

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

- ▶ A taxon with a **greater than average** global geographic range is likely to **survive for longer** than a taxon with **less than average** global geographic range.

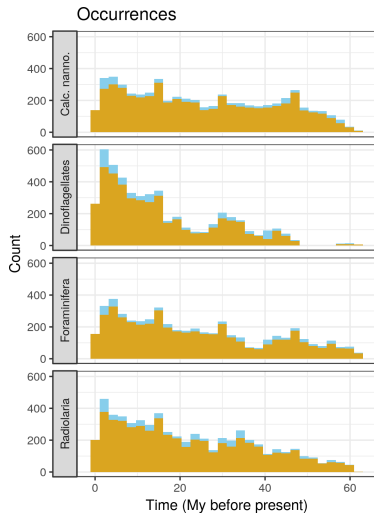
Predicting extinction

- ▶ A taxon with a **greater than average** global geographic range is likely to **survive for longer** than a taxon with **less than average** global geographic range.
- ▶ A taxon's global geographic range can change over time.

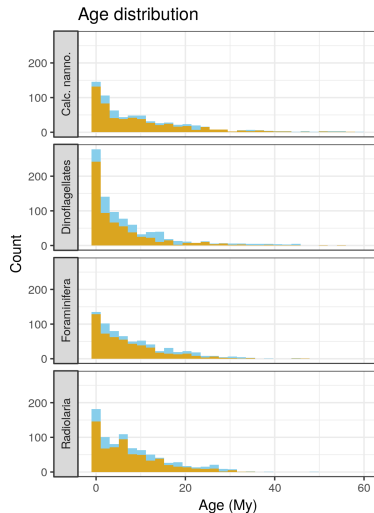
Predicting extinction

- ▶ A taxon with a **greater than average** global geographic range is likely to **survive for longer** than a taxon with **less than average** global geographic range.
- ▶ 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**?

Data being analyzed



Occurrence type Last Standard

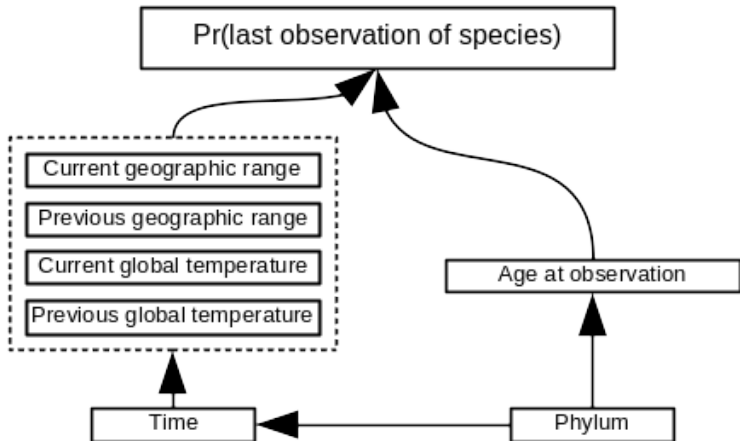


State Extant Extinct

How we're analyzing the data

- ▶ 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.
- ▶ Explore model adequacy using posterior predictive distribution.
- ▶ Estimate out-of-sample predictive performance using k -fold cross-validation.

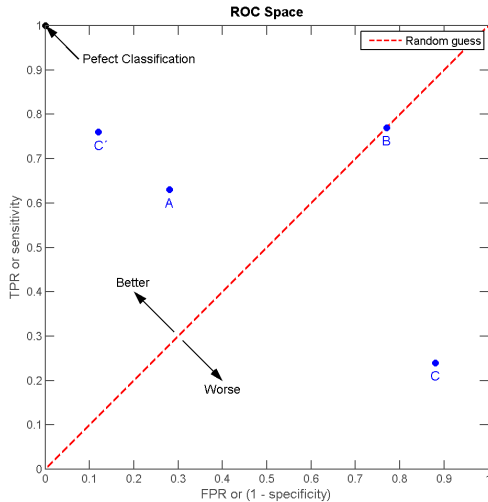
A conceptual model for predicting extinction



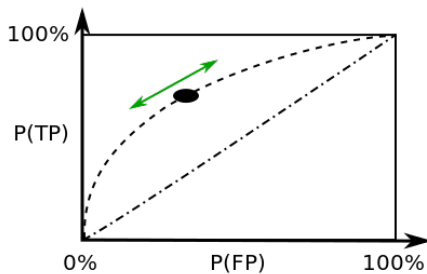
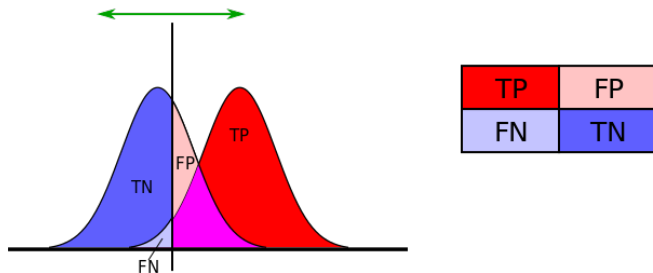
Measuring performance: Receiver Operating Characteristic

		Actual class	
		1	0
Predicted class	1	TRUE POSITIVE	FALSE POSITIVE
	0	FALSE NEGATIVE	TRUE NEGATIVE

