

Effects of prior information on estimates of species interactions from time series data

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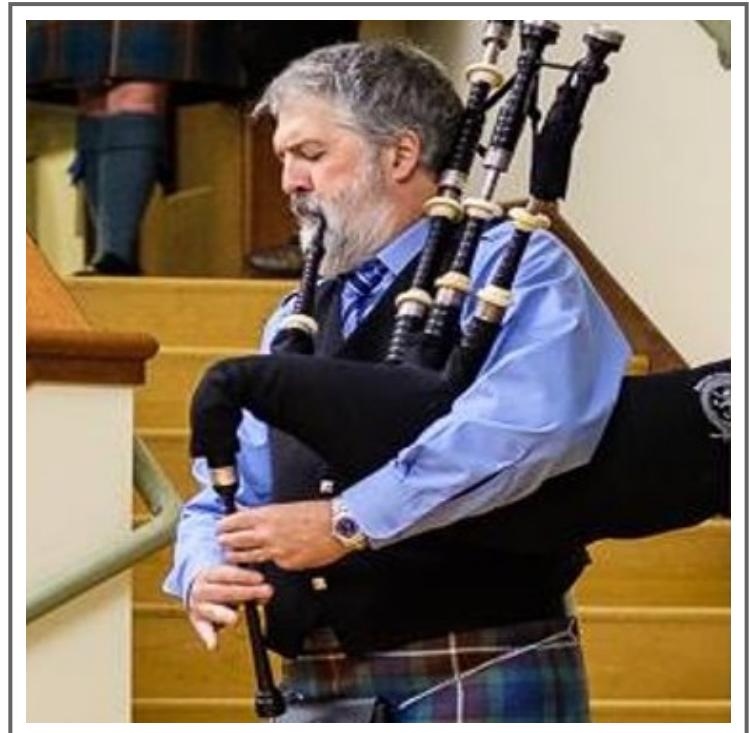
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Coauthors



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Steve Katz (Washington St Univ)

