

species associations and long-term dynamics in phytoplankton communities

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acknowledgements — do what you want with the slides



**NSERC
CRSNG**

Slides: bit.ly/paleointeract

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community response to environmental change



Credit: NOAA George E. Marsh Album [Public domain], via Wikimedia Commons

community response to environmental change



Credit: Michael Knall [Public domain], via Wikimedia Commons

community response to environmental change



species interactions

Community ecology is *the study of the interactions that determine the distribution and abundance of organisms* (Krebs, 2009)

Yet change in community **composition** in space or time is often the primary focus of research — especially in palaeoecology

network representation

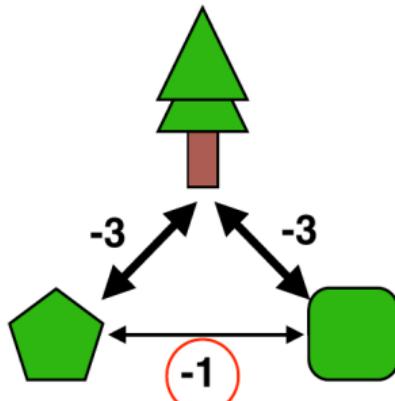
Networks are a convenient way to represent community composition data



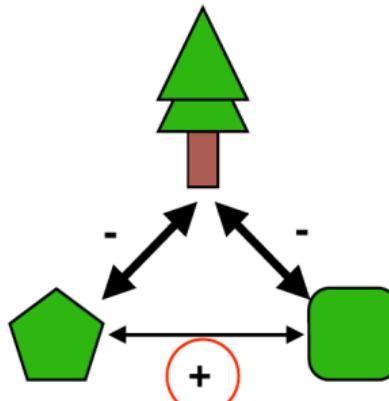
Photo by Clint Adair on Unsplash

species interactions

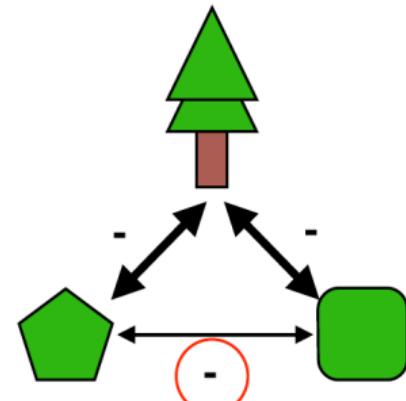
A) "True" interaction strengths



B) Observed correlations

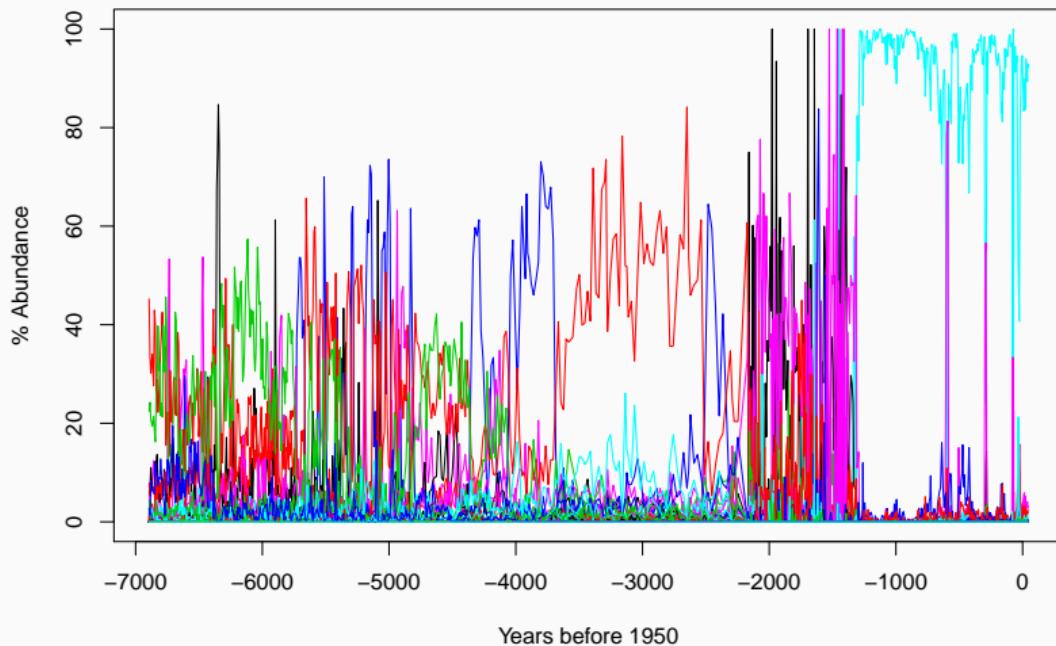


C) Inferred partial correlations



Source: Harris (2016) *Ecology* **97**(12), 3308–3314

complex multivariate species data



Data provided by Jeffery Stone (Indiana State University); Spanbauer *et al* PLOS One 2014

methods

Flavours of undirected graphs — are species conditionally dependent given relationships with all other variables?

Mixed Graphical Model

- Gaussian responses, enet penalties, 1st-order interactions — partial correlations
- Time-varying version works with irregularly spaced data
- **mgm** R package Halsbeck & Waldorp, ArXiv

Markov Random Fields

- Ising-like model of binary responses
- Conditional random fields approximated by pair-wise logistic regressions
- **MRFcov** R package Clark *et al* (2018) *Ecology*
- Covariate (t) included as a node in the network

