How predictable is extinction?

Forecasting species survival at million-year timescales

Peter D Smits, Seth Finnegan

Department of Integrative Biology, University of California – Berkeley

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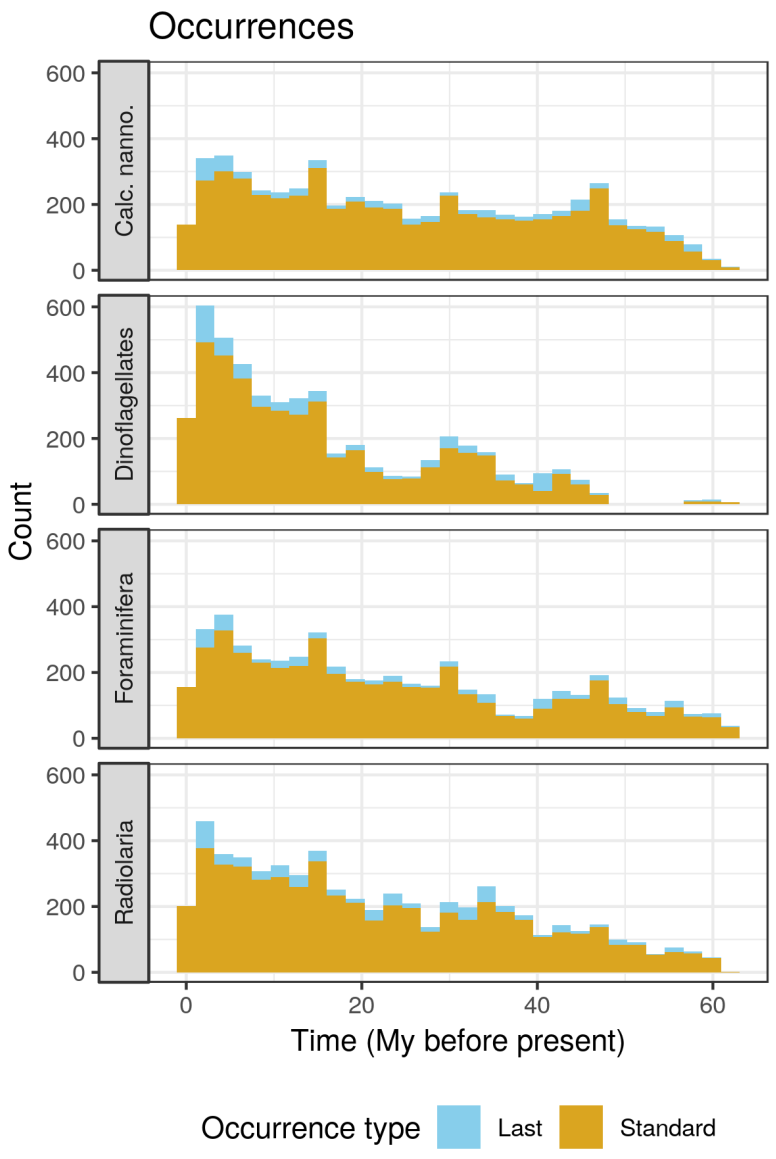
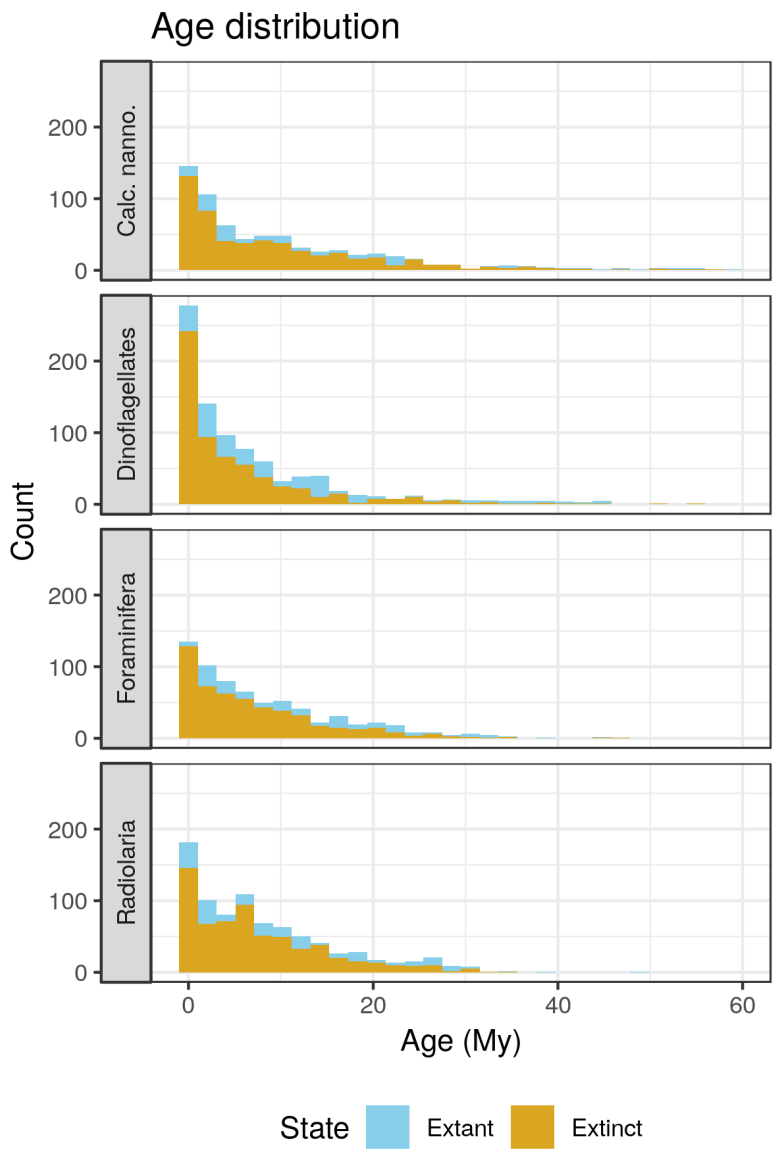
- A taxon's global geographic range can change over time.
- What happens to extinction risk as a taxon changes geographic range? How is extinction risk impacted if that taxon's global geographic range has recently increased or decreased?