Estimating species interactions is a long-standing goal in ecology

Predation

Competition

Facilitation

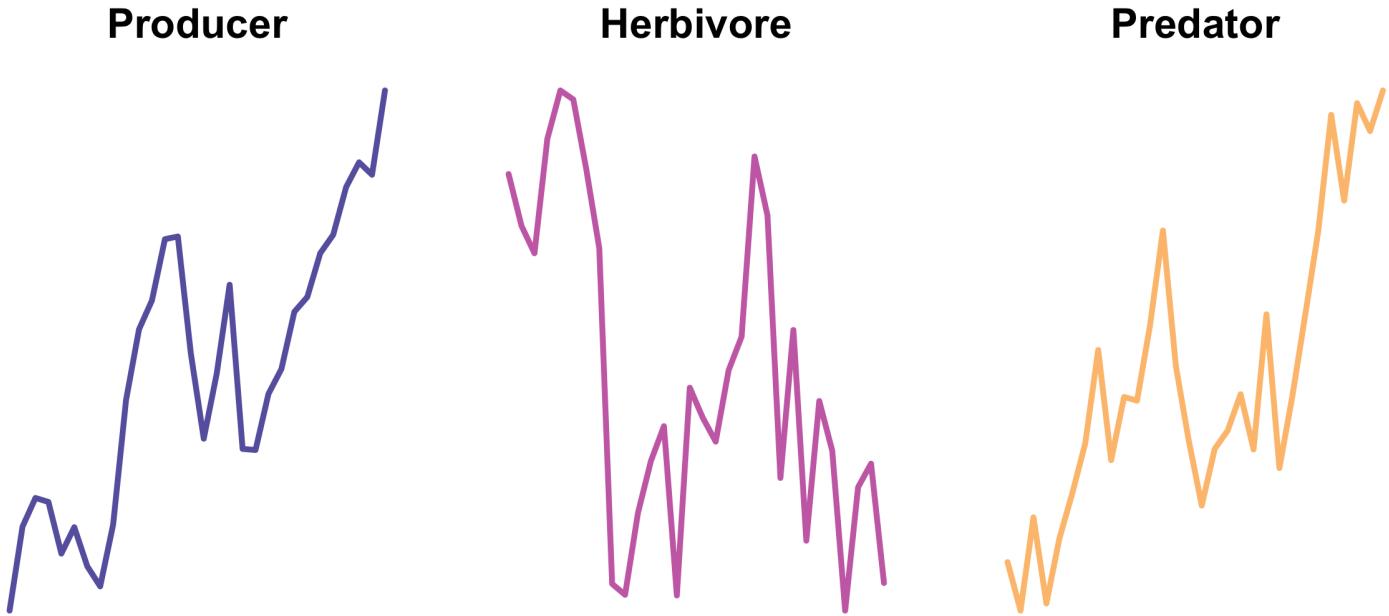


Photo: Anne Paine



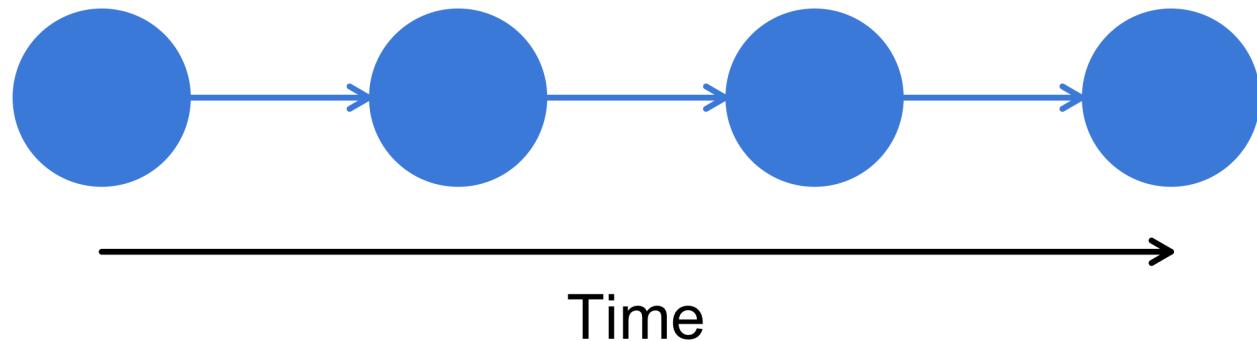
Photo: Adam Hinterthuer

Estimating interactions from time series

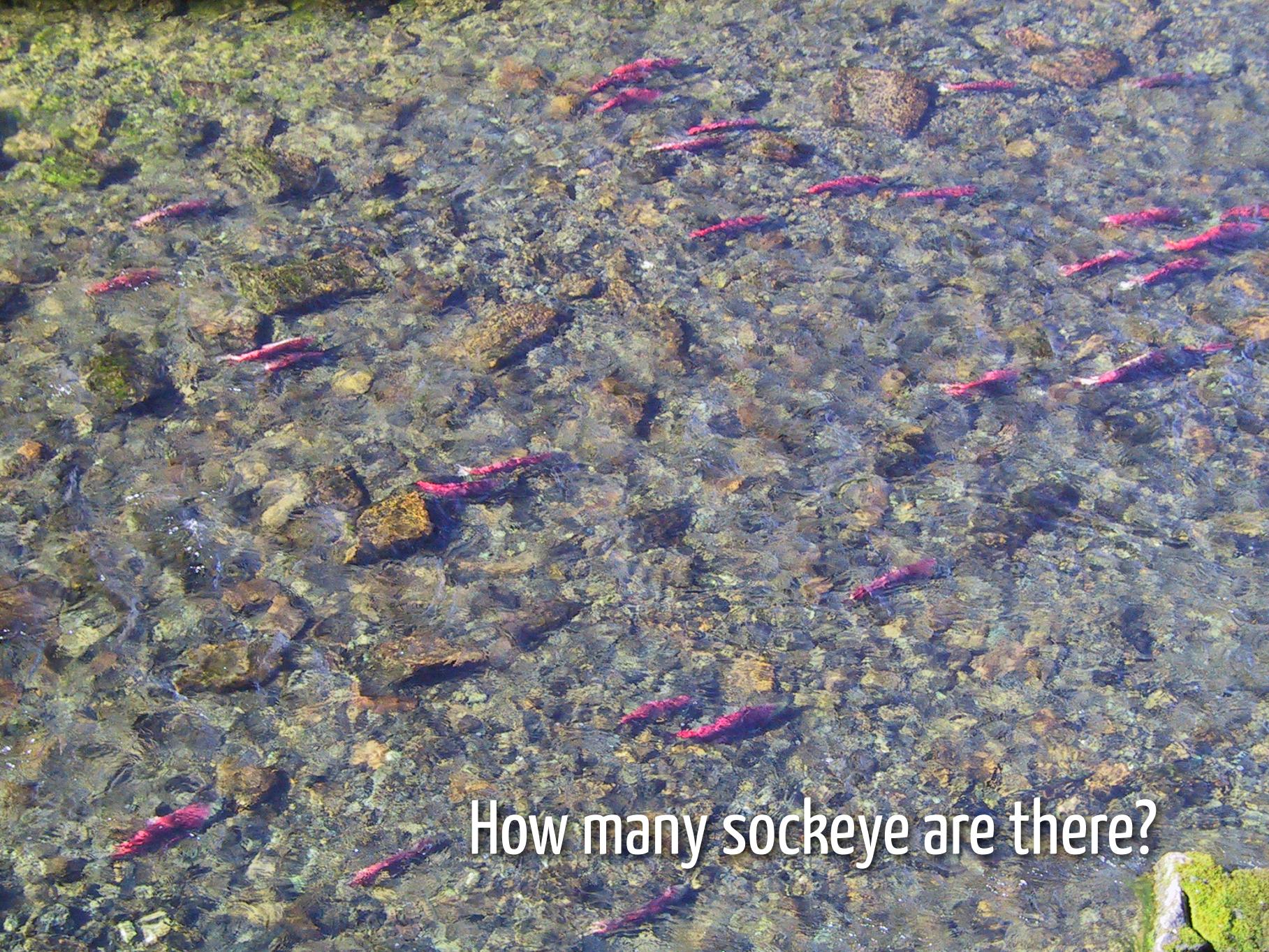


Multivariate autoregressive models

Describe **community dynamics over time**



Observing nature can be easy

A photograph showing a large school of sockeye salmon swimming in a river. The water is clear, revealing a rocky riverbed. The salmon are a vibrant red color, contrasting with the blue and green tones of the water. They are swimming in various directions, creating a sense of movement.

How many sockeye are there?

