Scaling and spatial patterns of species co-occurrence in a rocky intertidal meta-community

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#### It takes a village ...

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Data Wrangling/Computing

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### What is the role of species interactions?





## Macroecological signals of species interactions in the Danish avifauna

#### Nicholas J. Gotelli<sup>a,1</sup>, Gary R. Graves<sup>b</sup>, and Carsten Rahbek<sup>c</sup>

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The role of intraspecific and interspecific interactions in structuring biotic communities at fine spatial scales is well documented, but the signature of species interactions at coarser spatial scales is unclear. We present evidence that species interactions may be a significant factor in mediating the regional assembly of the Danish avifauna. continental mainland regions (23). Inferences of community assembly rules from statistical analyses of presence/absence data are controversial. Even with the use of sophisticated null-model analyses, it is not possible in most systems to discriminate spatial patterns generated by species interactions from those caused by historical



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Modified Fig. 2 in Chamberlain et al. 2014 Ecol. Lett.



Patterns in species co-occurrence as signals of species interactions



Diamond 1975, Connor & Simberloff 1979, Gotelli 2000, Peres-Neto et al. 2001, Ovaskainen et al. 2010

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Diamond 1975, Connor & Simberloff 1979, Blois et al. in press *Ecography* Illustrations: Raffaele et al. *Birds of the West Indies* 



Illustrations: Raffaele et al. Birds of the West Indies

Are there non-random patterns of species co-occurrence?

Do patterns of species co-occurrence change in different spatial/environmental contexts?











Latitude (°N)



### Multivariate regression approach

- Input:
  - presence/absence matrix of species
  - environmental matrix
- Account for similarities/differences in habitat preferences (fundamental niche)
- Output:
  - matrix of residual correlations among species

(a measure of non-random co-occurrences)

#### Need to account for habitat preferences

- currents upwelling index, along- and cross-shelf
- temperature water
- water retention shelf width (distance to 100 and 200m depth)
- phytoplankton abundance chlorophyll-a
- nutrient availability PON, nitrate
- substrate heterogeneity

## Are there non-random patterns of species co-occurrence?

Do patterns of species co-occurrence change in different spatial/environmental contexts?

# Are there non-random co-occurrences overall?

Yes, do see residual co-occurrences in all contexts!





Are there non-random patterns of species co-occurrence?

Do patterns of species co-occurrence change in different spatial/environmental contexts? *Oceanographic regions Wave exposure* 

# Environmental and spatial contexts of the Oregon coast



oceanographic sites organized into biogeographic regions



wave regime measured relative wave acceleration

#### Relative frequency of co-occurrences



#### Relative frequency of co-occurrences



#### Relative frequency of co-occurrences

proportion of positive co-occurrences co-occurrences

proportion of negative co-occurrences

#### Absolute value of pairwise co-occurrences



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Do patterns of species co-occurrence change in different spatial/environmental contexts? *Oceanographic regions Wave exposure* 



mean species turnover ( $\beta_{div}$ ) = 0.63



mean species turnover ( $\beta_{div}$ ) = 0.59



note: different colors = different species pairs

Are there non-random patterns of species co-occurrence?

Do patterns of species co-occurrence change in different spatial/environmental contexts? *Oceanographic regions Wave exposure* 



mean species turnover ( $\beta_{div}$ ) = 0.58



note: different colors = different species pairs

## Are there *predictable* context-dependencies in species interactions?



#### Environmental Stress Models and the Stress Gradient Hypothesis



Preliminary analysis: ESM does not adhere for *wave stress* or *thermal stress* in this system

ESM: Modified Menge-Sutherland model (1987 *AmNat*) from Bruno et al. 2003 *TREE* SGH: Bertness & Callaway 1994 *TREE*, review in Maestre et al. 2009 *J. Ecol.* 

### Hypothesis generation & testing

observe communities



	sp 1	sp 2	sp 3	sp 4
site 1	1	0	1	0
site 2	0	1	1	1
site 3	1	0	0	1

statistical test of co-occurrence patterns



experimental test of species interactions

