How predictable is extinction?

Forecasting species survival at million-year timescales

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Foundational assertion of conservation paleobiology

By studying the past,
we can better predict the future.

What are we predicting?

Extinction is hard to predict, but is important to conservation decisions.

Predicting extinction

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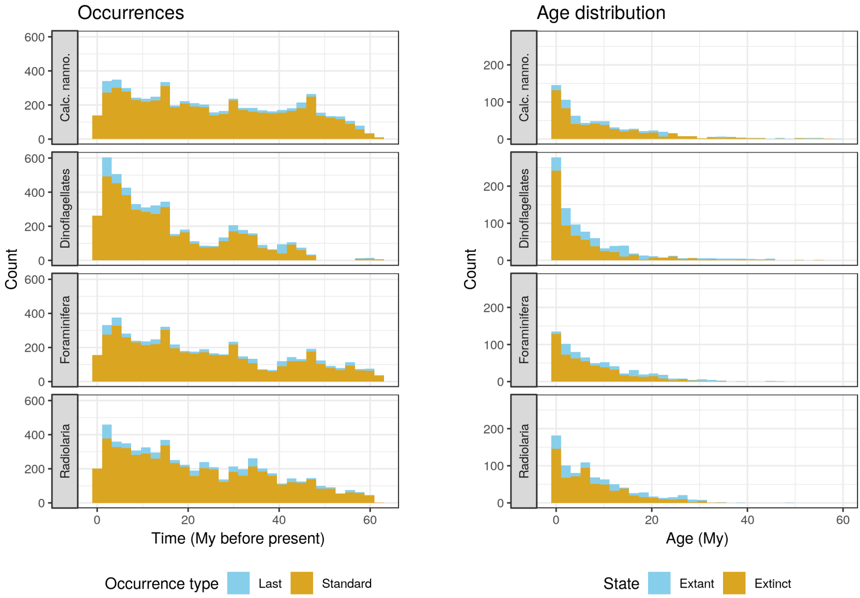
- A taxon's global geographic range can change over time.
- What happens to extinction risk as a taxon changes geographic range? How is extinction risk impacted if that taxon's global geographic range has recently increased or decreased?

Encoding the past

- Change in geographic range between current observation and previous observation.
- Average global temperature at time of previous observation (Mg/Ca isotope).
- Age in millions of years at time of observation.

Data being analyzed



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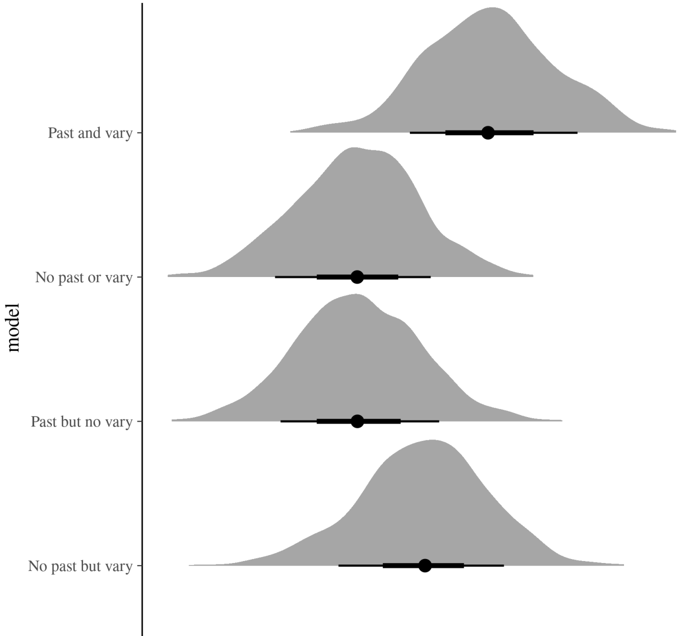
- Estimate out-of-sample predictive performance using k-fold cross-validation.

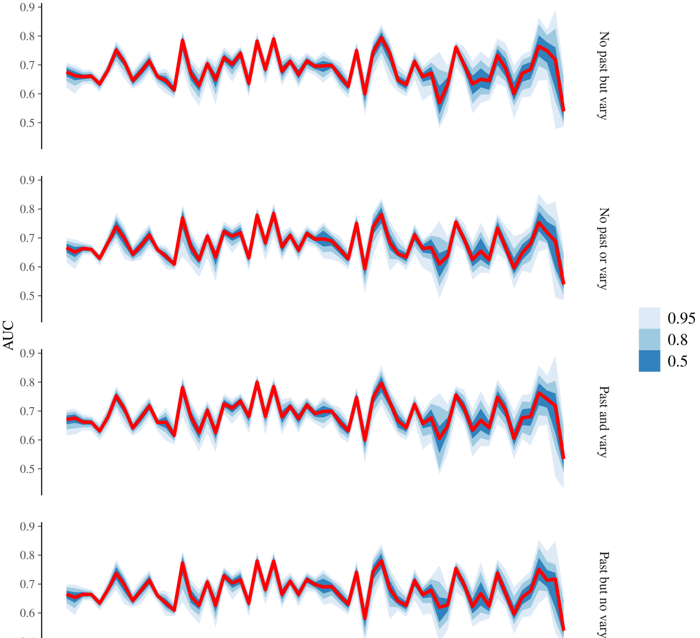
A conceptual model for predicting extinction

