



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

Allison Barner

Sally Hacker

Bruce Menge

Department of Integrative Biology

Oregon State University

 @algaebarnacle

It takes a village...

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Hacker, Menge & Novak labs at OSU





Photo: David Gonzales

A high-angle photograph of a mountain range. The upper portion shows jagged, rocky peaks partially covered in snow, with some clouds hanging in the sky. The lower portion shows a steep, rocky slope covered in a dense forest of evergreen trees. A semi-transparent grid pattern is overlaid across the middle of the image, where the text is located.

What is the role of species interactions?

Photo: David Gonzales



Paine 1966, 1969 *Am Nat*, Gotelli et al. 2010 *PNAS*, Araújo & Luoto 2007 *GEB*



Macroecological signals of species interactions in the Danish avifauna

Nicholas J. Gotelli^{a,1}, Gary R. Graves^b, and Carsten Rahbek^c

^aDepartment of Biology, University of Vermont, Burlington, VT 05405; ^bDepartment of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20013; and ^cCenter for Macroecology, Evolution and Climate, Department of Biology, University of Copenhagen, DK-2100 Copenhagen Ø, Denmark

Communicated by Thomas W. Schoener, University of California, Davis, CA, December 21, 2009 (received for review August 6, 2009)

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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Communicated by Thomas M. Blackburn

The role of intraspecific interactions in shaping biotic communities at the regional scale: a signature of species interactions in the Danish avifauna. We present evidence for the role of intraspecific interactions as a factor in mediating the

Future climate



Future climate + host plant (UD)

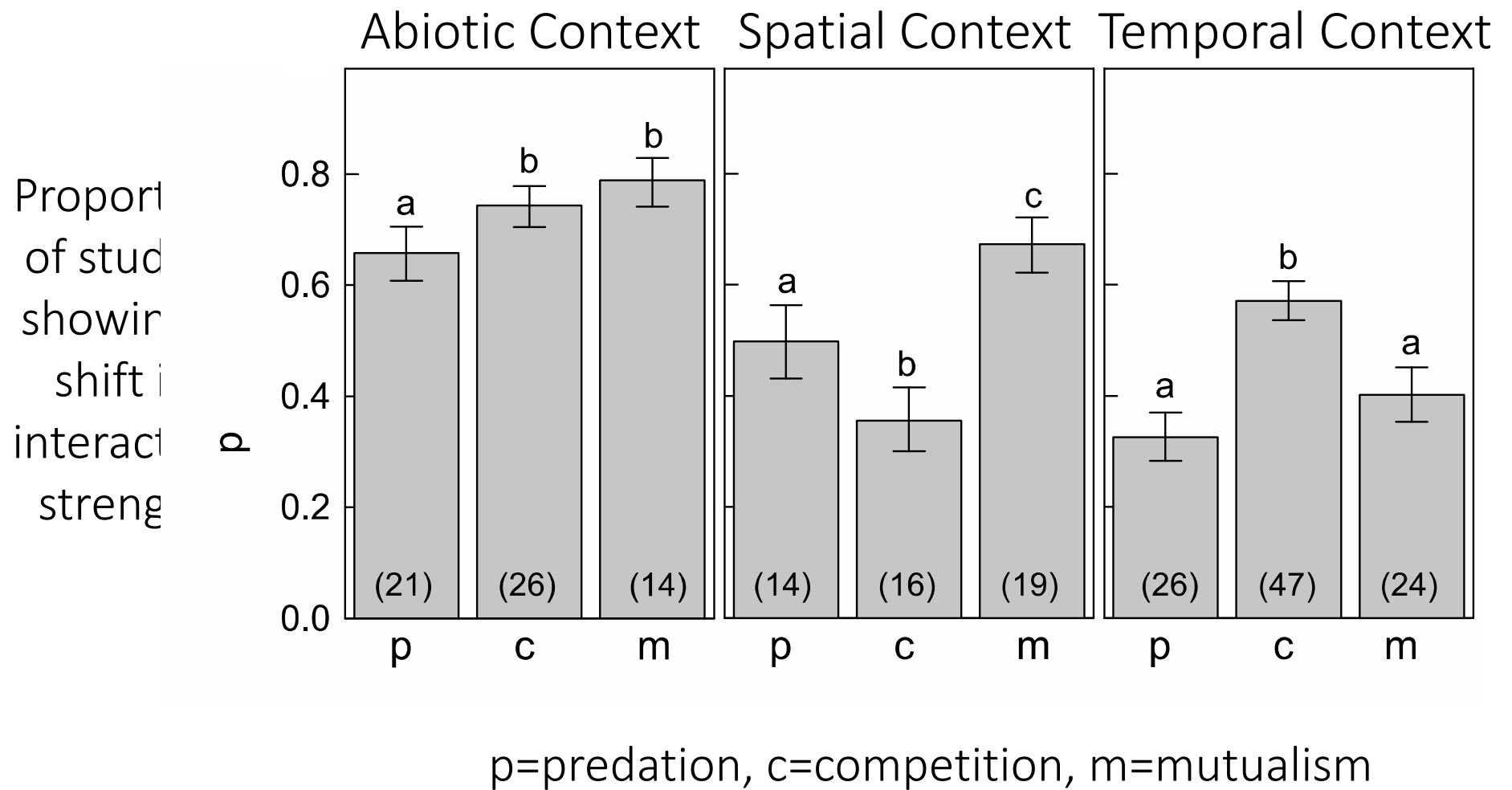


August 6, 2009)

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Carpinteria salt marsh food web, Lafferty et al. 2006