kassjön

kassjön



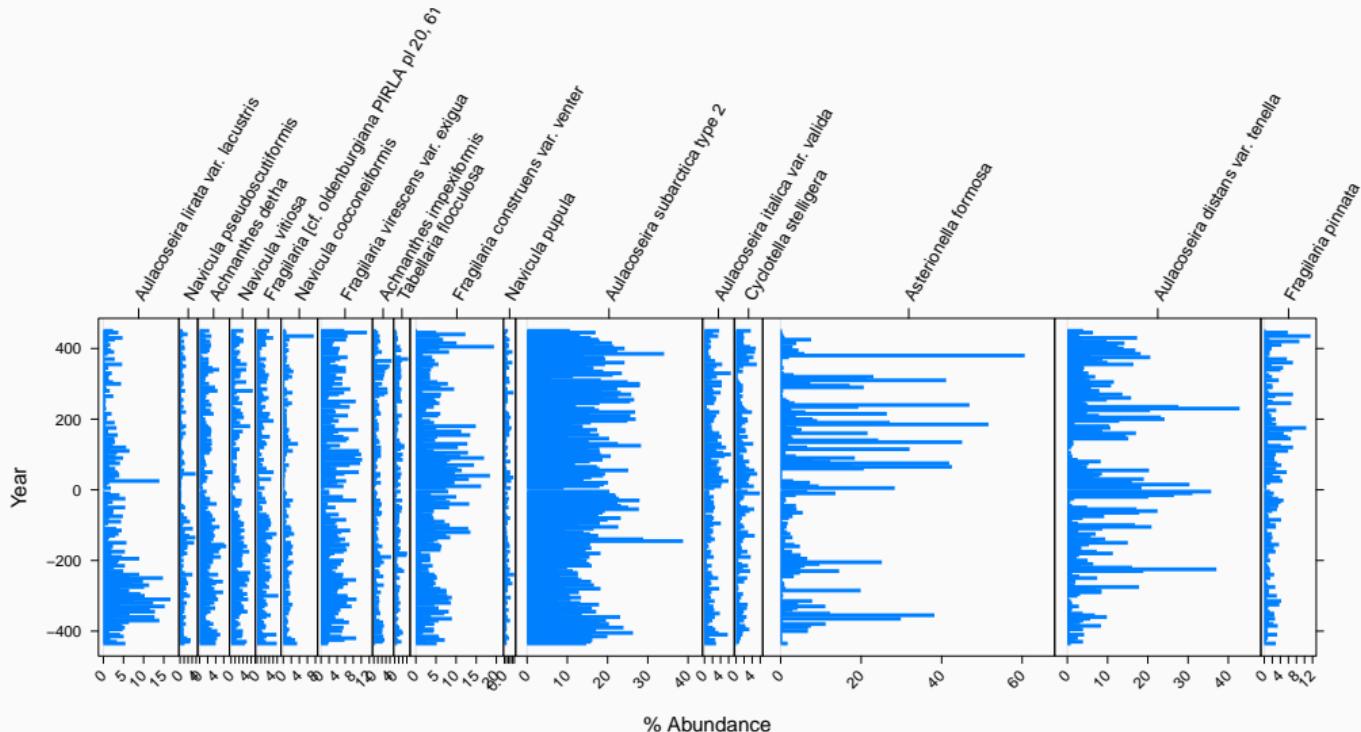
Source: © John Anderson

kassjön

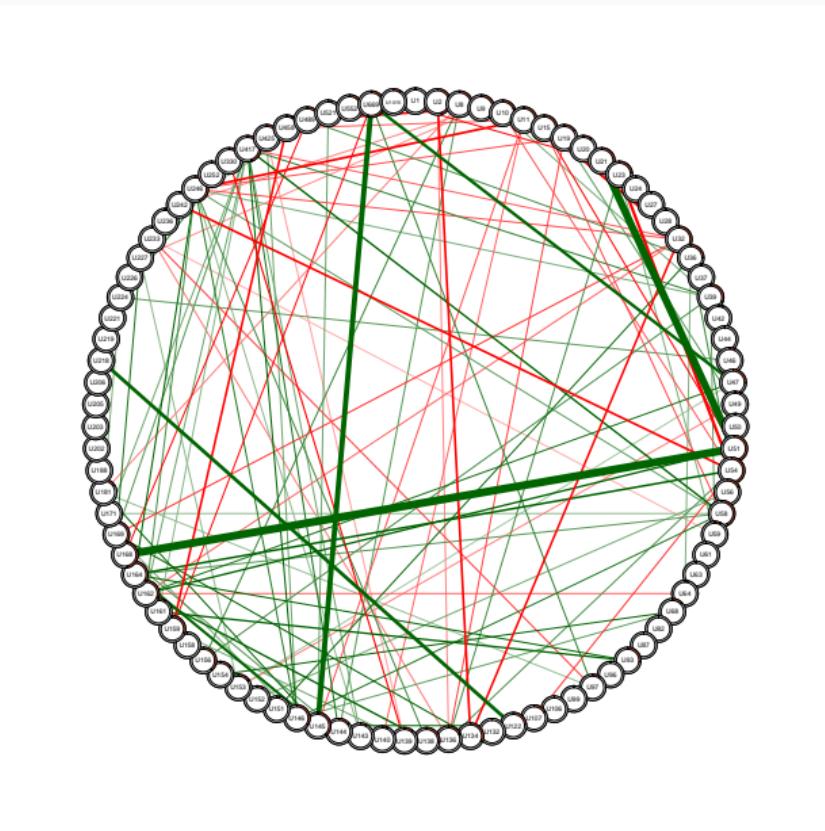
- Kassjön, Northern Sweden
- Small, dimictic, mesotrophic lake
- Seasonally anoxic; winter and summer
- Forms annual laminations due to strong spring
minerogenic input (Spring melt)