Data being analyzed

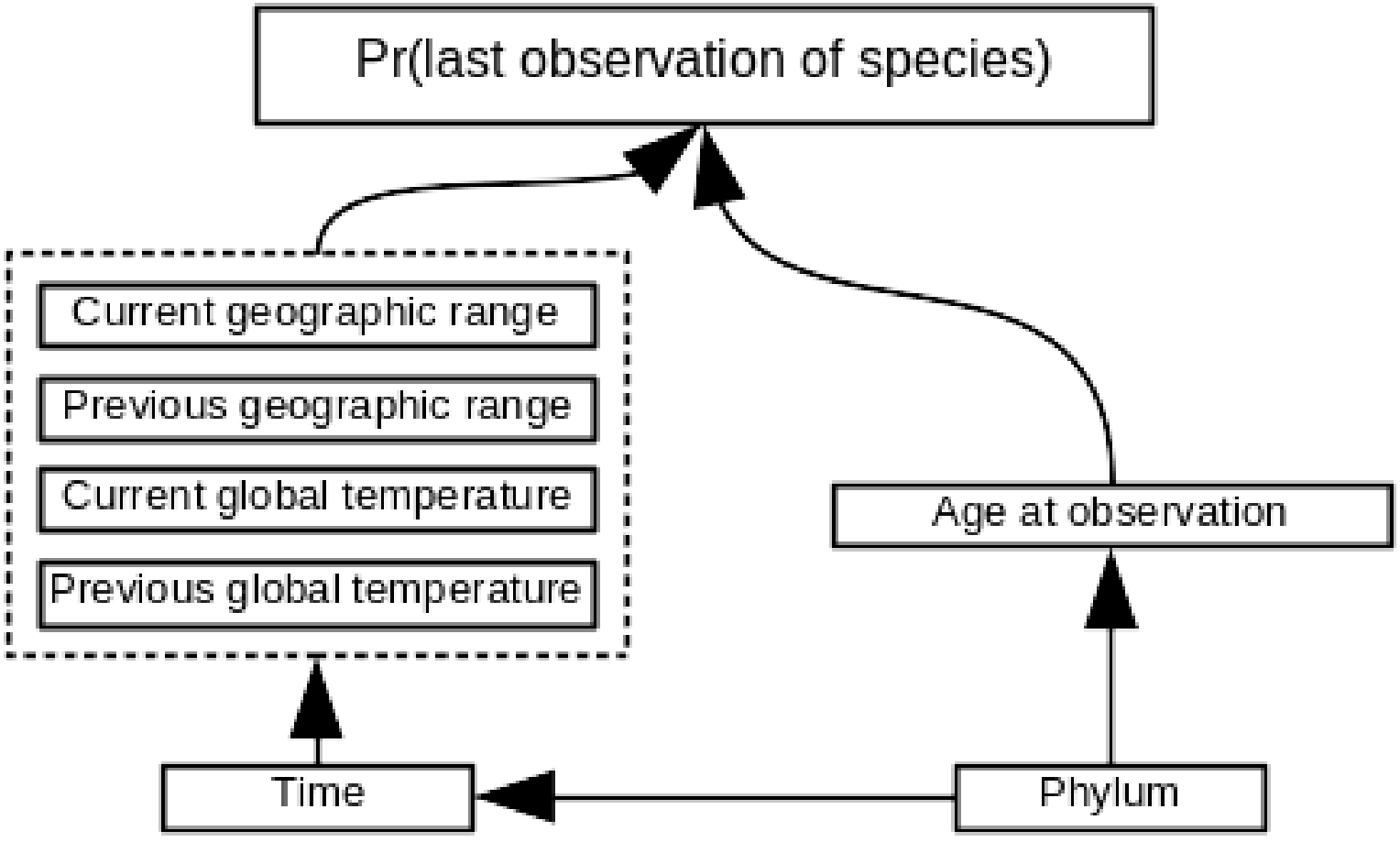




How we're analyzing the data

- 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.

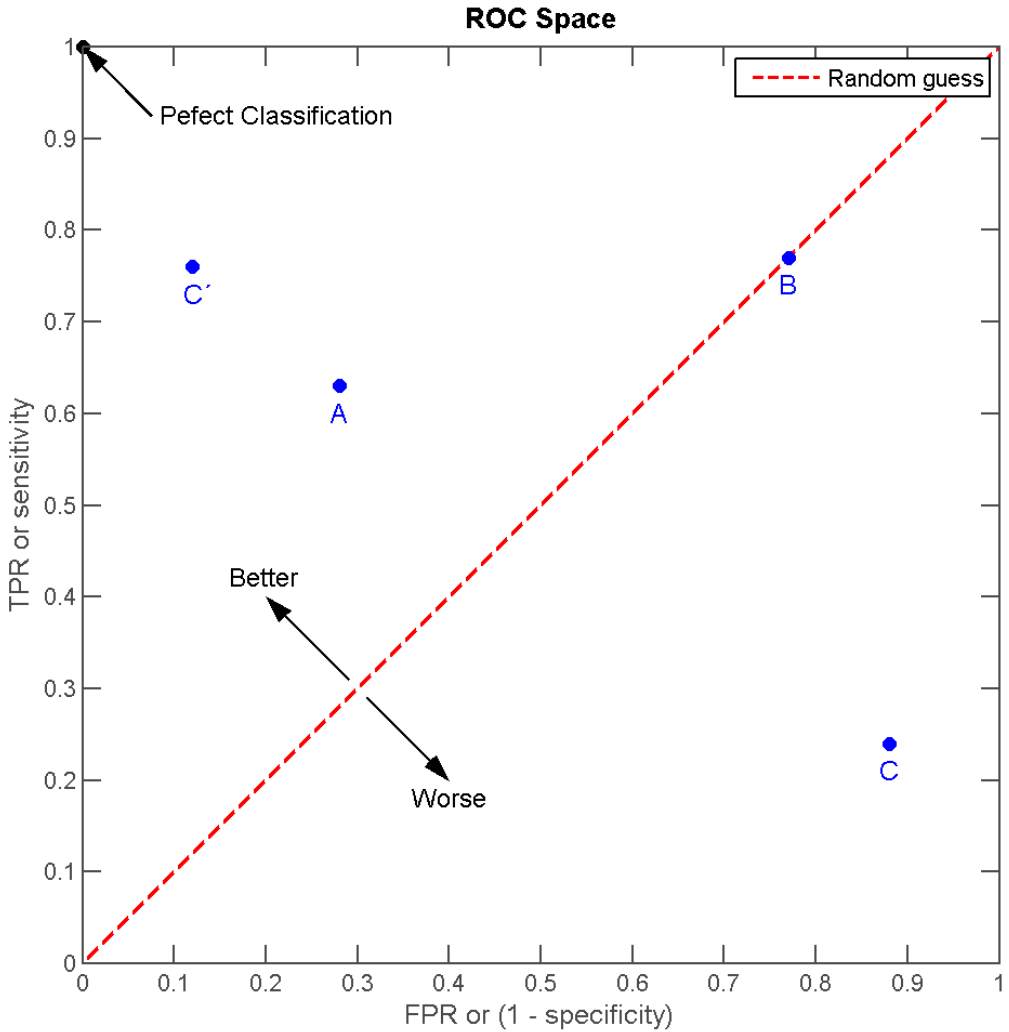
A conceptual model for predicting extinction



