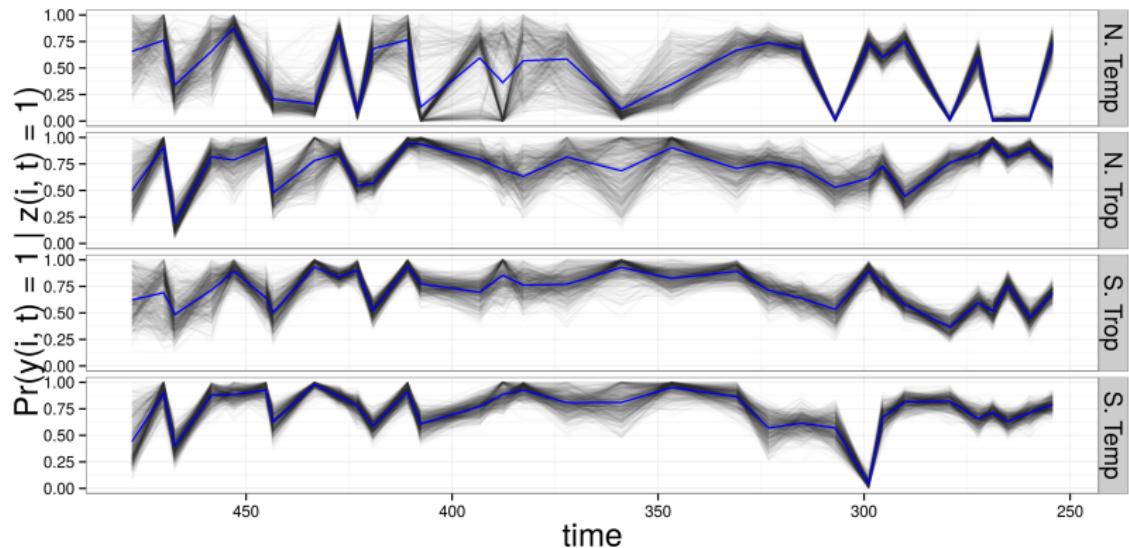
# Estimated latent diversity



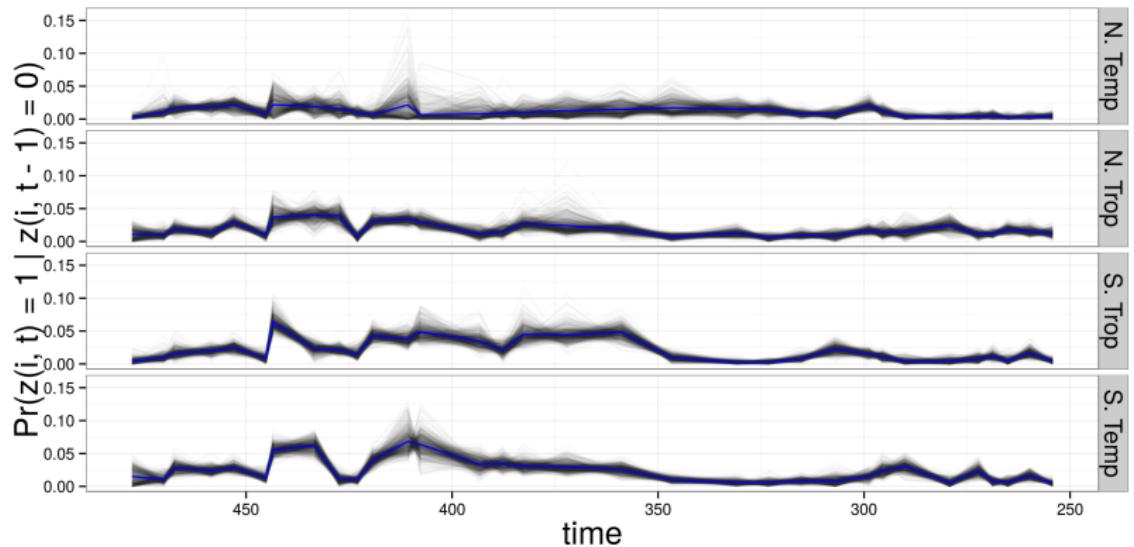
# Turnover probability



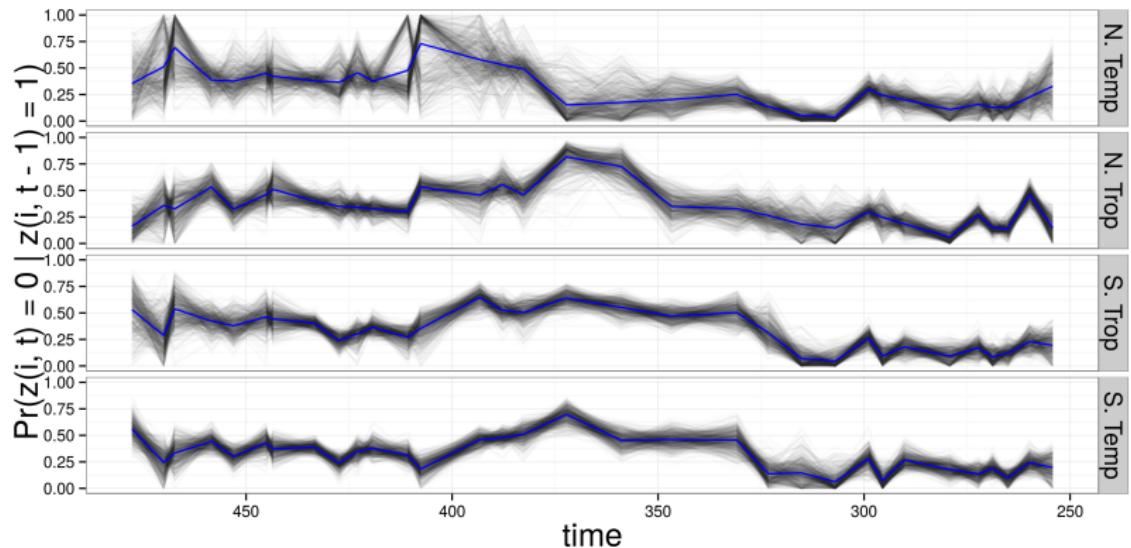
# Observation probability



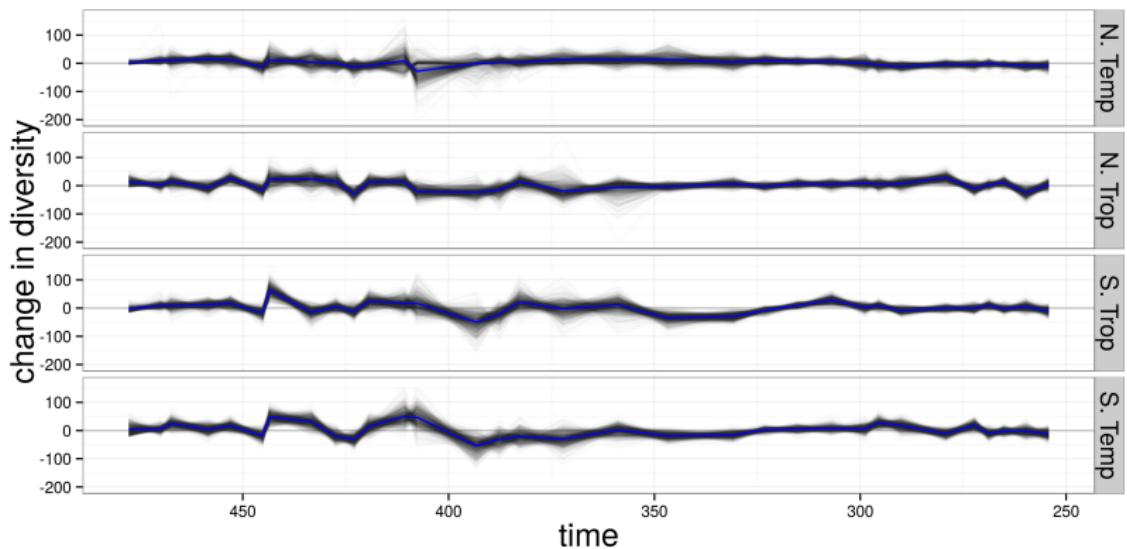
# Gain probability



# Loss probability



# Change in diversity



## Major