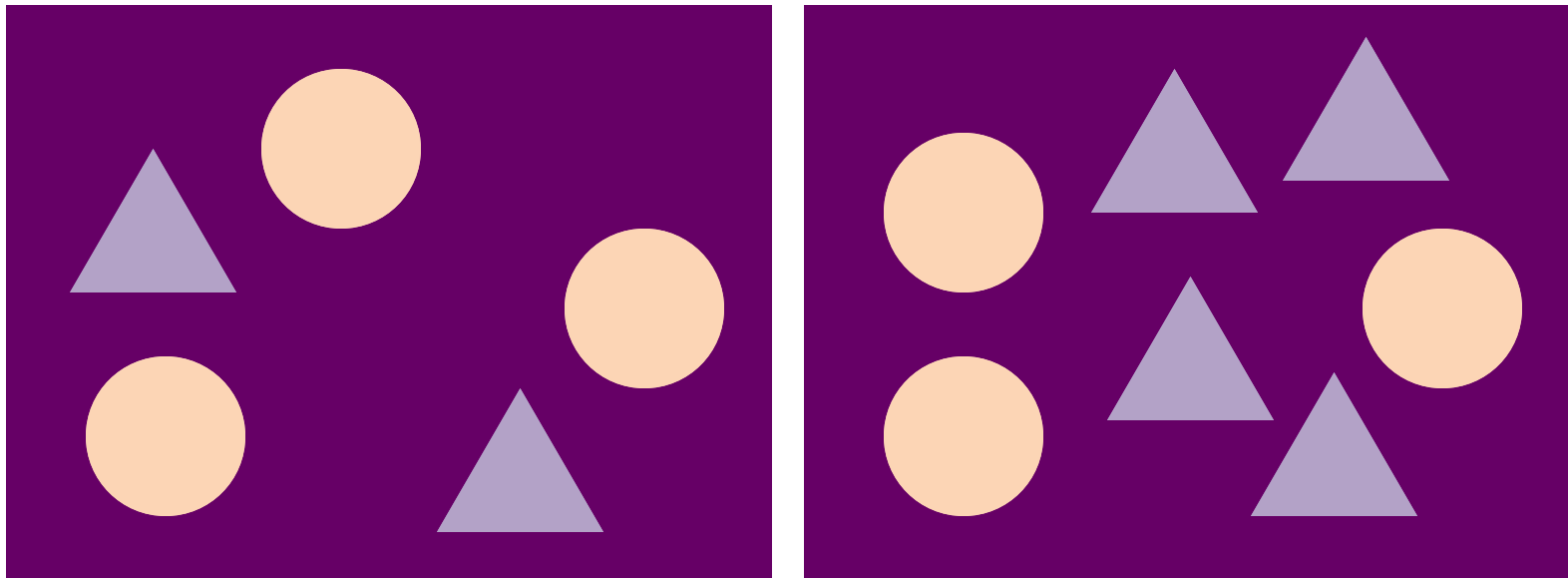




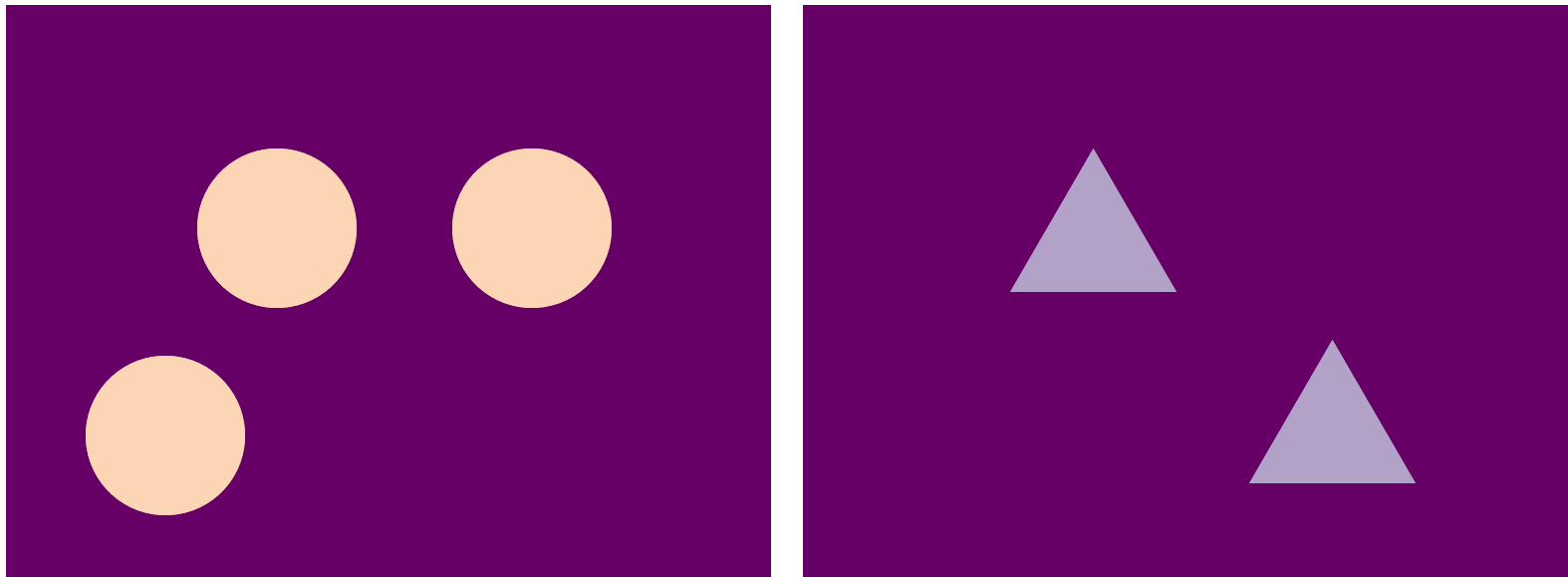
SPECIES INTERACTIONS



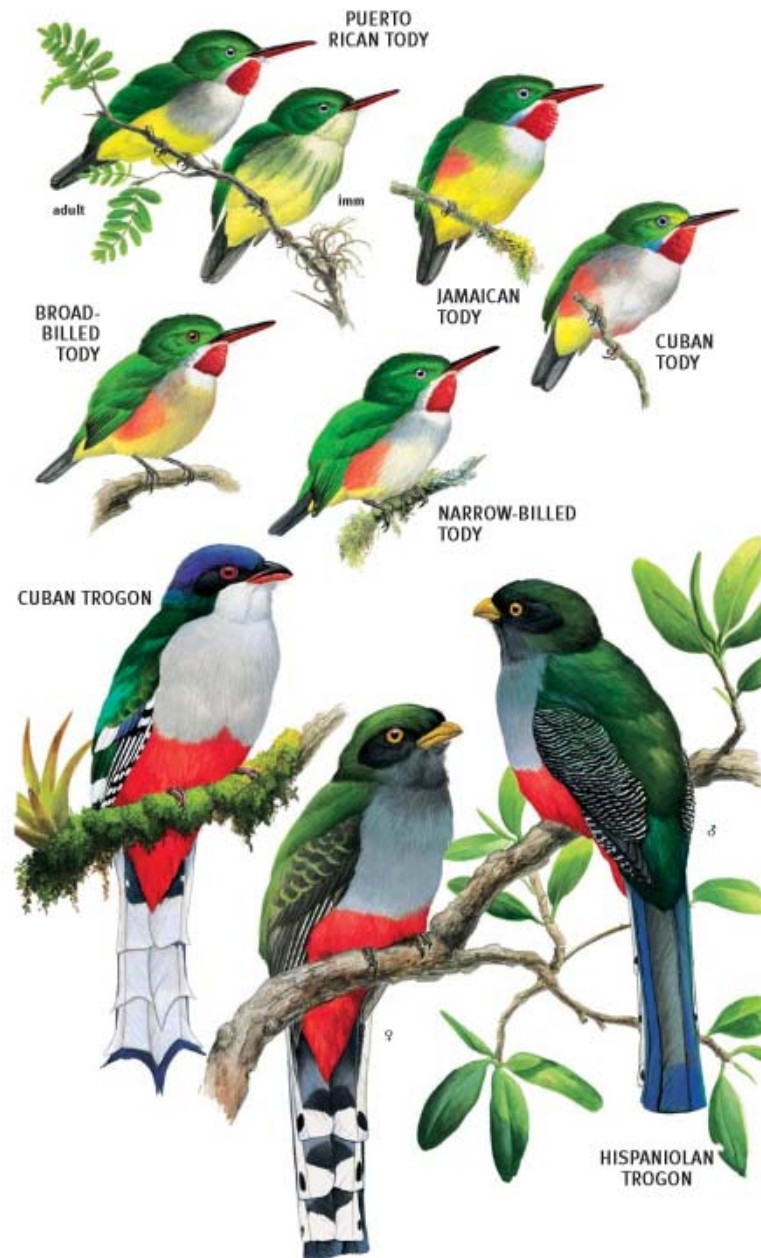
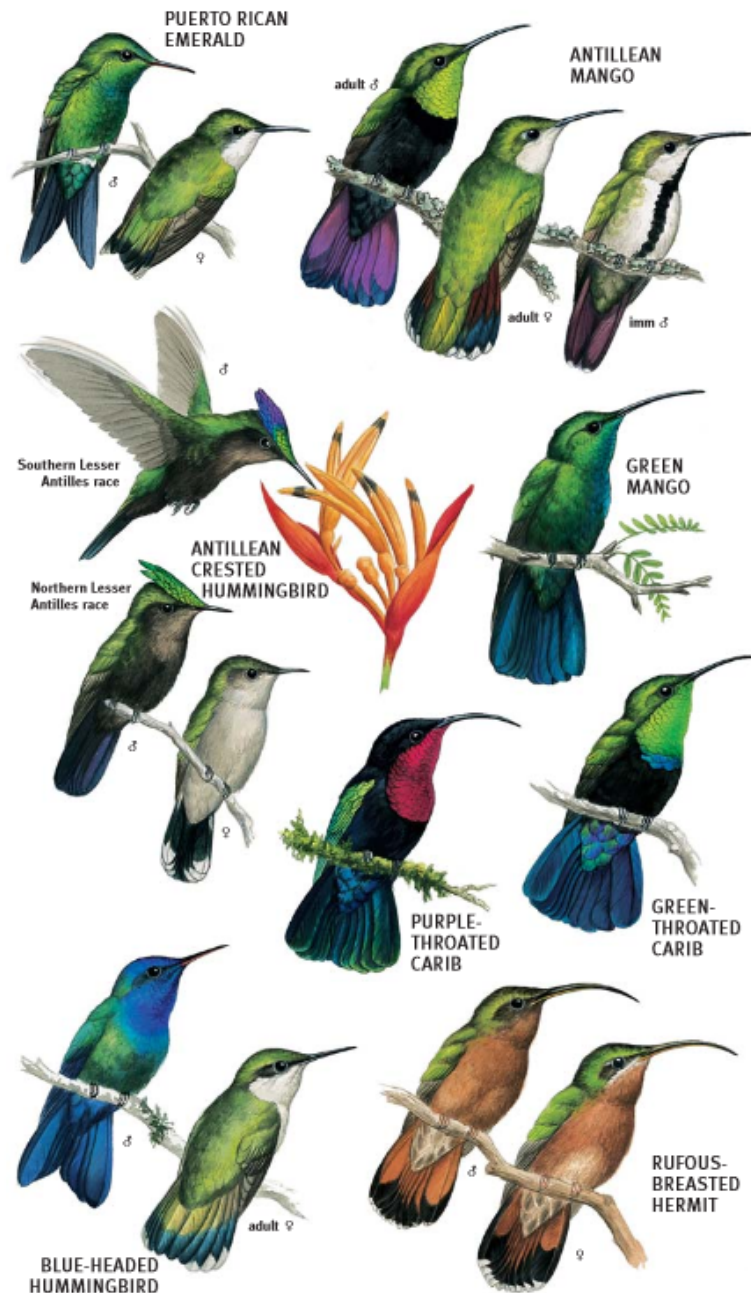
Patterns in species co-occurrence as signals of species interactions