Measuring performance: confusion matrix

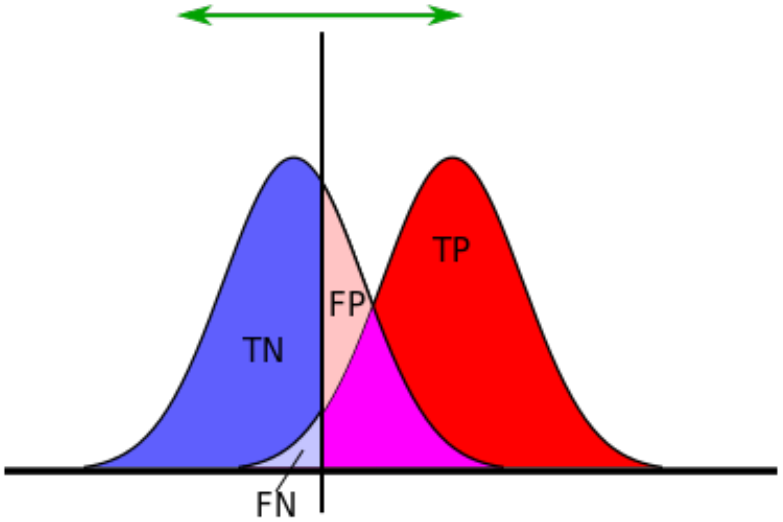
		Actual class	
		1	0
Predicted class	1	TRUE POSITIVE	FALSE POSITIVE
	0	FALSE NEGATIVE	TRUE NEGATIVE

Measuring performance: Receiver Operating Characteristic

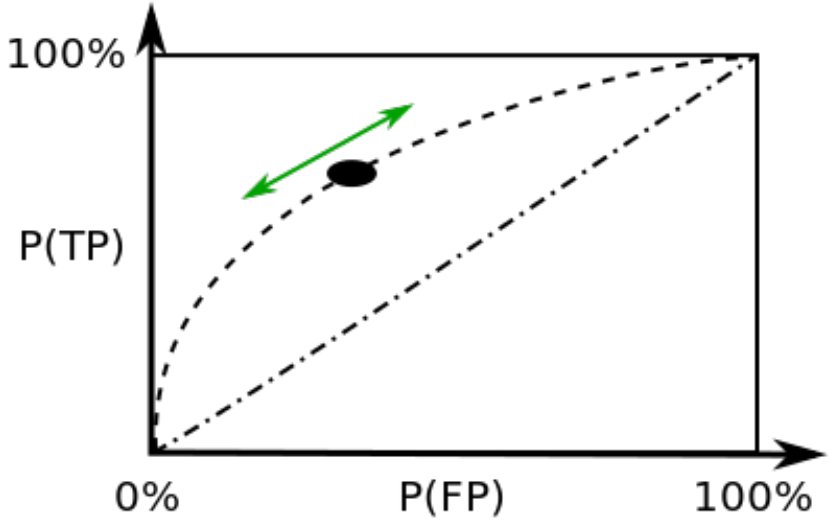


(wikimedia)