assumptions

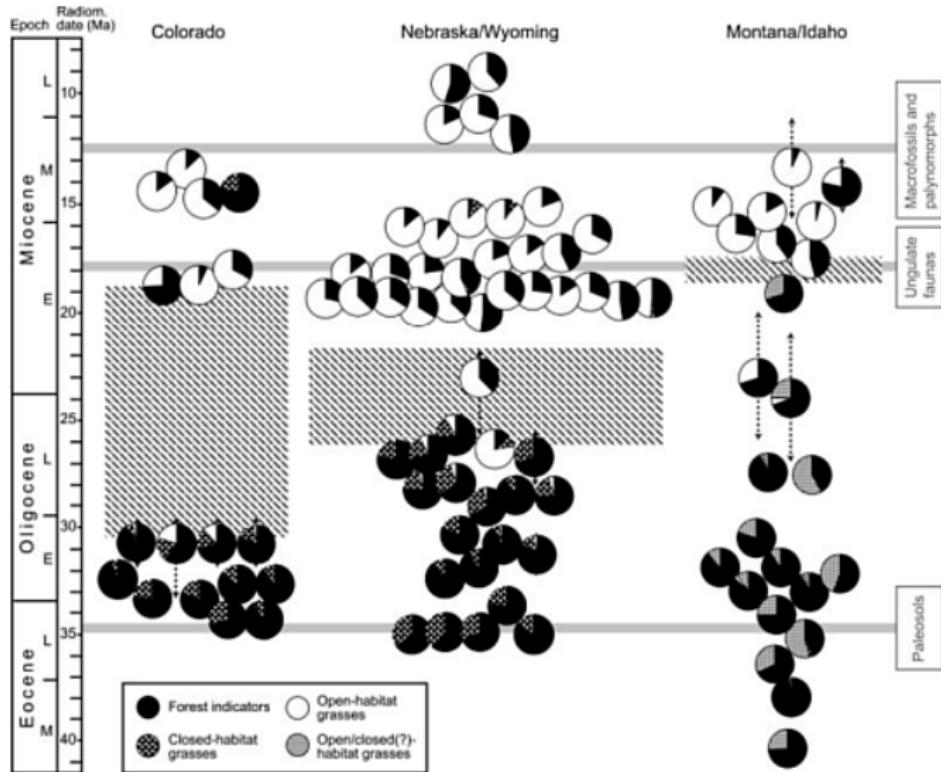
- ▶ first-order Markov process
  - ▶ can lead to some taxa existing longer than in actuality
- ▶ any taxon can occur in any geographic unit independent of other units
- ▶ all of the above possibly controlled for by sampling parameter
  - ▶ further assumes all times and places can be considered similar