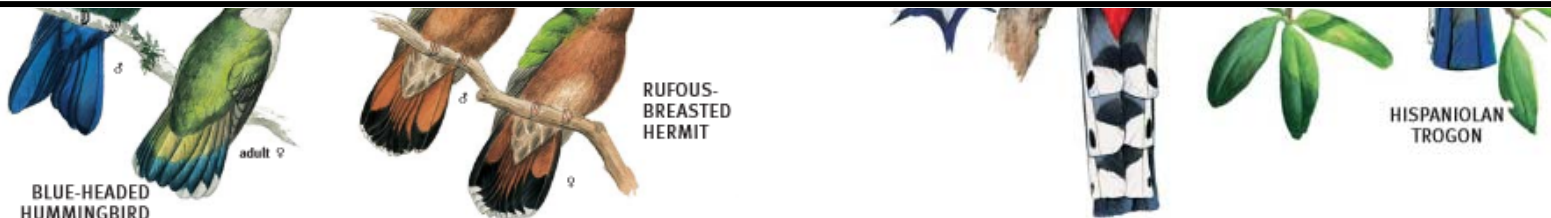
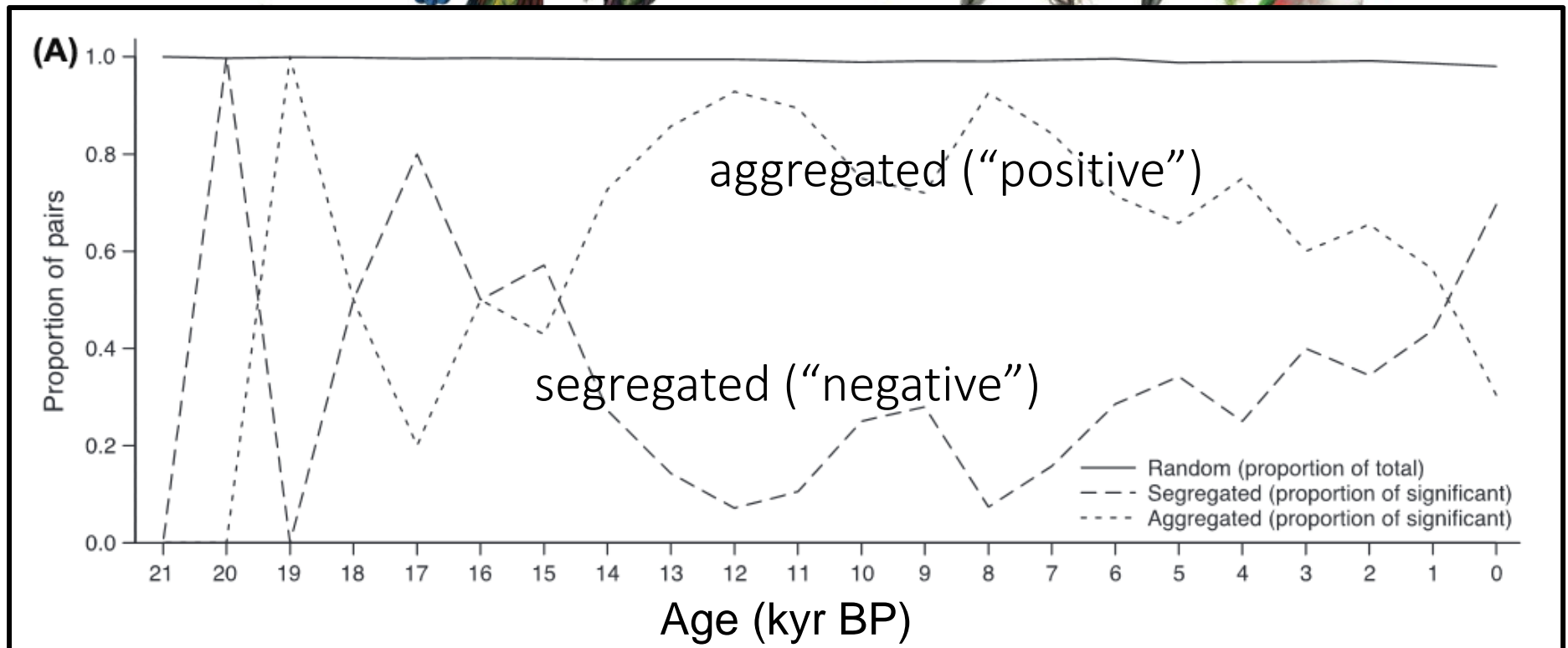
Patterns in species co-occurrence as signals of species interactions