Source: © John Anderson

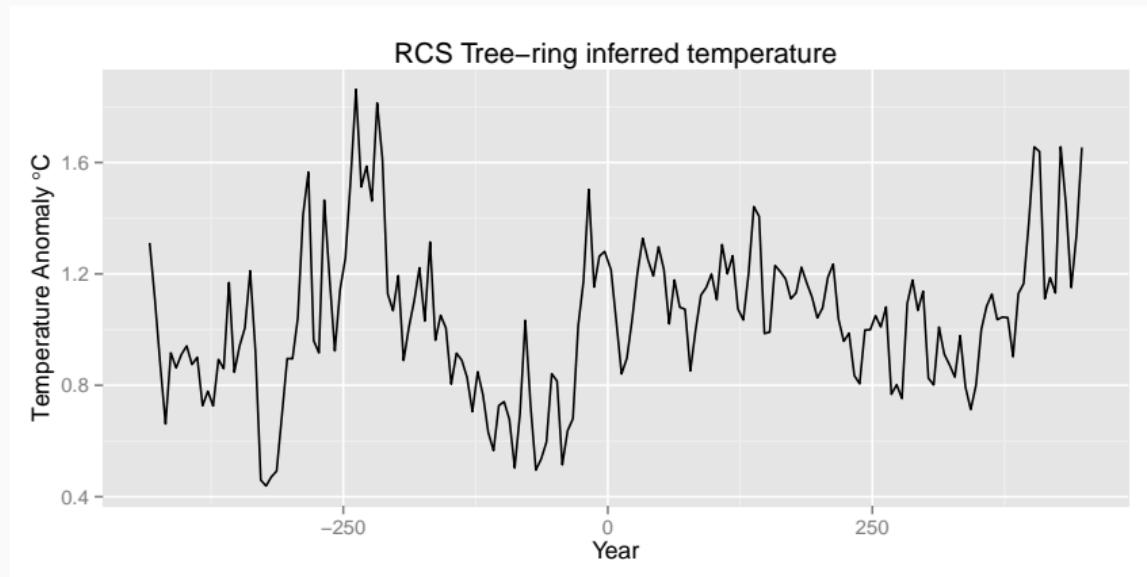


kassjön interactions



kassjön — do interactions change over time?

600 years of severe climate — particularly cold conditions ~330BC with glacial expansion at this time in Scandinavia



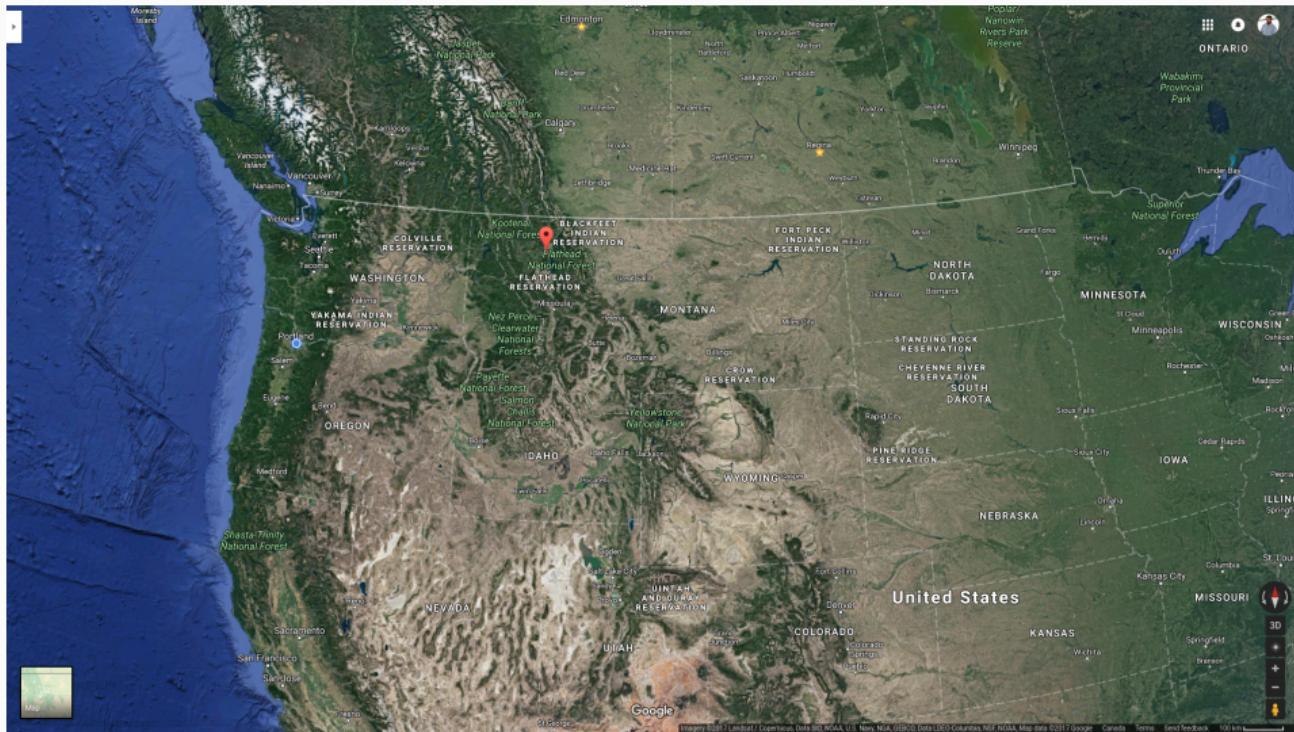
kassjön — do interactions change over time?