- ▶ possible direction
  - ▶ increase taxonomic and/or temporal scope
  - ▶ more latitudinal bands

# Changes in Cenozoic mammal ecotype composition

## Question

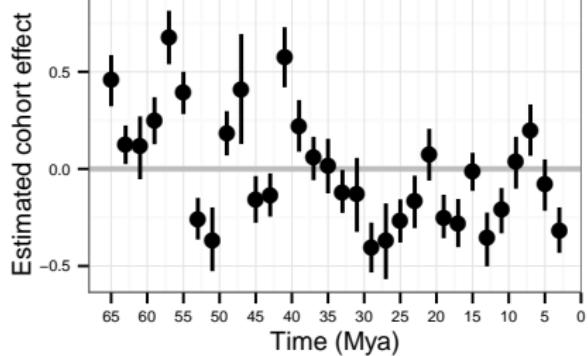
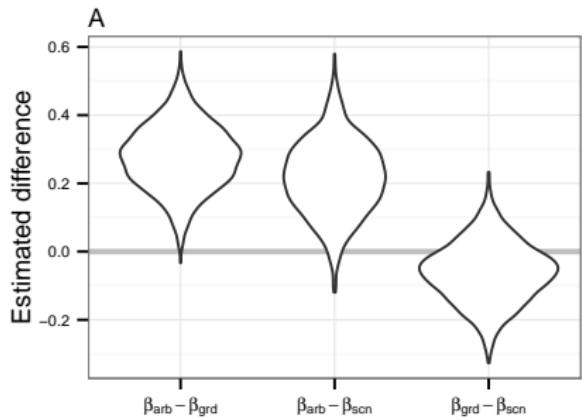
How do occurrence ratios of mammalian ecotypes change over time?