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



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

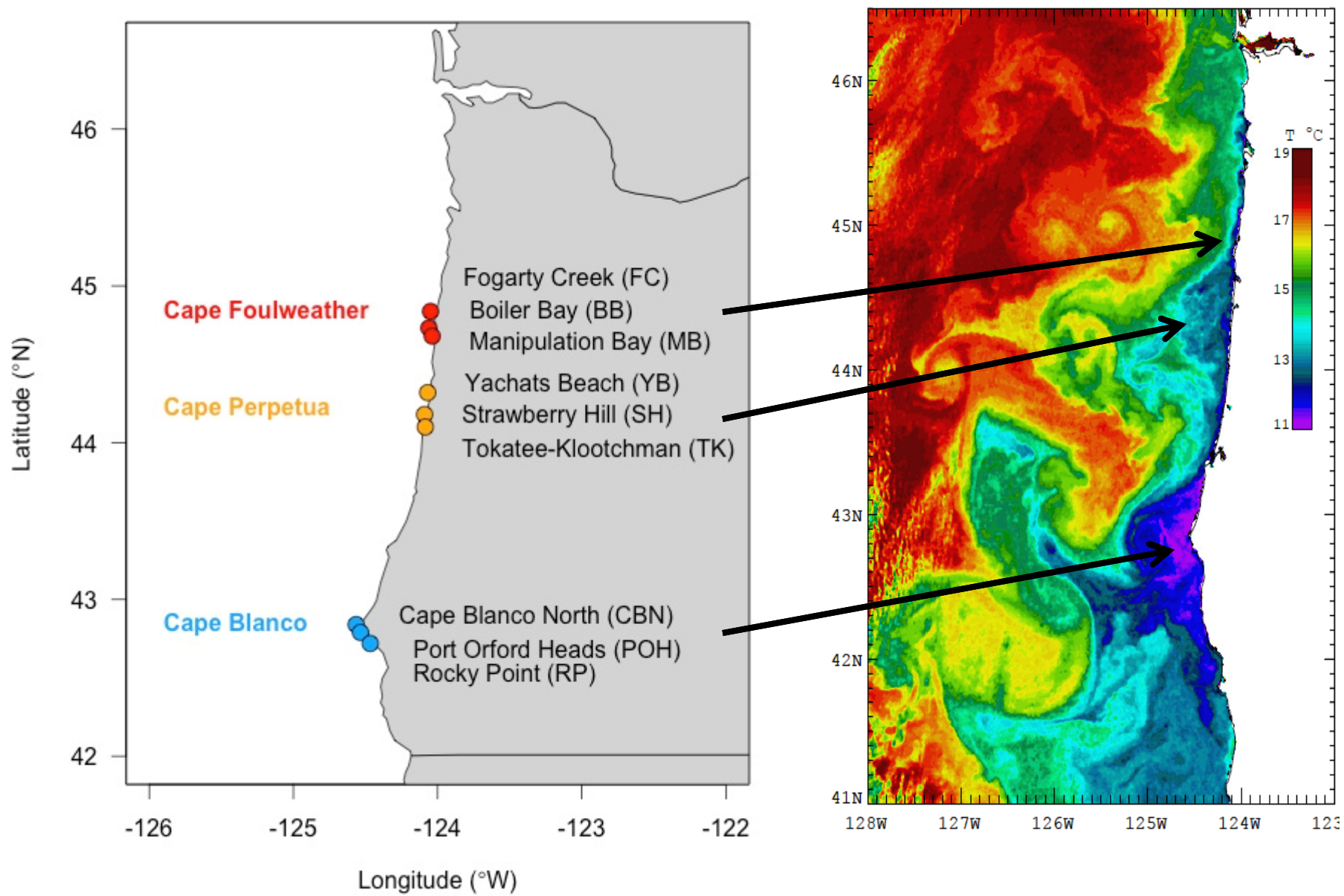


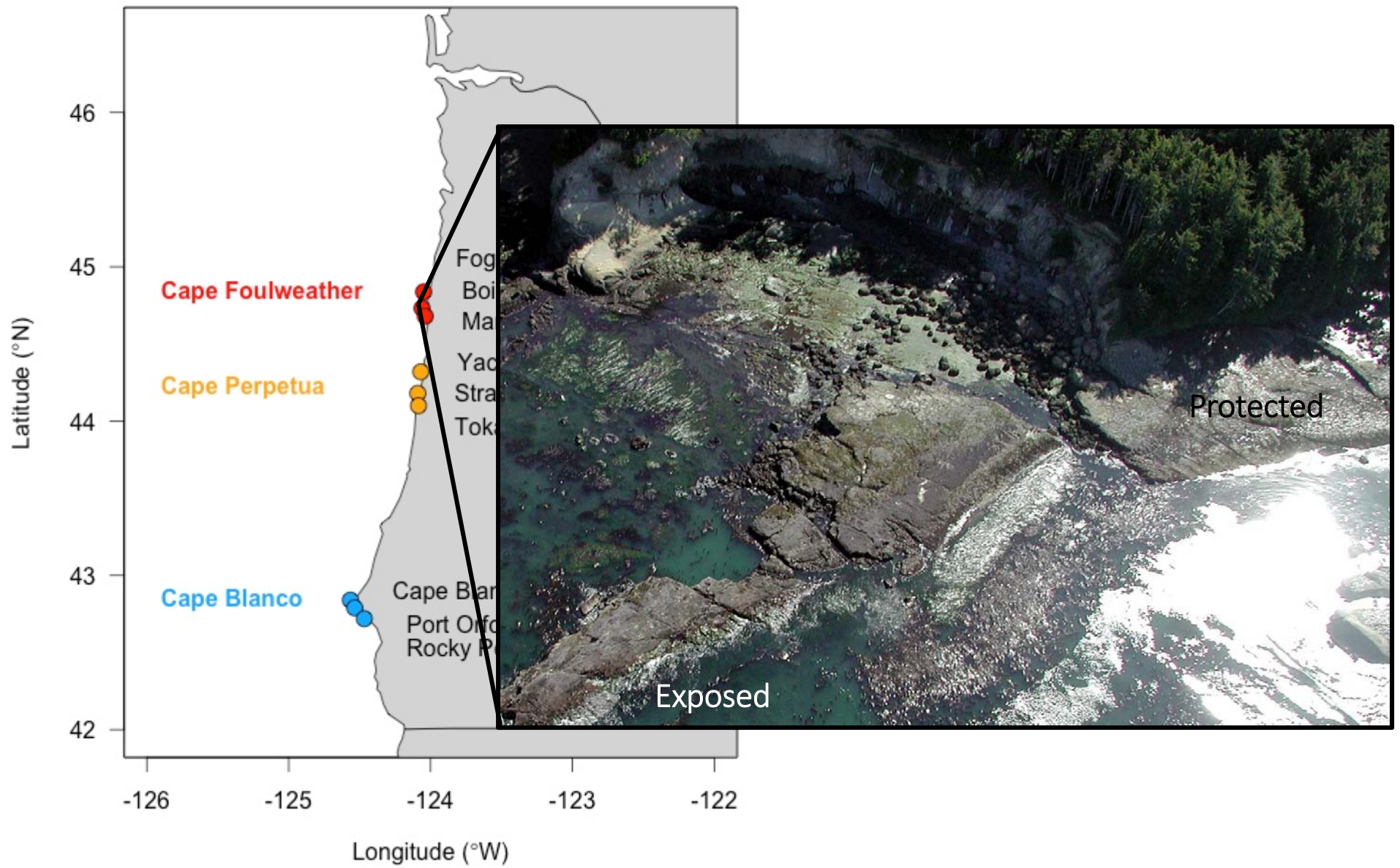
Diamond 1975, Connor & Simberloff 1979, Blois et al. in press *Ecography*
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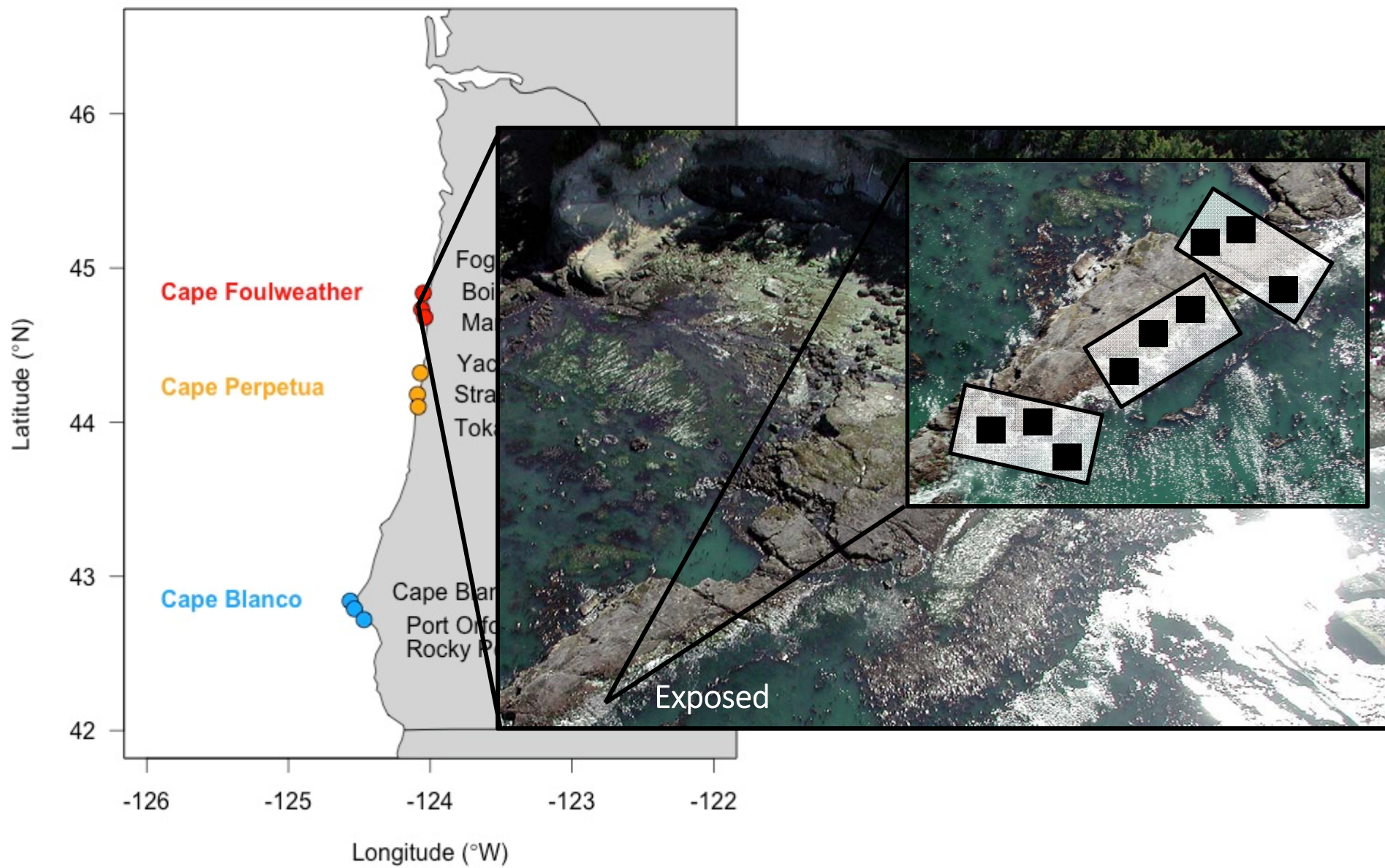
Are there non-random patterns of
species co-occurrence?