Photo by Gemma Evans on Unsplash

foy lake

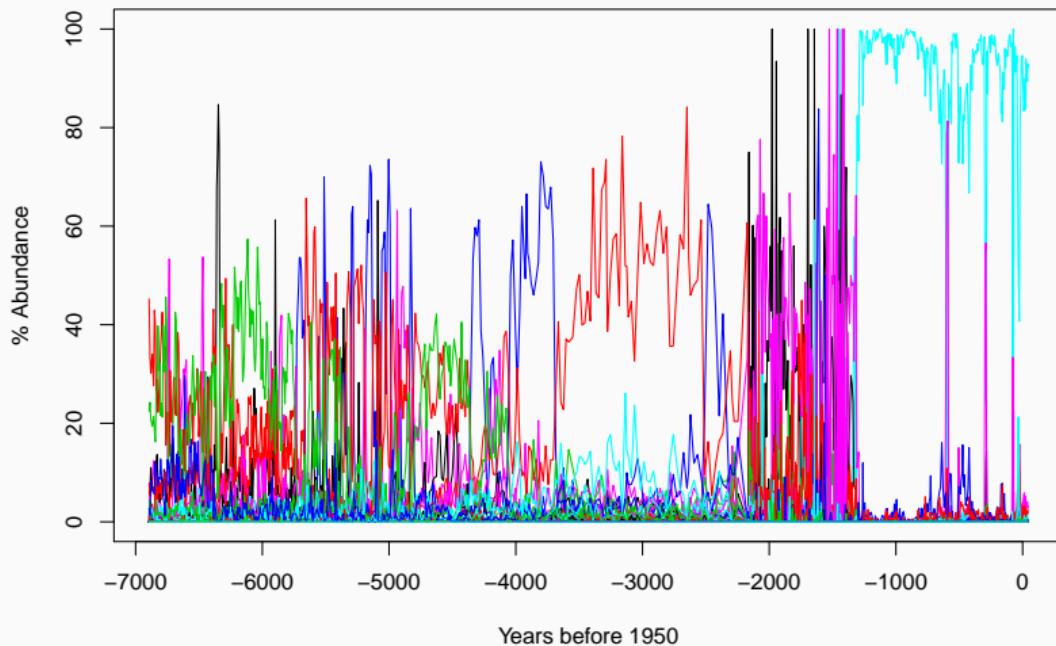
foy lake — montana



foy lake — montana



complex multivariate species data



Data provided by Jeffery Stone (Indiana State University); Spanbauer *et al* PLOS One 2014