Measuring performance: Receiver Operating Characteristic

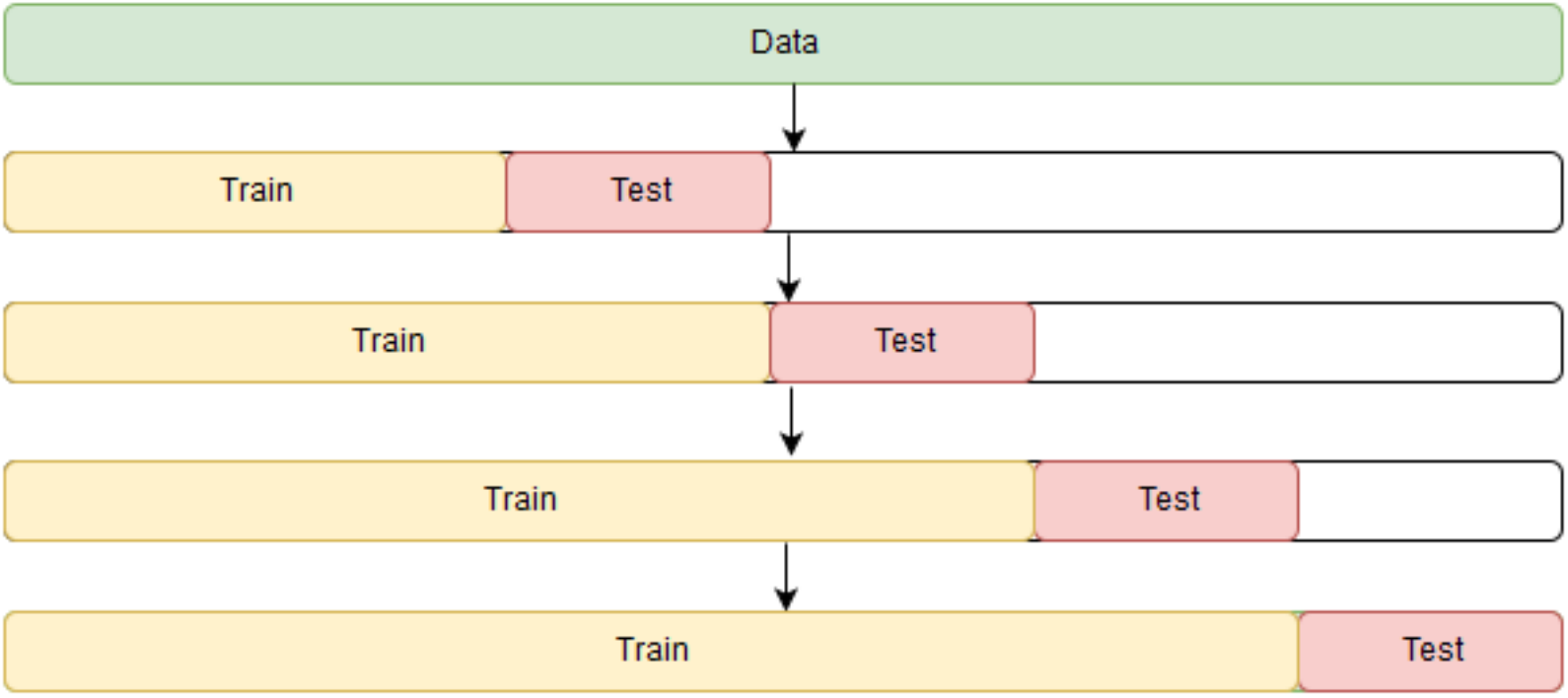