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



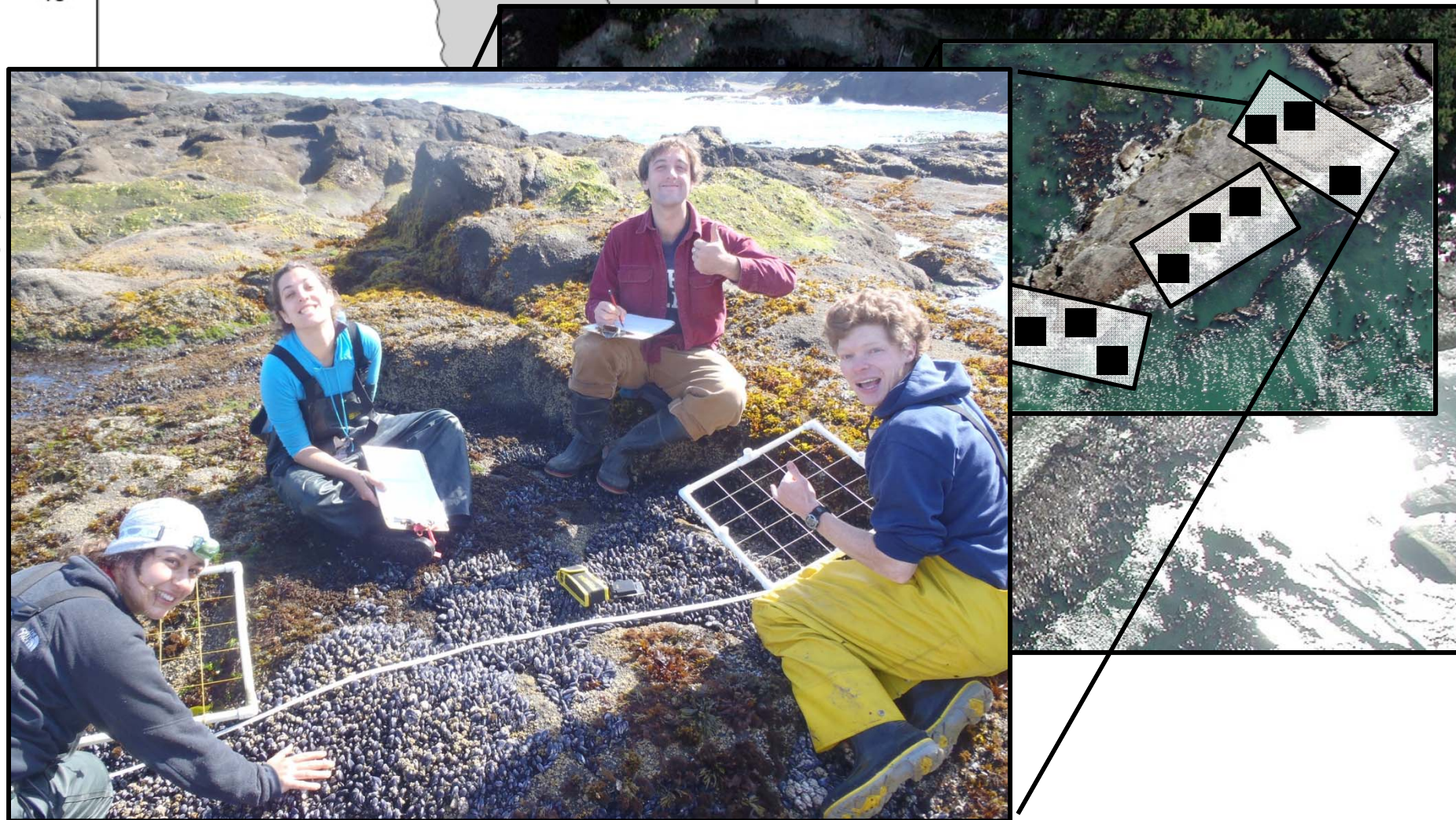






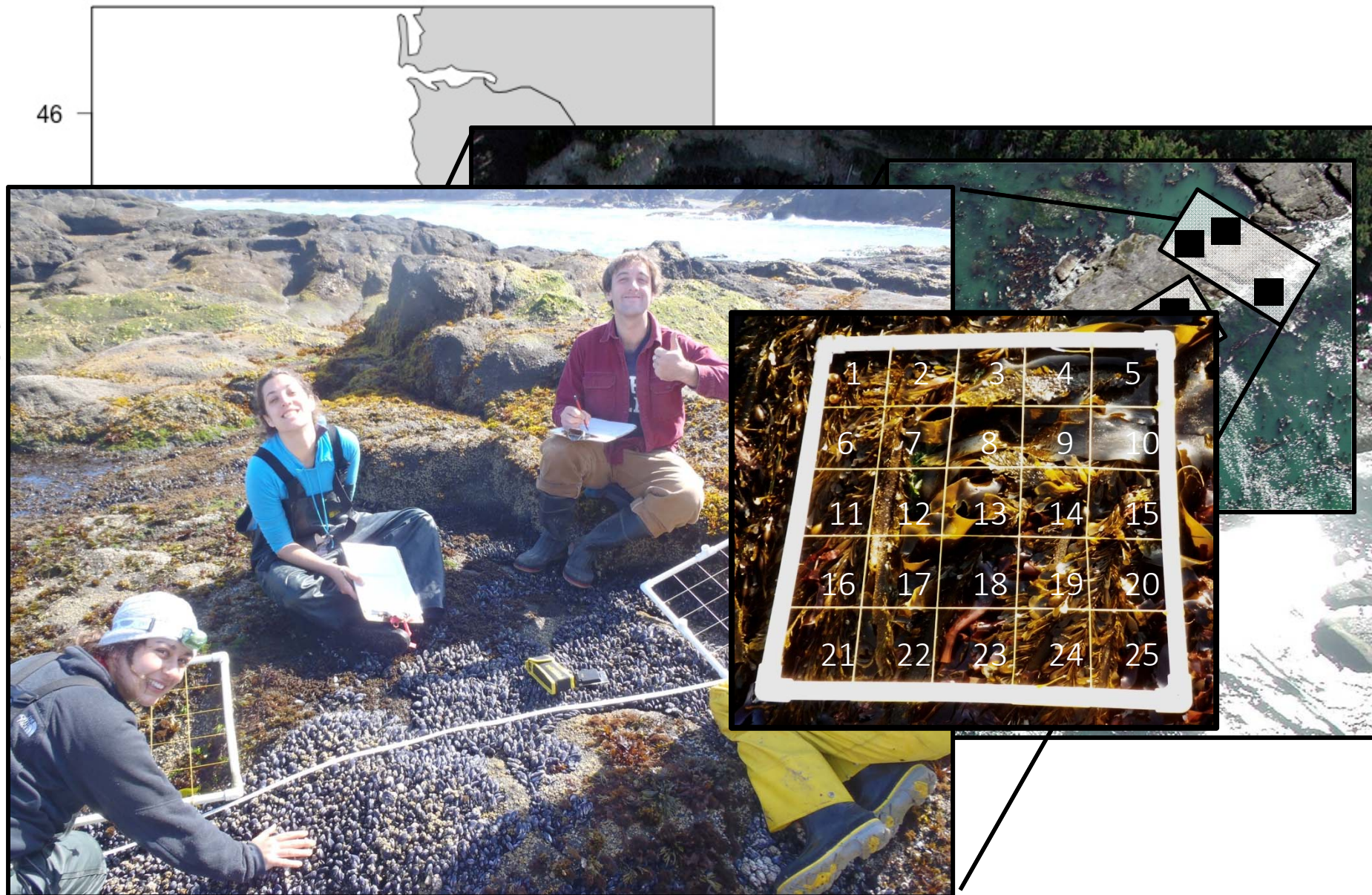
Latitude ($^{\circ}$ N)

46



Latitude ($^{\circ}$ N)

46



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

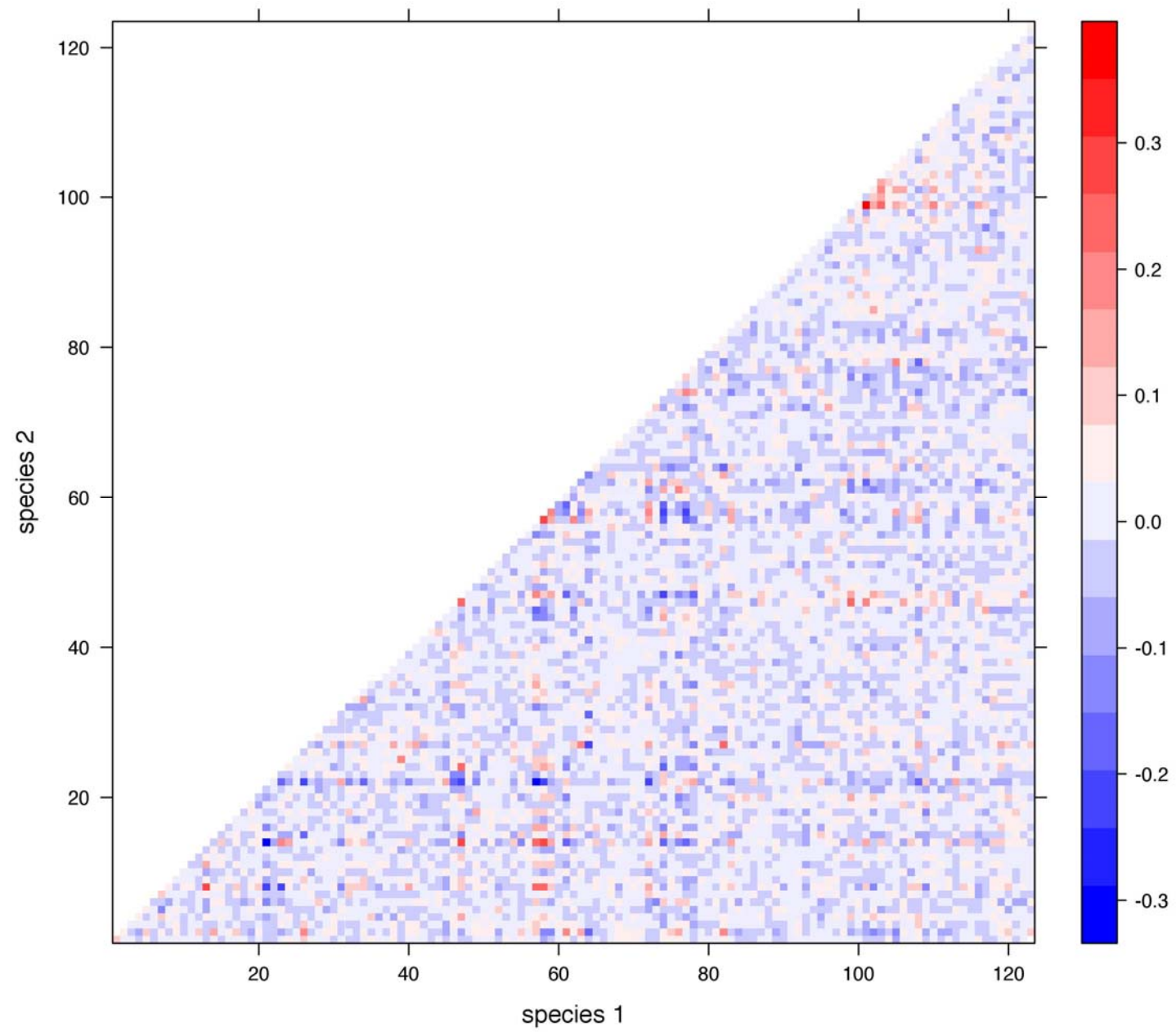
- currents upwelling index, along- and cross-shelf
- temperature water
- water retention shelf width (distance to 100 and 200m depth)
- phytoplankton abundance chlorophyll-*a*
- nutrient availability PON, nitrate
- substrate heterogeneity

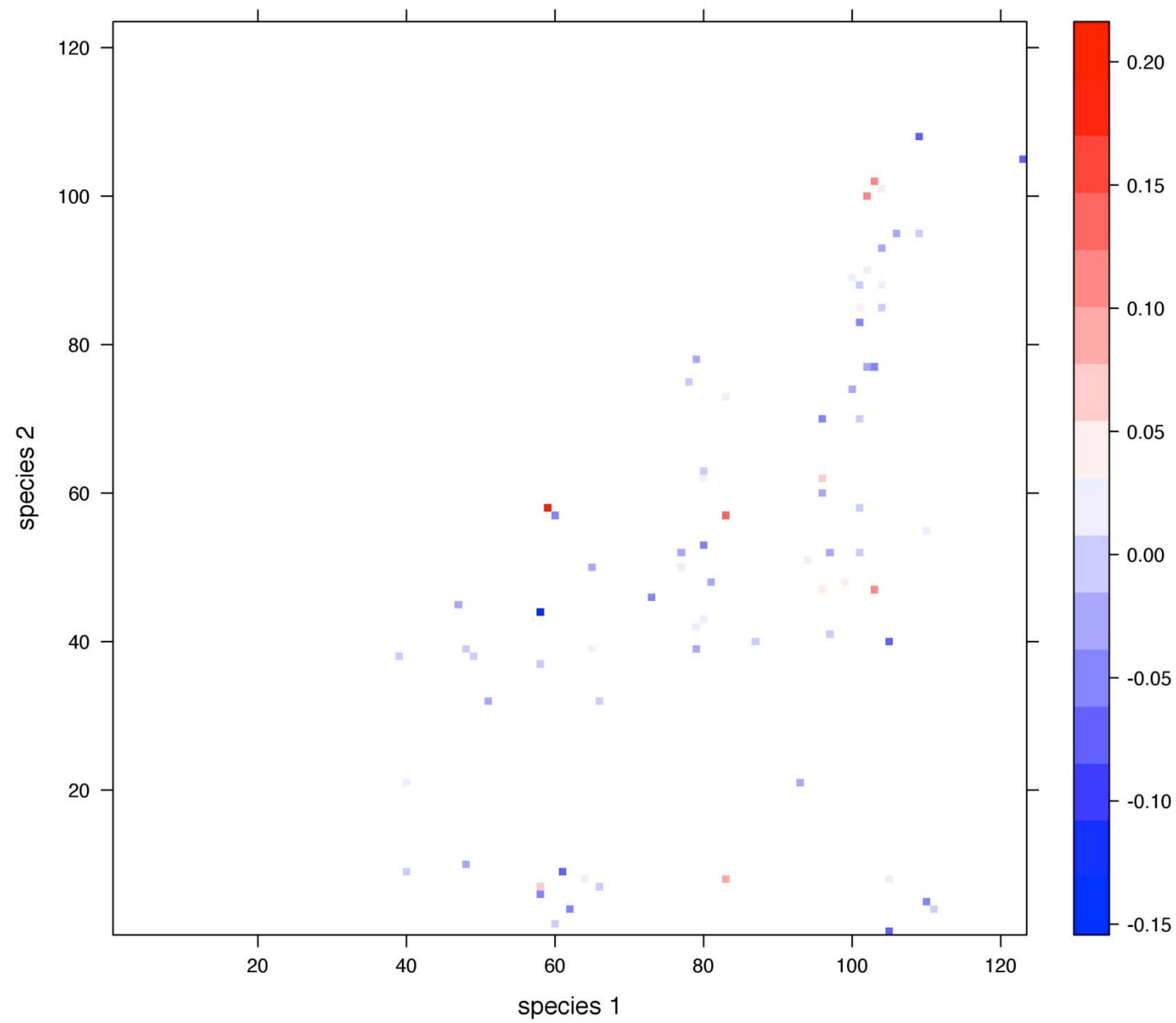
Are there non-random patterns of
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Do patterns of species co-occurrence change in
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Are there non-random
co-occurrences overall?