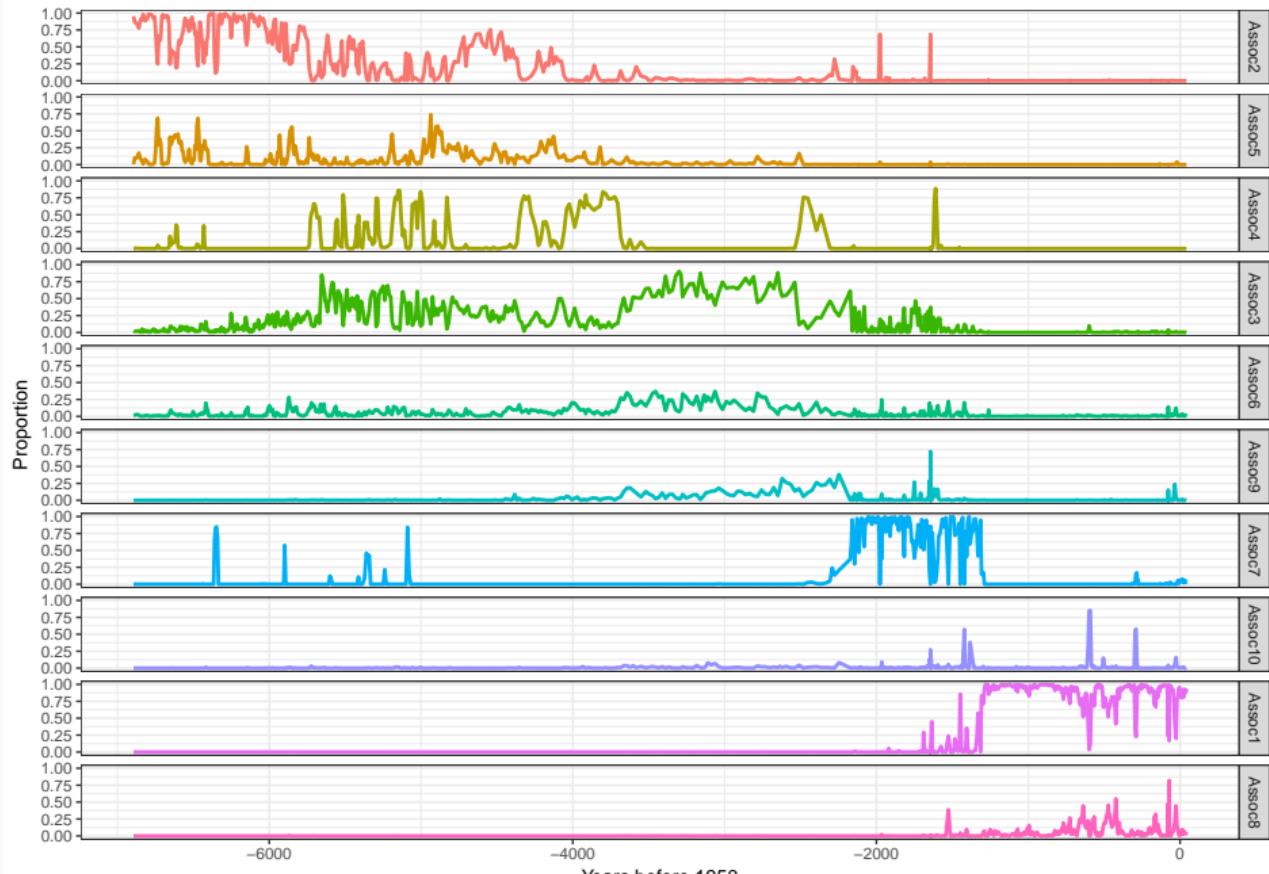
topic model — individual skittles from one of the flavour packs