Measuring performance: Receiver Operating Characteristic

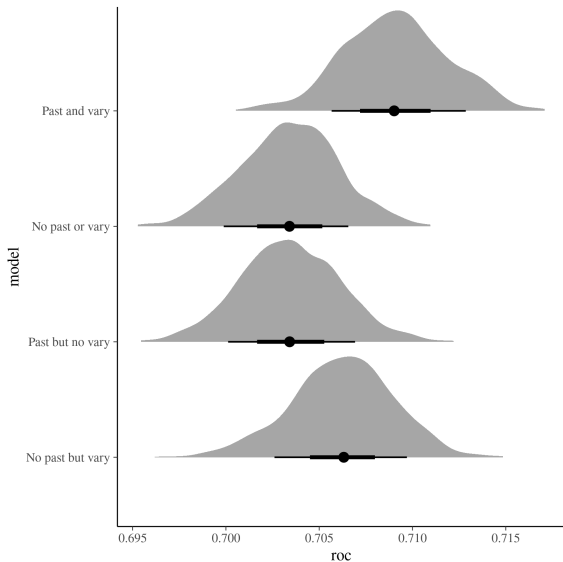


Measuring performance: Receiver Operating Characteristic

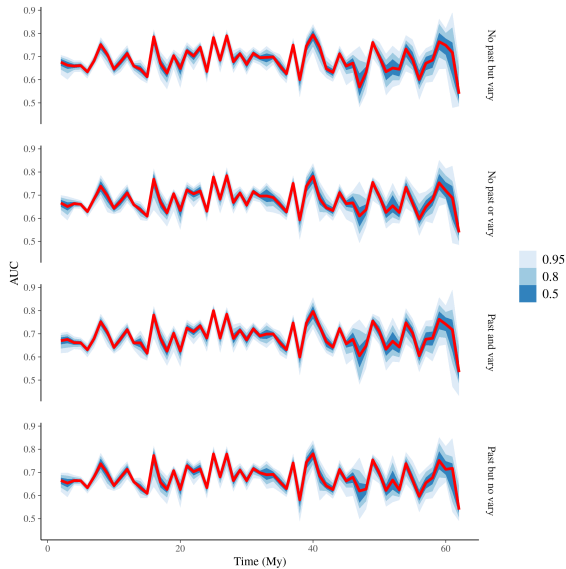


(wikimedia)

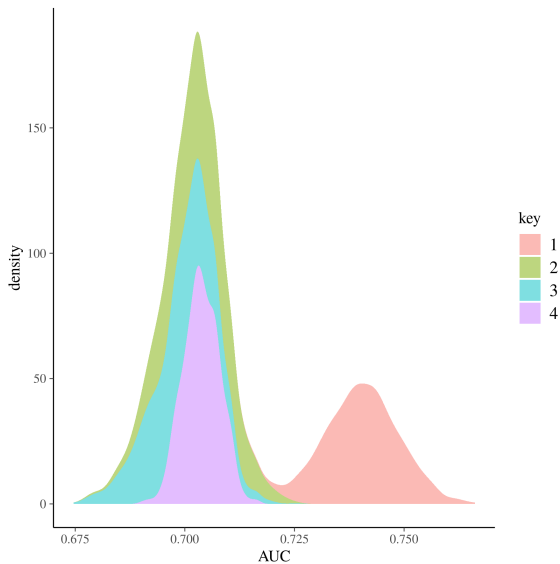
In-sample predictive performance, full dataset



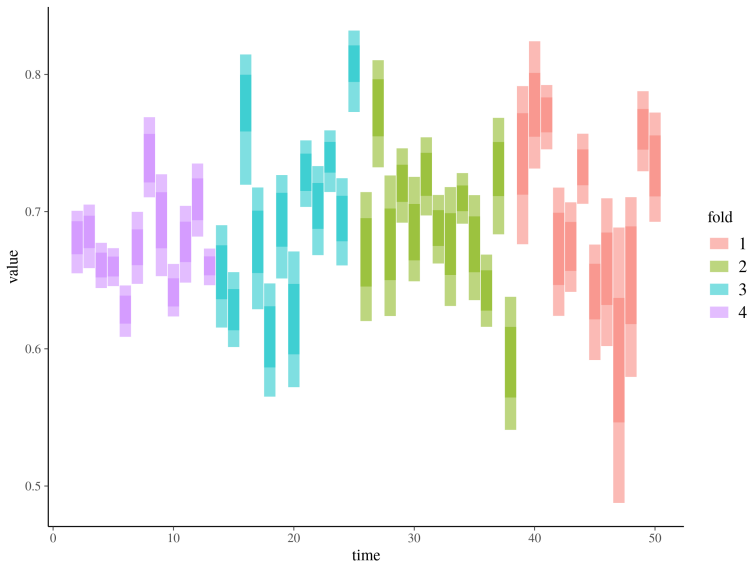
In-sample predictive performance, by time



Cross-validation results, full dataset



Cross-validation results, by time



Next steps

- ▶ Consider non-linear/threshold effects of covariates (e.g. GAMM, etc.).
- ▶ What are the possible effects of other, unconsidered covariates (e.g. foram ecology)?

Summary

- ▶ **The past matters.** Our best supported model includes our historical covariates and allows all effects to vary over time.
- ▶

Acknowledgements