# Environmental shift



(Stromberg 2005 PNAS)

# Possible link?



(Smits 2015 *PNAS*)

## Details and covariates

- ▶ Interest is specifically change in **composition**, and not taxonomic turnover.
- ▶ Covariates
  - ▶ body size of taxon i
  - ▶ dietary category of taxon i
  - ▶ climate (dO18) of time bin j

# Multi-logit regression

$$y_i \sim \text{Categorical}(K, \pi)$$

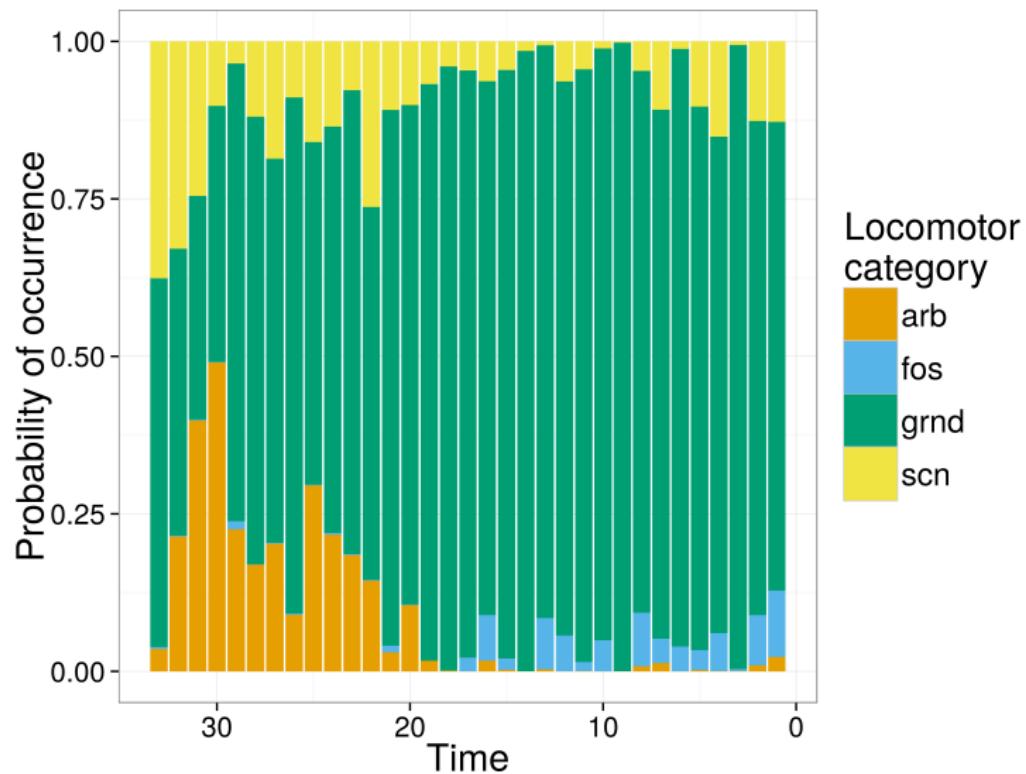
$$\pi_k = \frac{\exp(\beta_{k,j[i]} X_i)}{\sum_{k=1}^K \exp(\beta_{k,j[i]} X_i)}$$