TP	FP
FN	TN



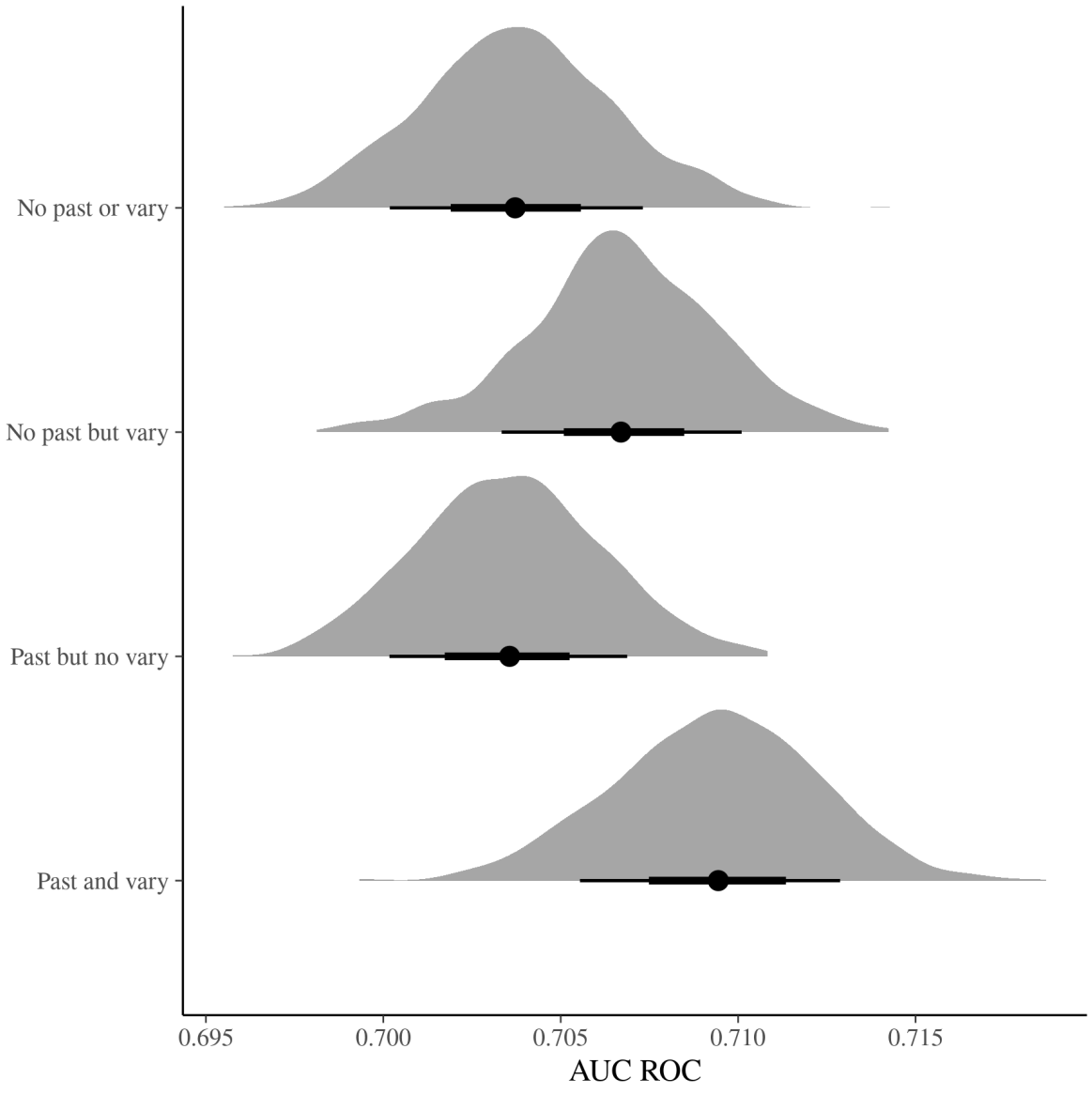
(wikimedia)