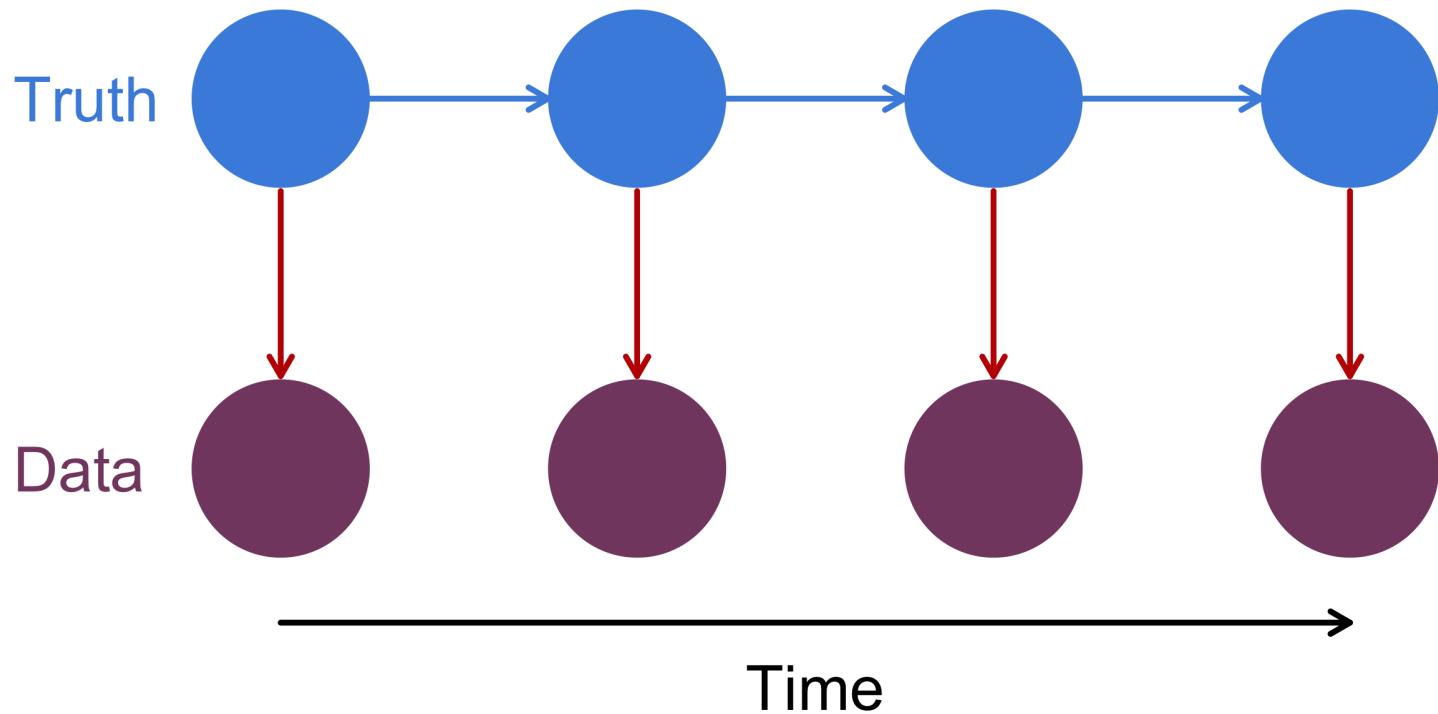
Observing nature can also be hard



How many mayflies are there?

Multivariate autoregressive models

Data = Truth \pm Errors



Multivariate autoregressive models

State model

$$\text{Density}_t = f(\text{Density}_{t-1}, \text{Environment}_{t-h}, \text{error}_t)$$

Observation model

$$\text{Data}_t = g(\text{Density}_t, \text{error}_t)$$

How does one actually do this?

Canned R packages

`dlm, vars, MARSS*`

*Holmes, Ward, Scheuerell (2020) *Analysis of multivariate time-series using the MARSS package*

Canned R packages

`dlm, vars, MARSS*`

Code-your-own

JAGS, Stan, greta

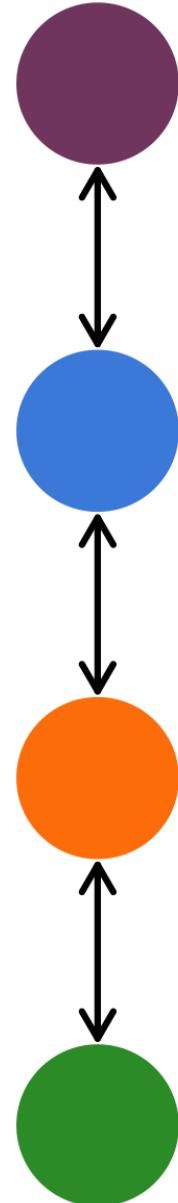
*Holmes, Ward, Scheuerell (2020) *Analysis of multivariate time-series using the MARSS package*

How accurate and precise are these models?

Simulating species interactions

4-member food chain

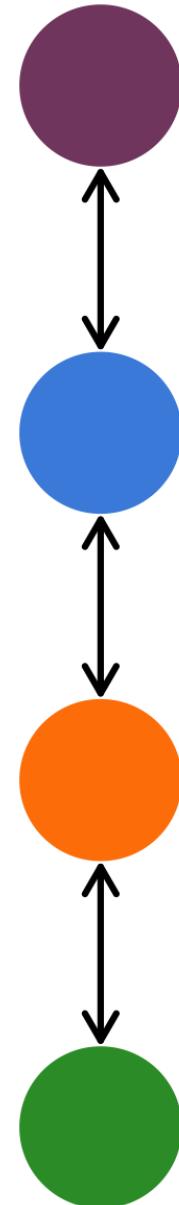
- 30 time steps (50 total - 20 burn-in)
- varying intensity of density-dependence
- varying interaction strengths
- varying levels of sampling & process errors