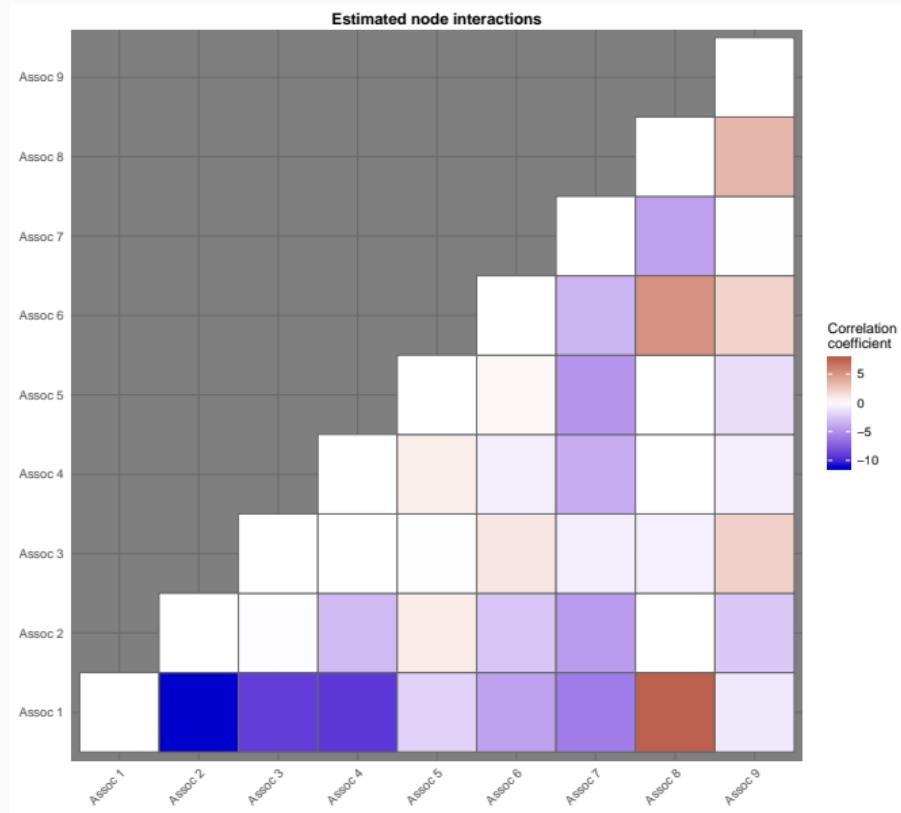
What are the proportion of flavours in each pack?