Measuring performance: k-fold cross-validation

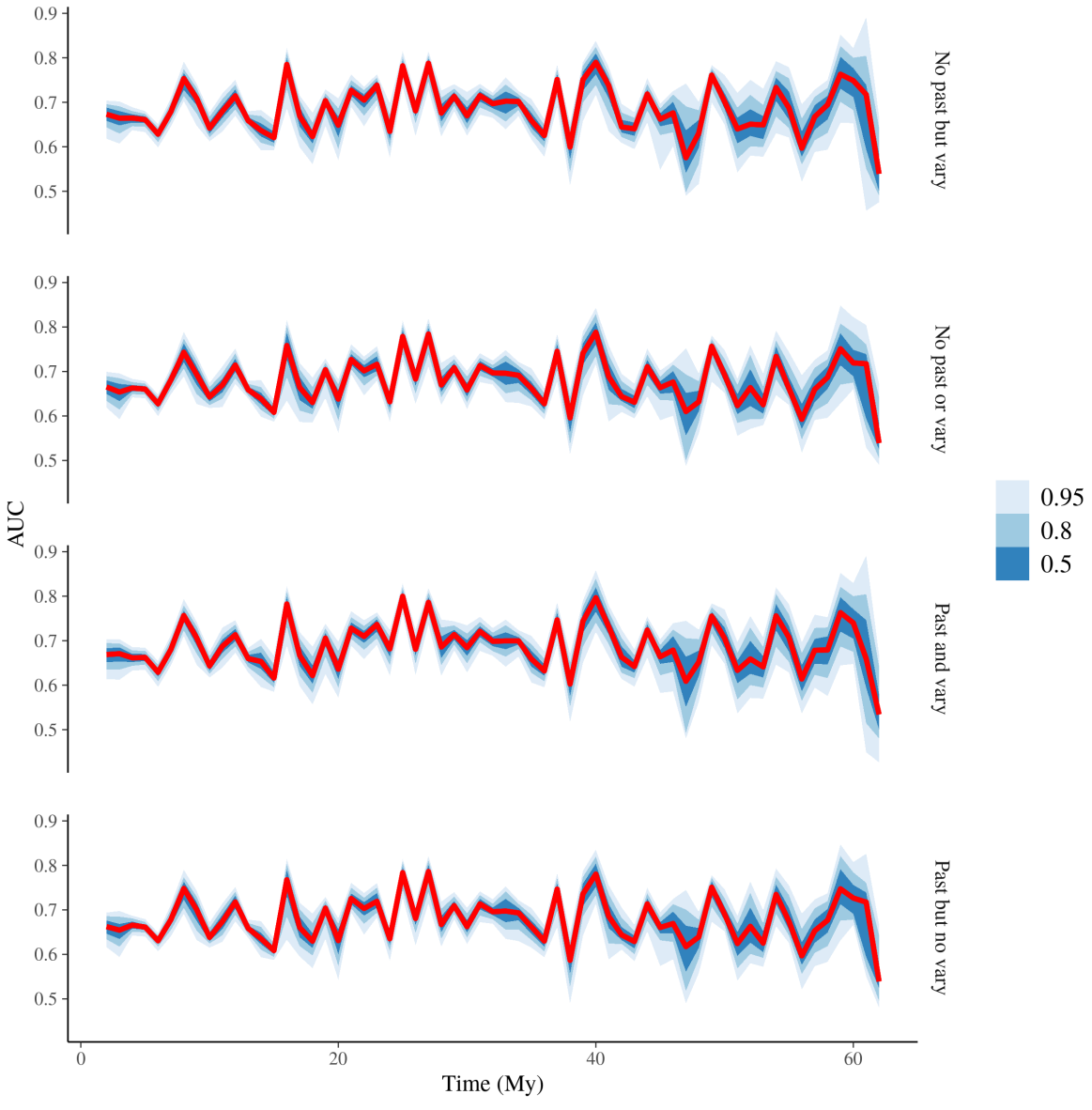


(Ken