$$\text{where } \beta_{K,j[i]} X_i = 0$$

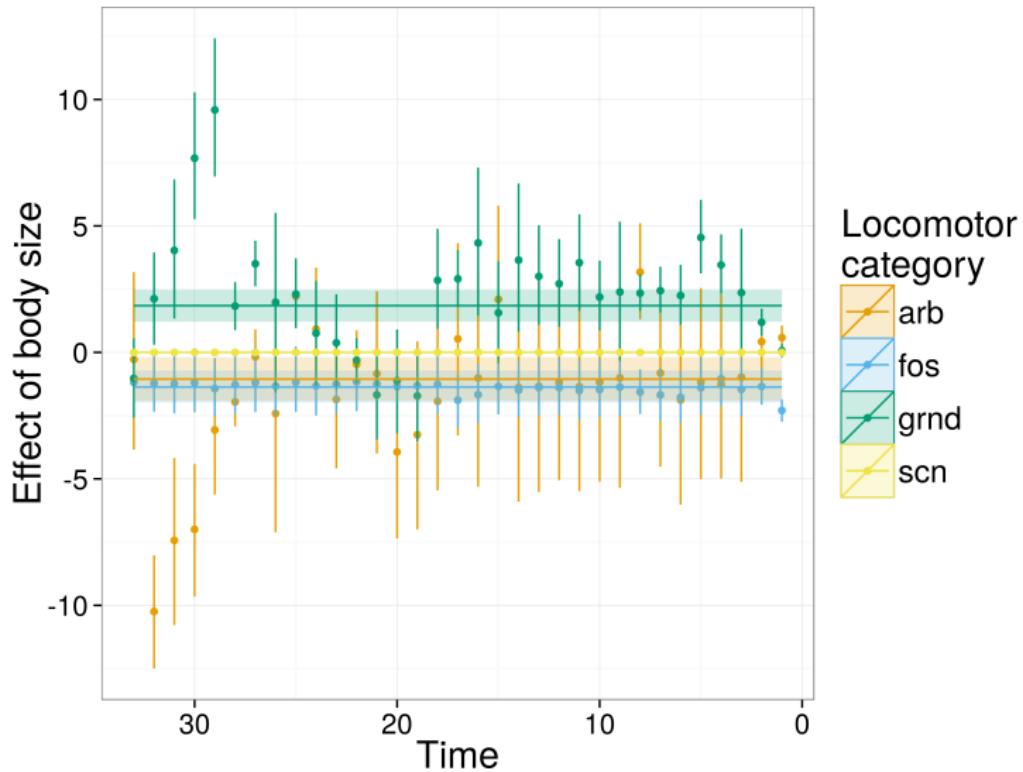
$$\beta_{k,j} \sim \mathcal{N}(\beta'_k, \sigma_k)$$

$$\beta_{k,j}[1] \sim \mathcal{N}(\beta'_k[1] + \alpha_k U_k, \sigma_k)$$

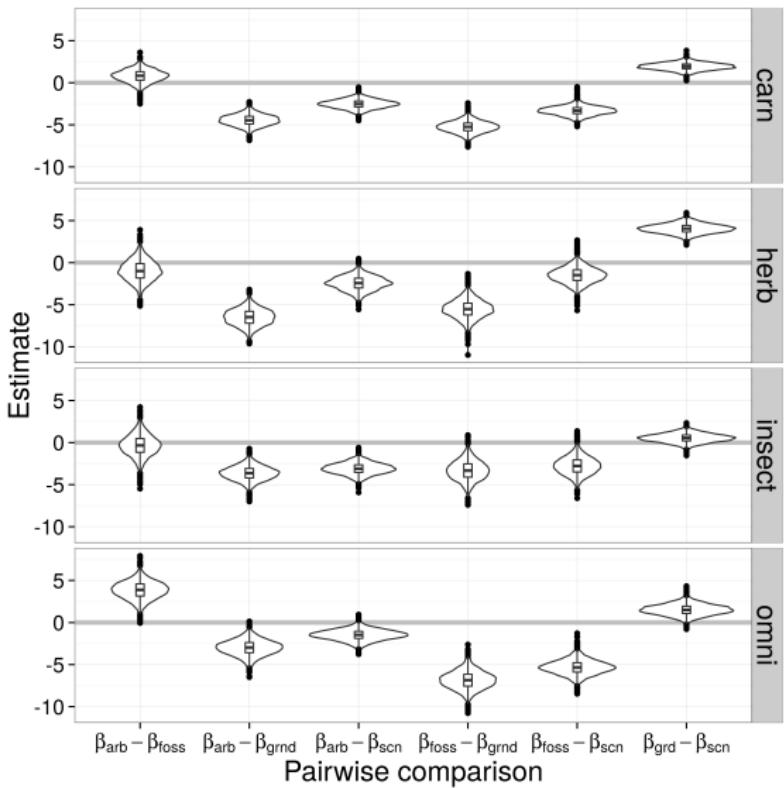
# Change in occurrence ratio over time



# Effect of body size on occurrence probability



# Effect of dietary category on occurrence probability



## Further developments

- ▶ NOTE currently single flat mean; allow trend/multiple?
  - ▶ time order is not currently modeled
- ▶ phylogenetic effect to be included (except  $k = K$ )
- ▶ climate as cohort-level predictor, integrating over uncertainty?
- ▶ observed taxa represent a proportional sample of reality
  - ▶ how can this be overcome in a model based framework?
- ▶ limits to complexity of model due to sample size

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## Things to consider

- ▶ TAing this spring and next year
- ▶ Funding?
  - ▶ FMNH fellow (but I don't spend time at the museum).
- ▶ Estimates for time of completion?
- ▶ Post-doctoral opportunities?