Estimating species interactions

4-member food chain

- state-space models fitted in Stan
- varying certainty of prior information

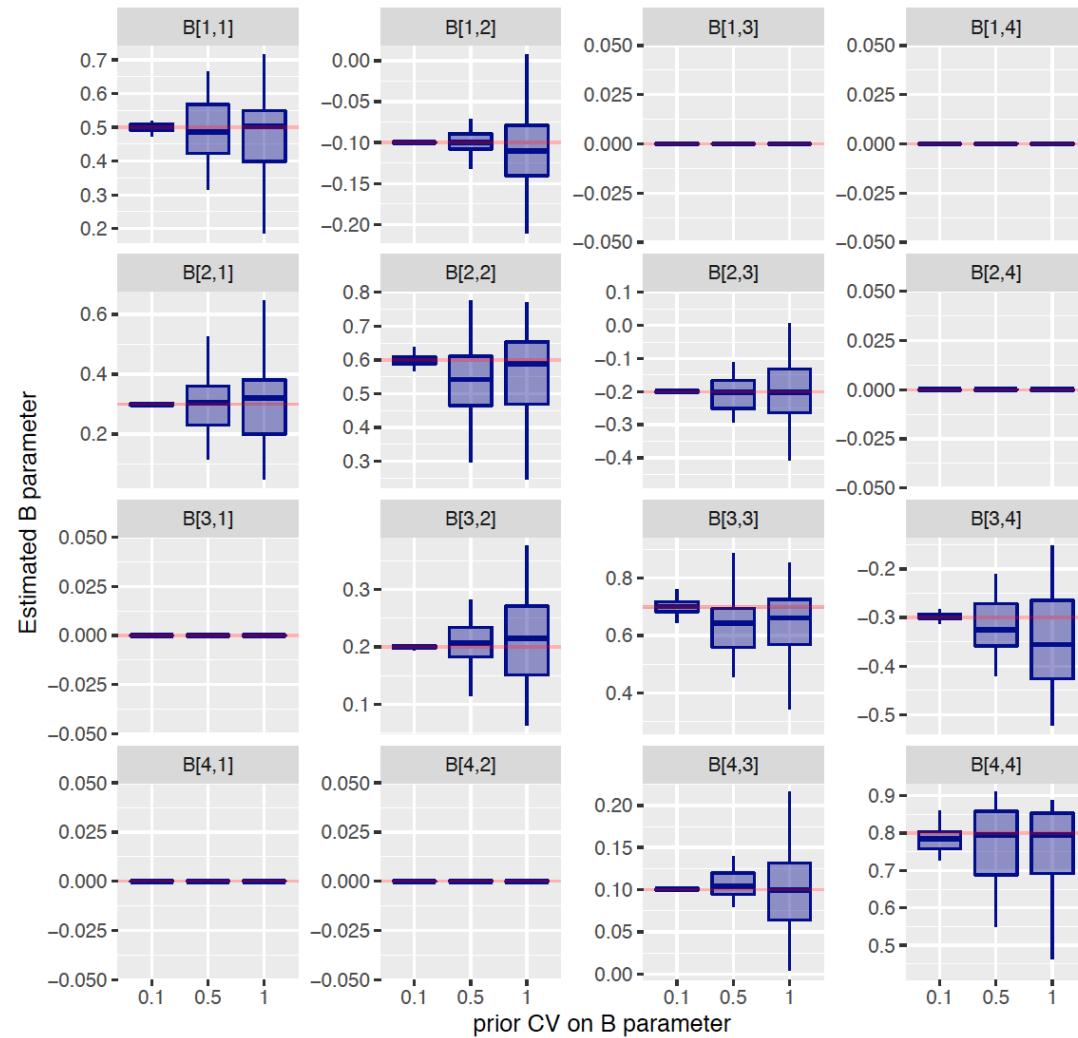


Bayes' rule

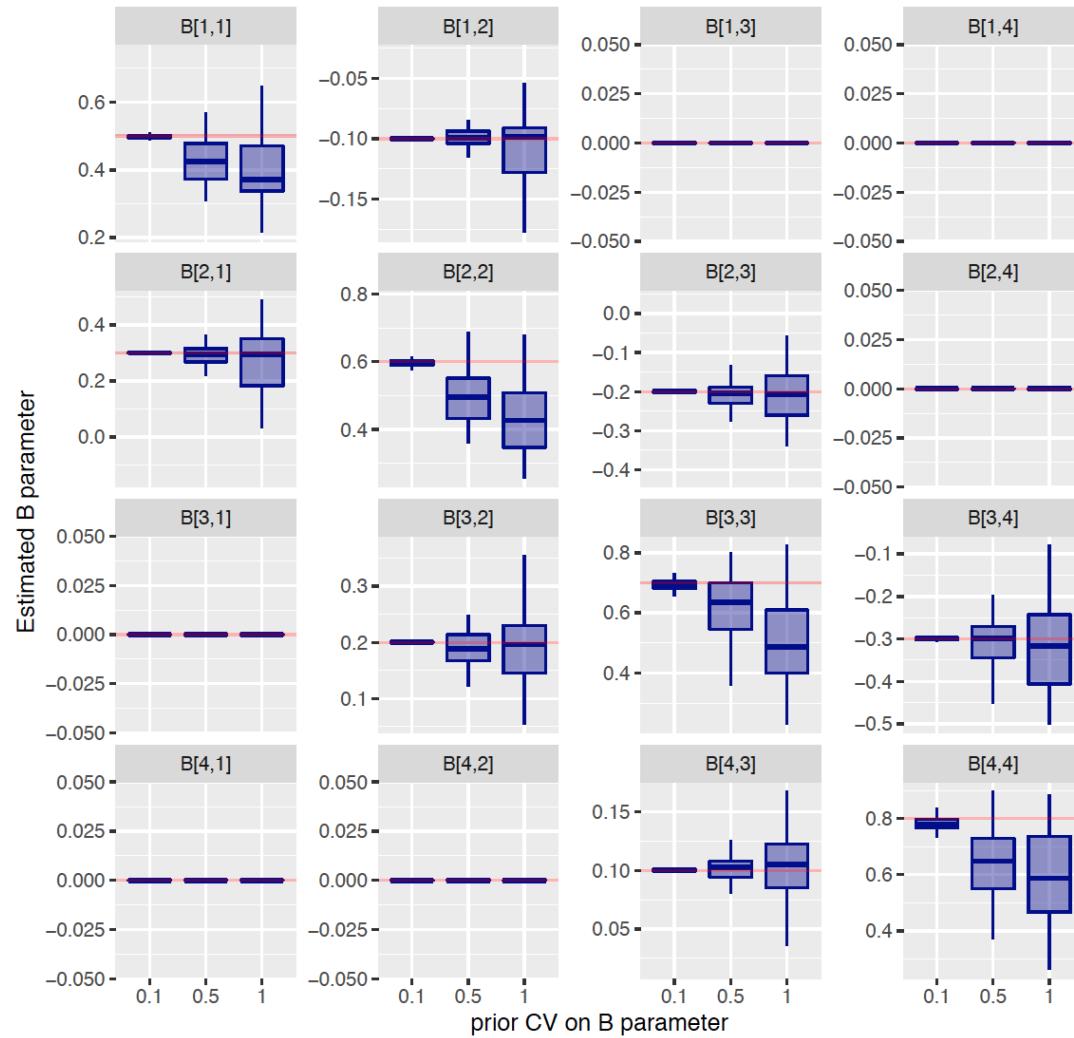
Posterior belief \propto Prior information \times Data likelihood

Effects on interaction strengths

Environmental noise > sampling error



Sampling error > environmental noise



Future directions

Examine other food web configurations

Future directions

Examine other food web configurations

Examine effects of 2+ observations of the process

Future directions

Examine other food web configurations

Examine effects of 2+ observations of the process

Compare results to likelihood based methods

Project repo on GitHub

https://github.com/mdscheuerell/mar_sims

Mark's website

<https://faculty.washington.edu/scheuerl/>