Williams, https://goo.gl/qLcfL8)

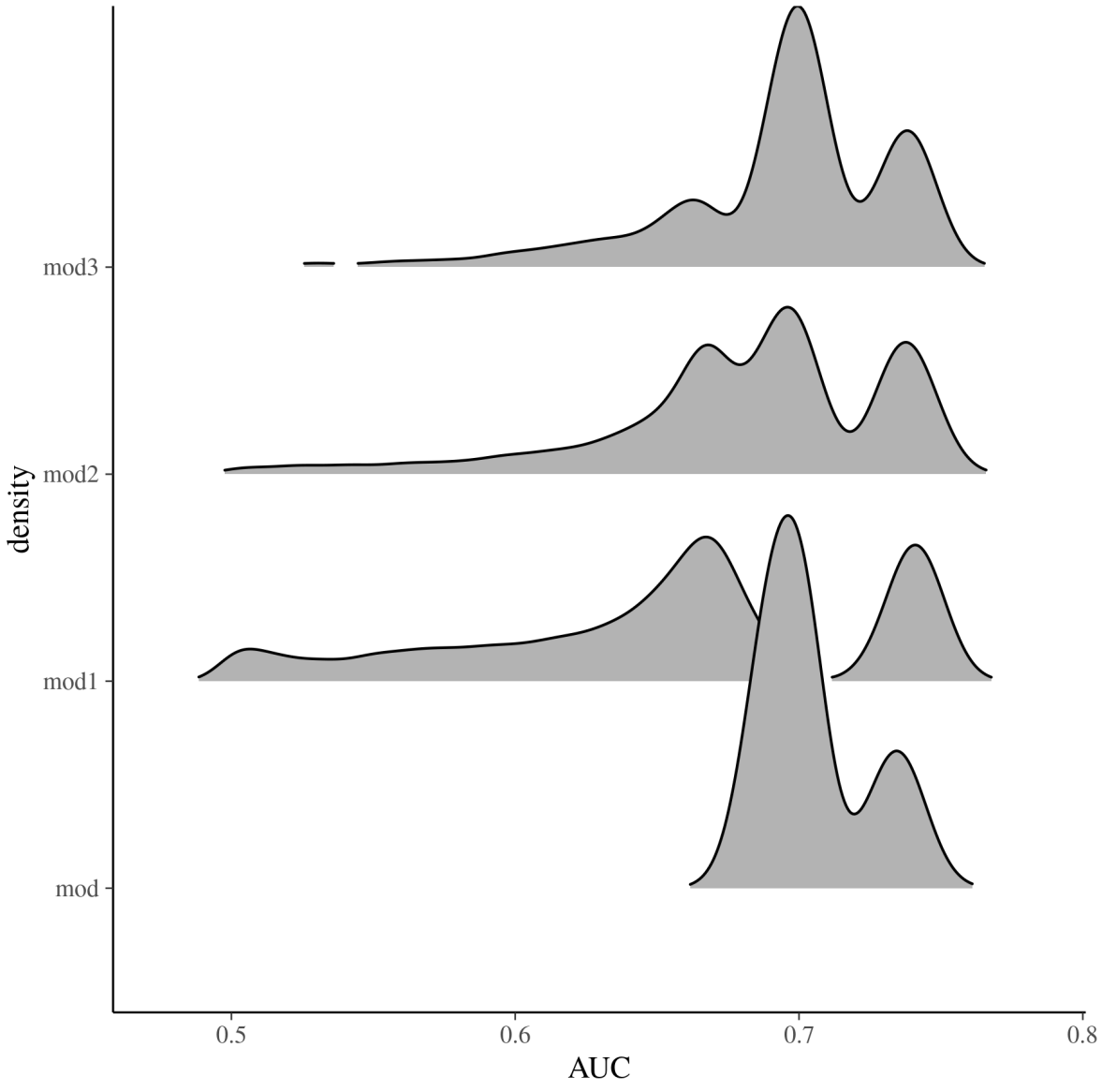
In-sample predictive performance, full dataset