How many of each pack comprise the skittle community?

correlated topic model



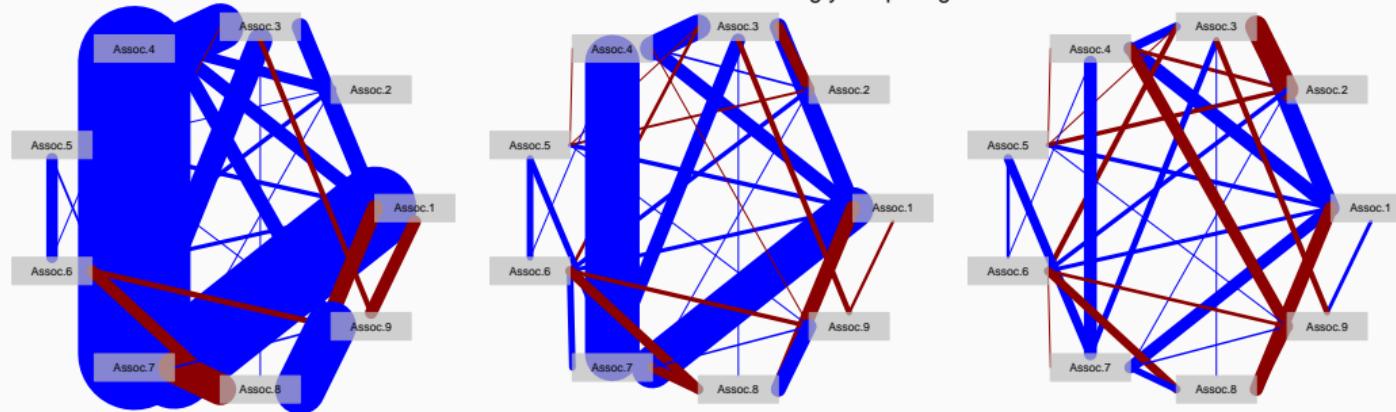
foy lake interactions



foy lake interactions — effect of time

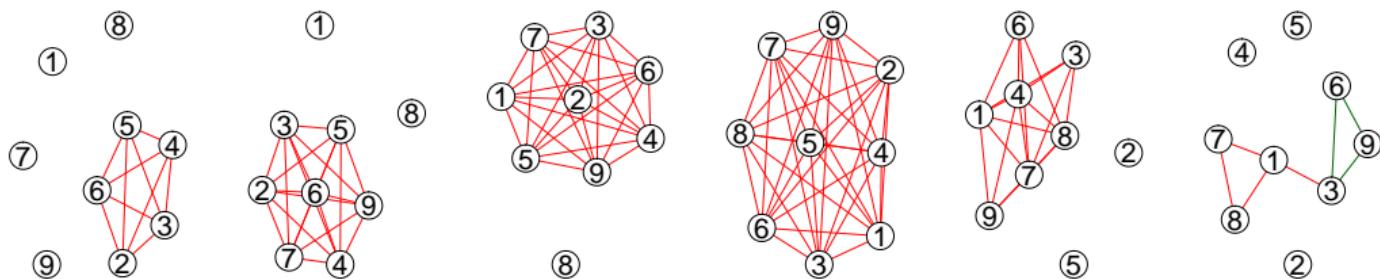
How interaction coefficients change due to time