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





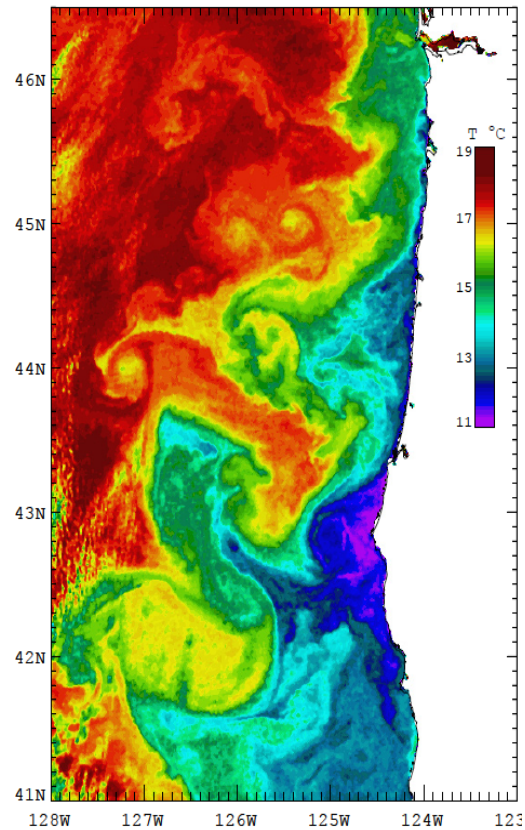
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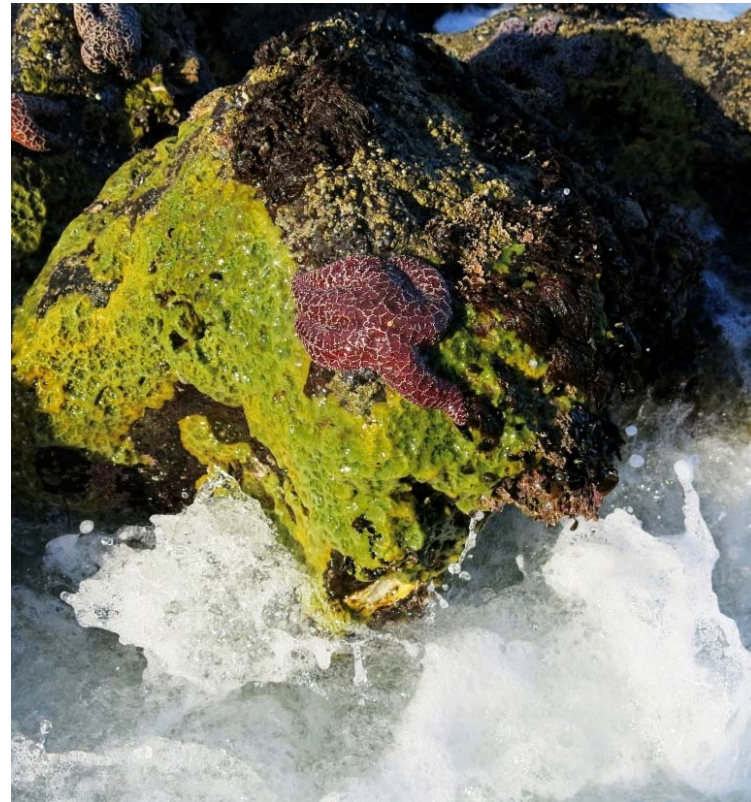
Oceanographic regions