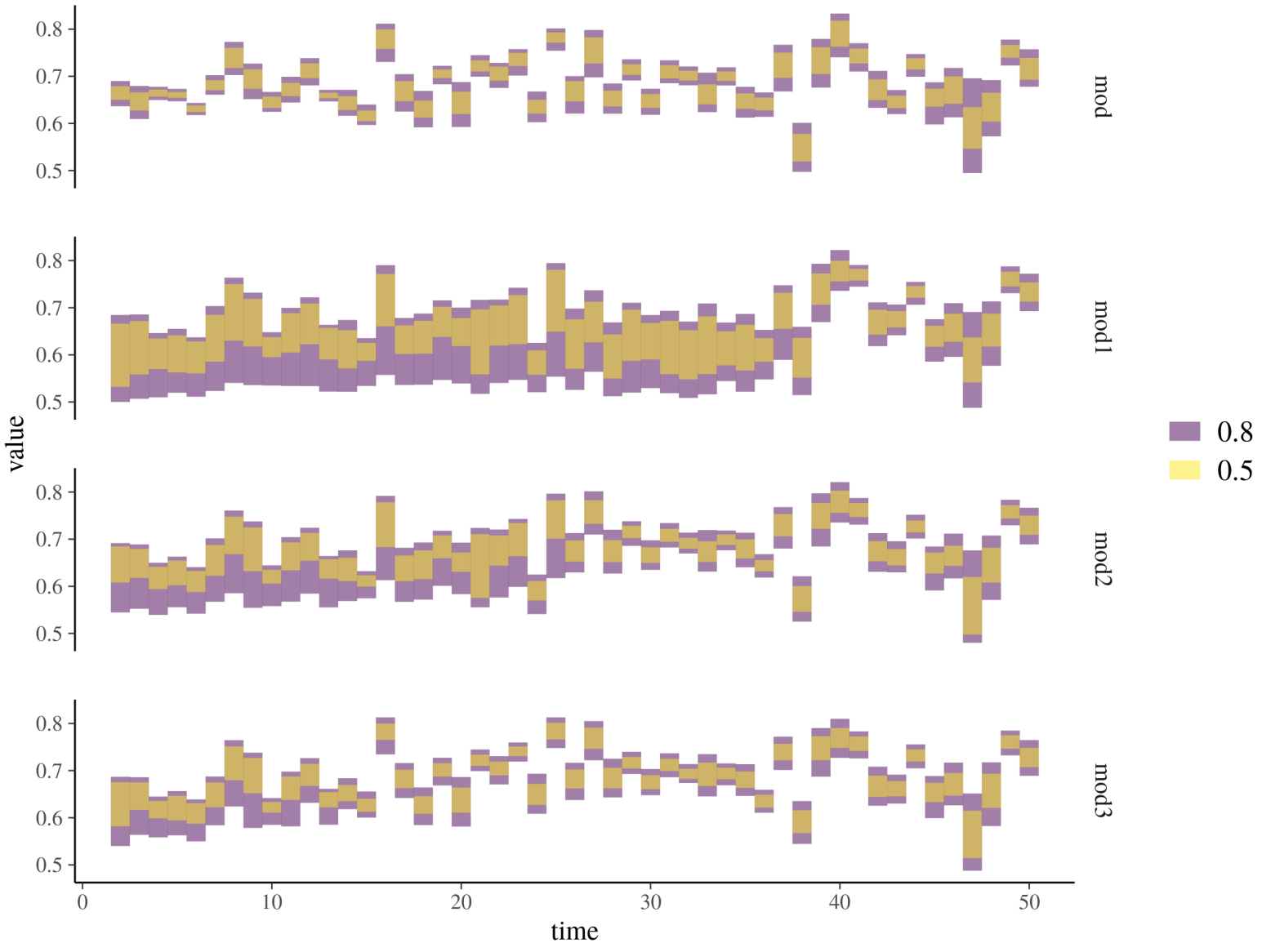
In-sample predictive performance, by time



Cross-validation results, full dataset



Cross-validation results, by time



Summary

- The past matters. . .
  - Our best supported model includes our historical covariates and allows all effects to vary over time.
- But not that much. . .
  - None of our models are good at predicting extinction.

Summary

- The past matters...
  - Our best supported model includes our historical covariates and allows all effects to vary over time.
- But not that much...
  - None of our models are good at predicting extinction.
- Mechanisms behind changes to geographic range operate at sub-million year scales. Perhaps their effects are weak/masked at million (or greater) year scales.

Acknowledgements