A statistical model for predicting extinction

In-sample predictive performance, full dataset



In-sample predictive performance, by time



Comparing our models

Model	LOOIC	SE LOOIC	WAIC	SE WAIC
Past and vary	12790.39	178.83	12786.06	178.77
No past but vary	12818.43	178.76	12815.40	178.71
Past but no vary	12850.45	179.42	12848.12	179.38
No past or vary	12850.87	179.46	12848.50	179.42

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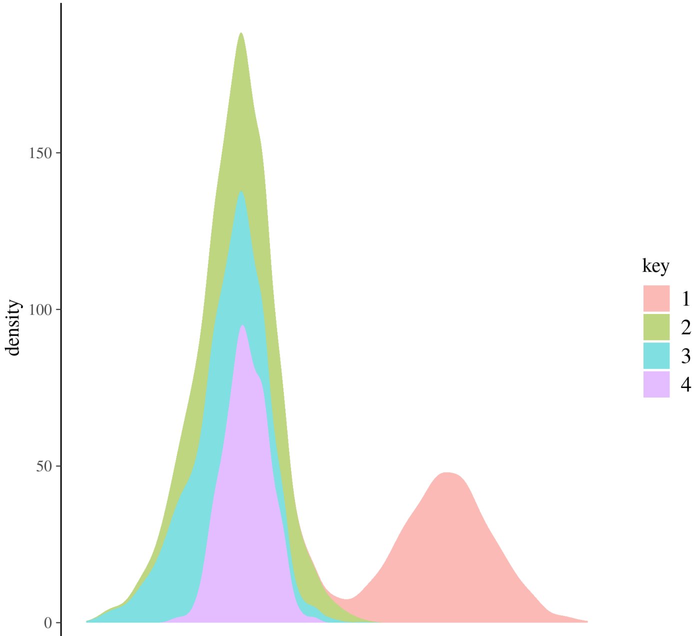
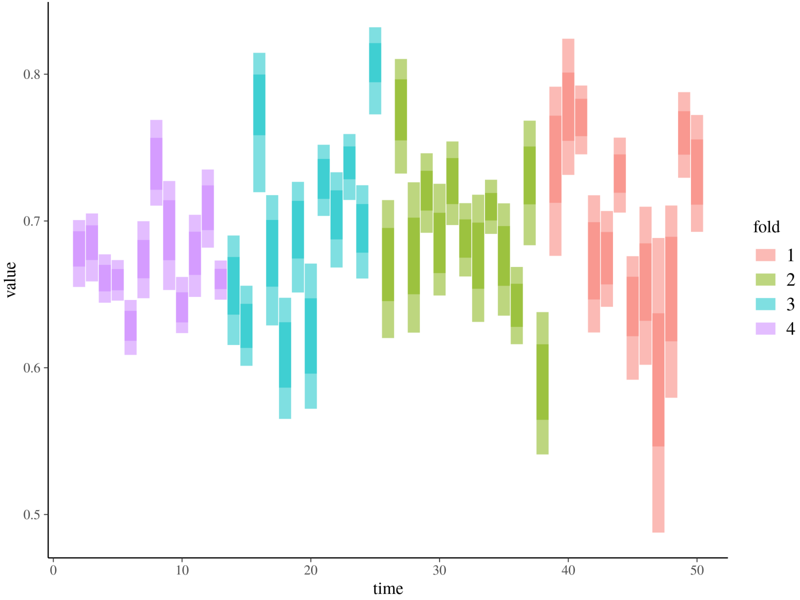
Cross-validation results, full dataset



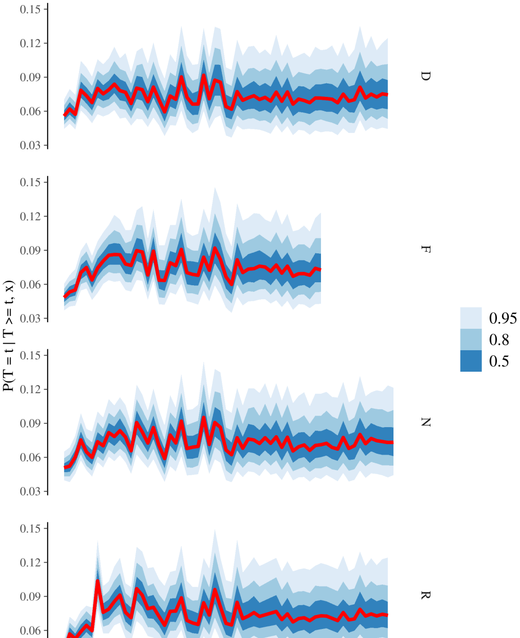
Cross-validation results, by time



Overall covariate effects

Covariate effects over time

Effects of age on extinction risk, by phylum



Summary

- extinction is very random and our estimates aren't near perfect
- historical covariates and varying effects seem important
- increasing model complexity has only

Conclusions

- consider non-linear effects of historical covariates – thresholds
- at MILLION YEAR timescales past kind of matters, but very marginally
- extinction is hard to predict at million year timescales – rarity

Acknowledgements