Wave exposure

Environmental and spatial contexts of the Oregon coast

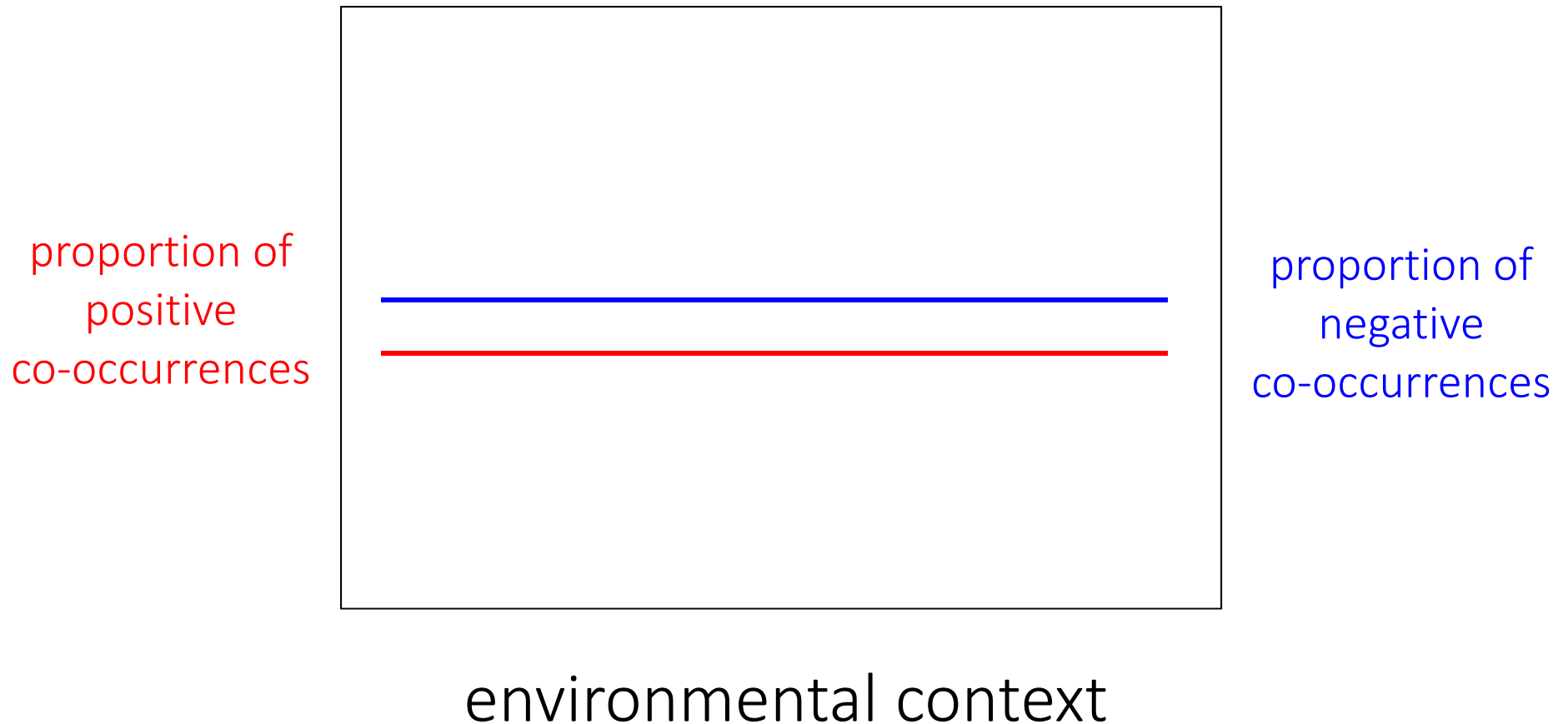


oceanographic
sites organized into
biogeographic regions

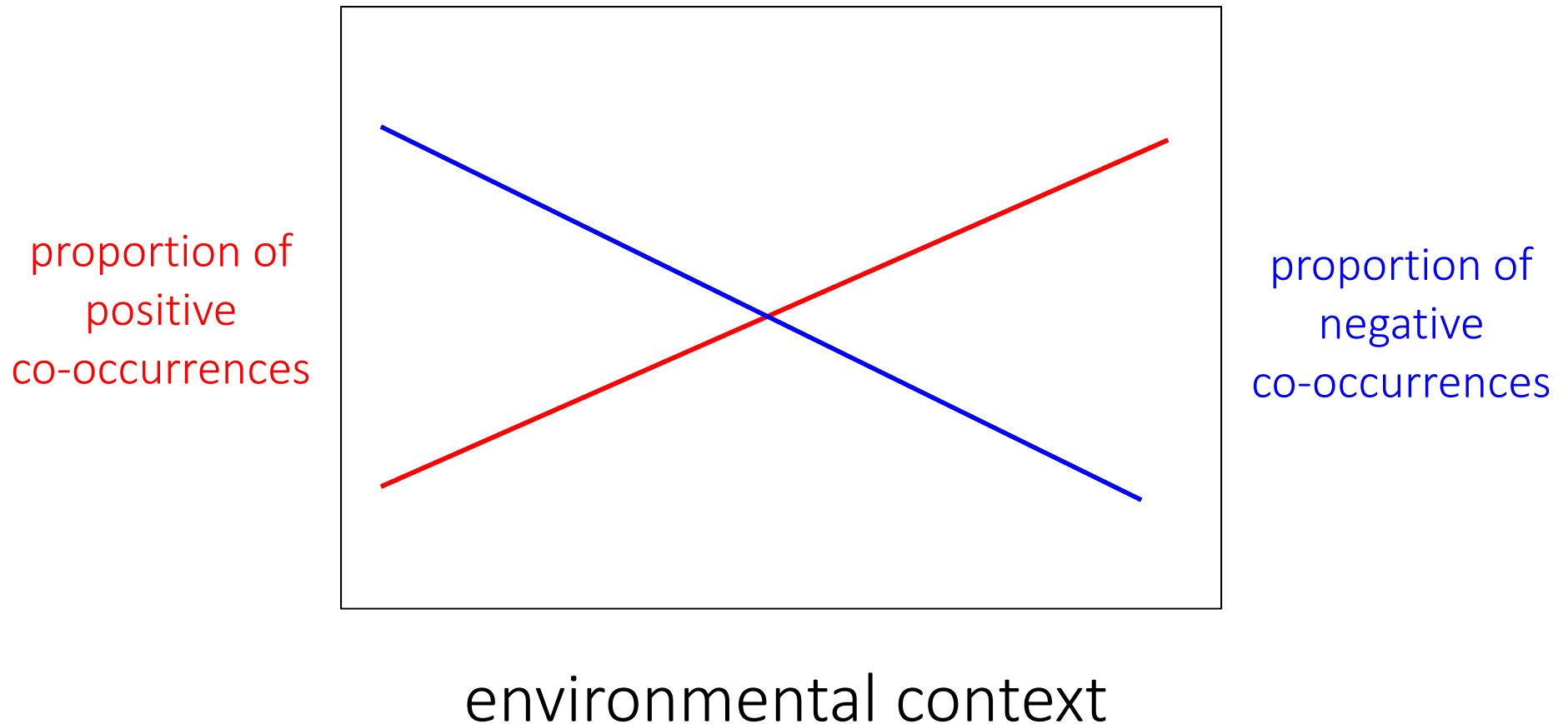


wave regime
measured relative
wave acceleration

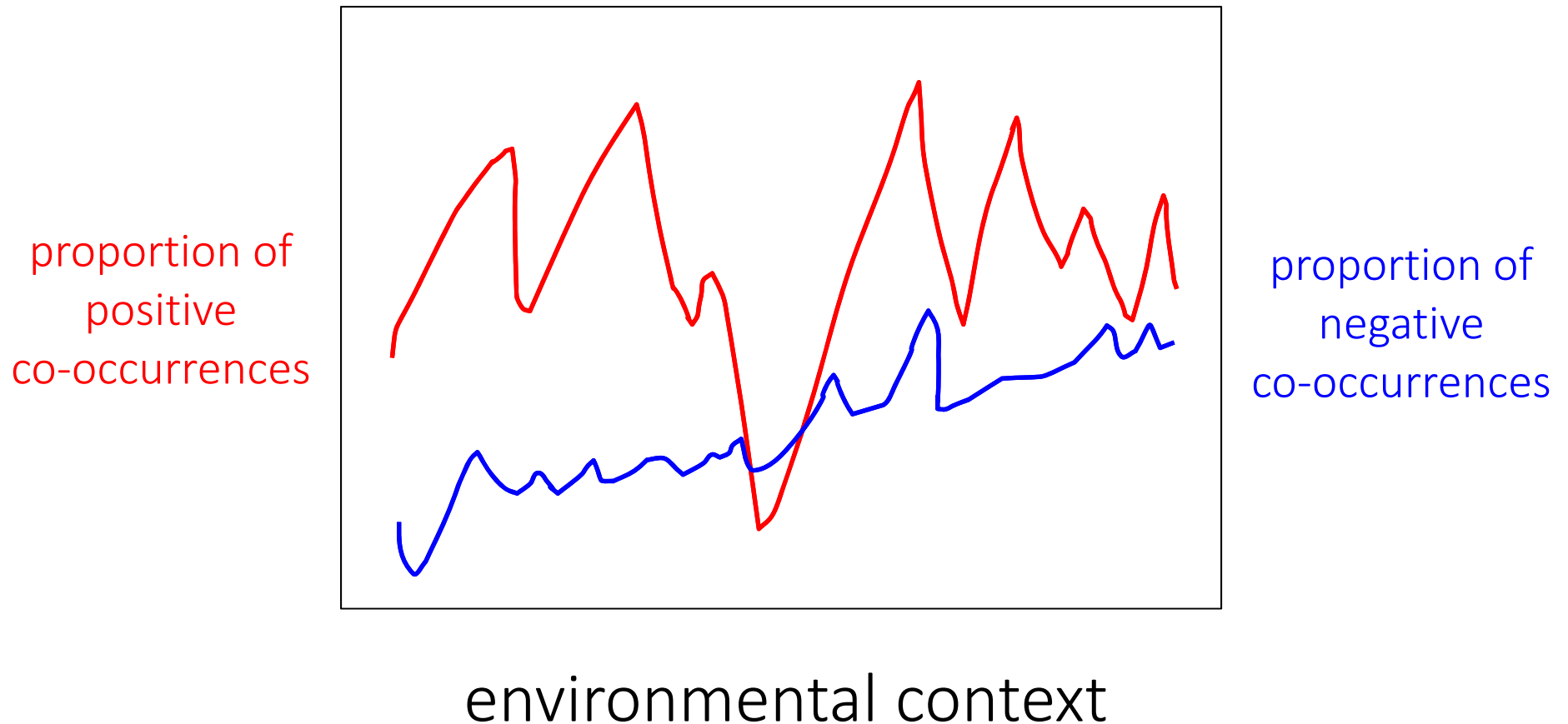
Relative frequency of co-occurrences



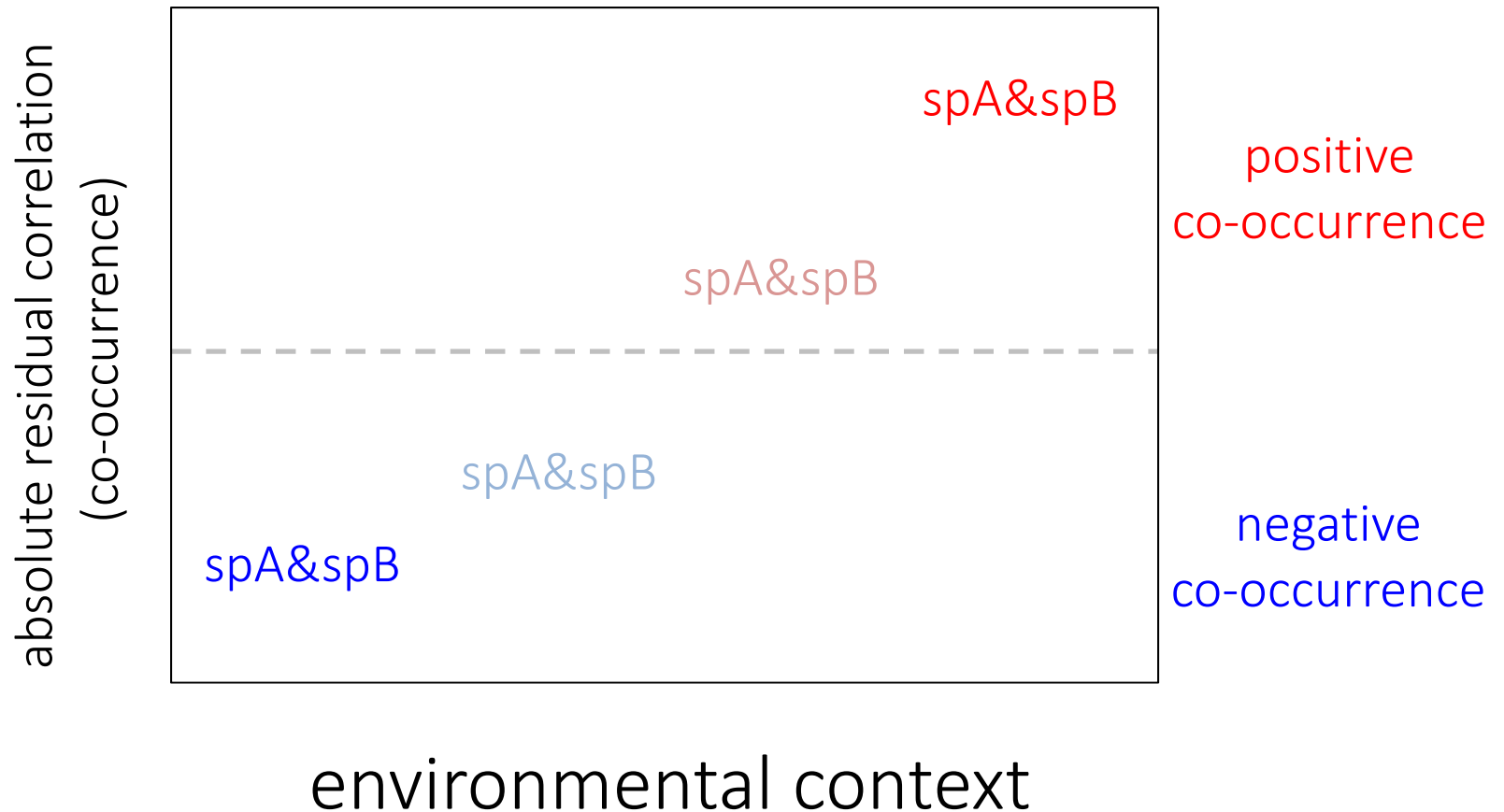
Relative frequency of co-occurrences



Relative frequency of co-occurrences



Absolute value of pairwise co-occurrences