Estimated node interactions at increasing yearbp magnitudes



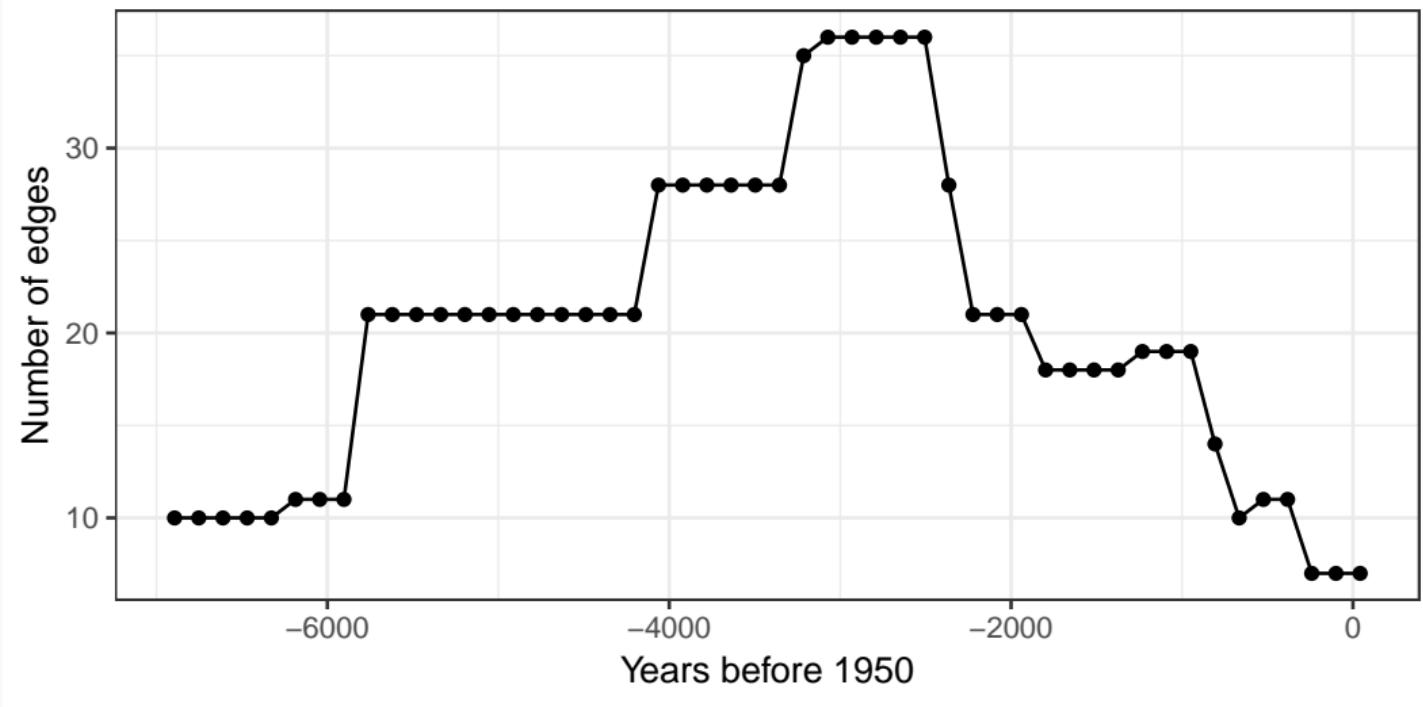
foy lake interactions — effect of time

How predicted interactions changes over time



foy lake interactions — effect of time

How network structure changes over time



what are these co-occurrence pattern-derived networks?

Attempting to divine process from pattern?

Range of methods failed to recover known interactions (Barner *et al*¹ & Freilich *et al*²)

*species interaction networks are a prediction of what [interactions] could be
(Delmas *et al*³)*

Considerable power issue; estimating a huge number of parameters & assuming the result is sparse

¹Ecology, 2018

²Ecology, 2018

³Biological Reviews, 2018

conclusions

MGMs & (conditional) MRFs are a potentially useful way of viewing (palaeo)ecological data

With species-rich data sets, models are data hungry

- power problems; assumptions about sparsity

Some dimension reduction may help — complicates the interpretation

work in progress — sensitivity to model settings & uncertainties?



Photo by Steve Harvey on Unsplash