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Oceanographic regions

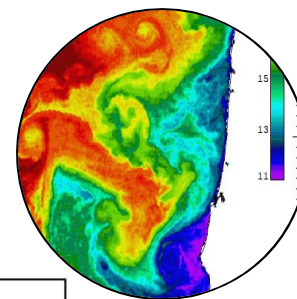
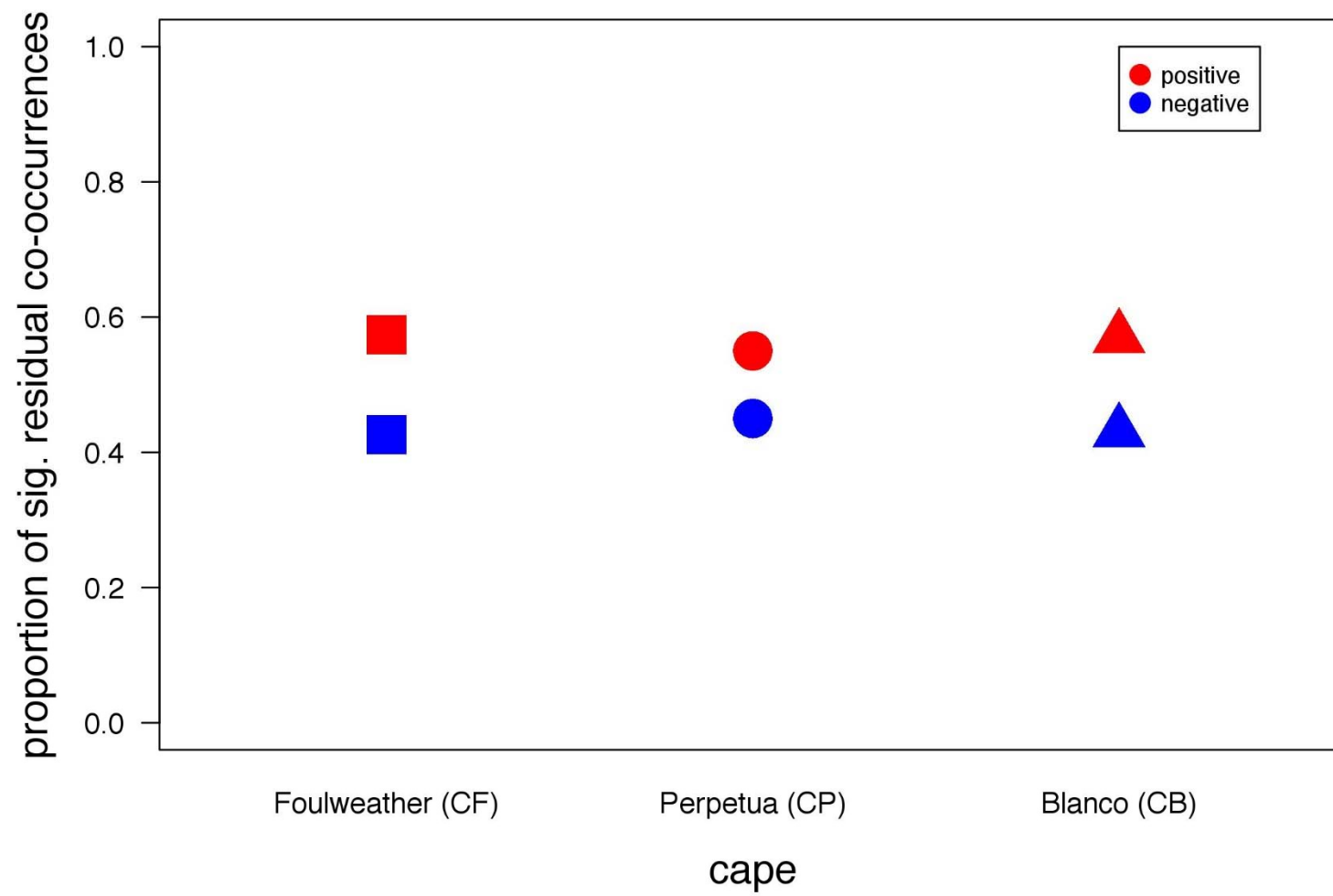
Wave exposure

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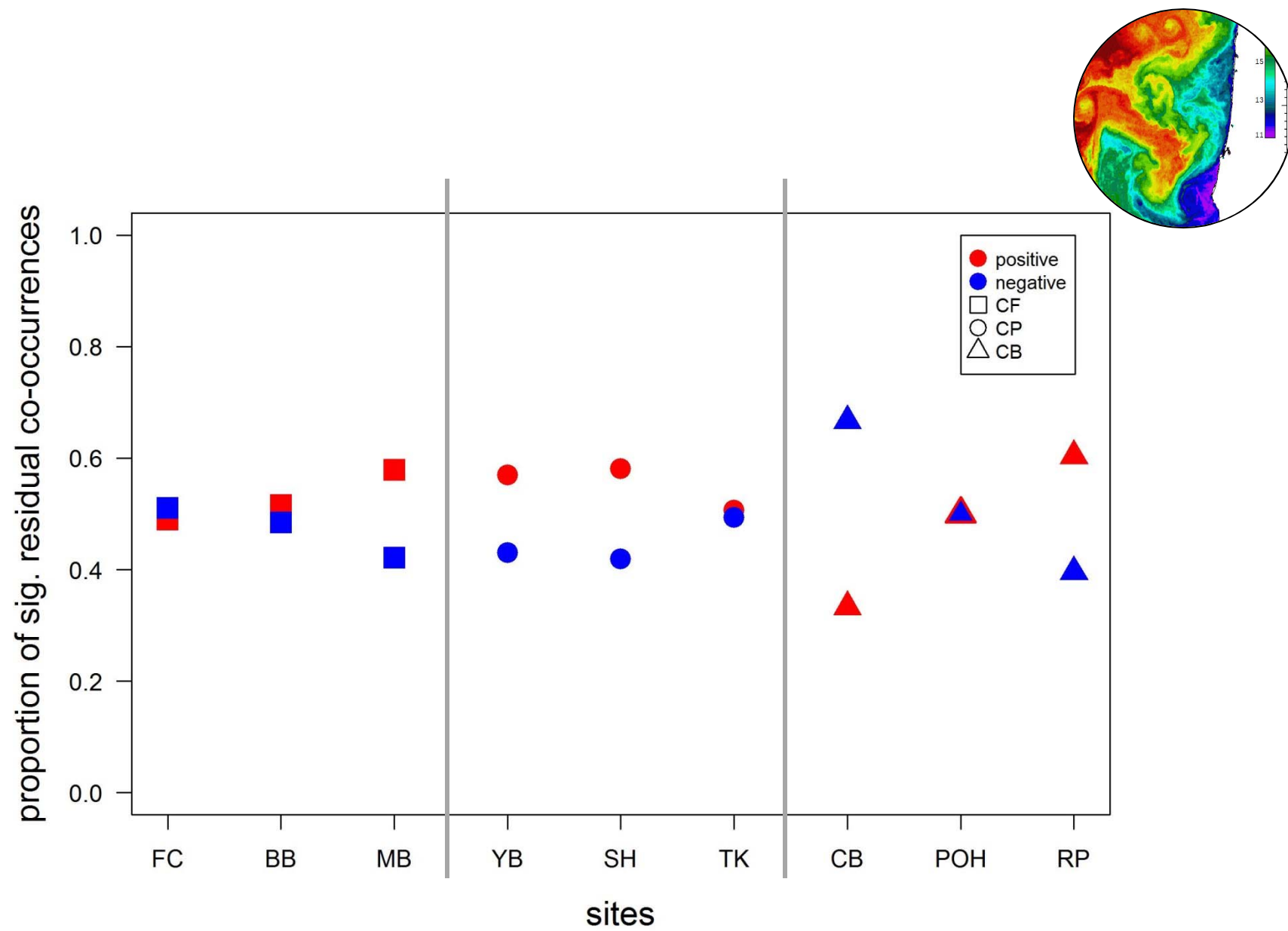
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Oceanographic regions

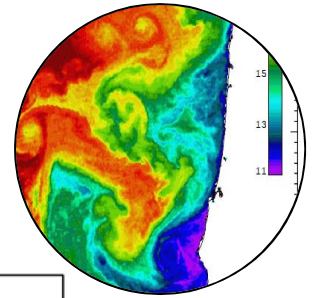
Wave exposure



mean species turnover (β_{div}) = 0.63



mean species turnover (β_{div}) = 0.59



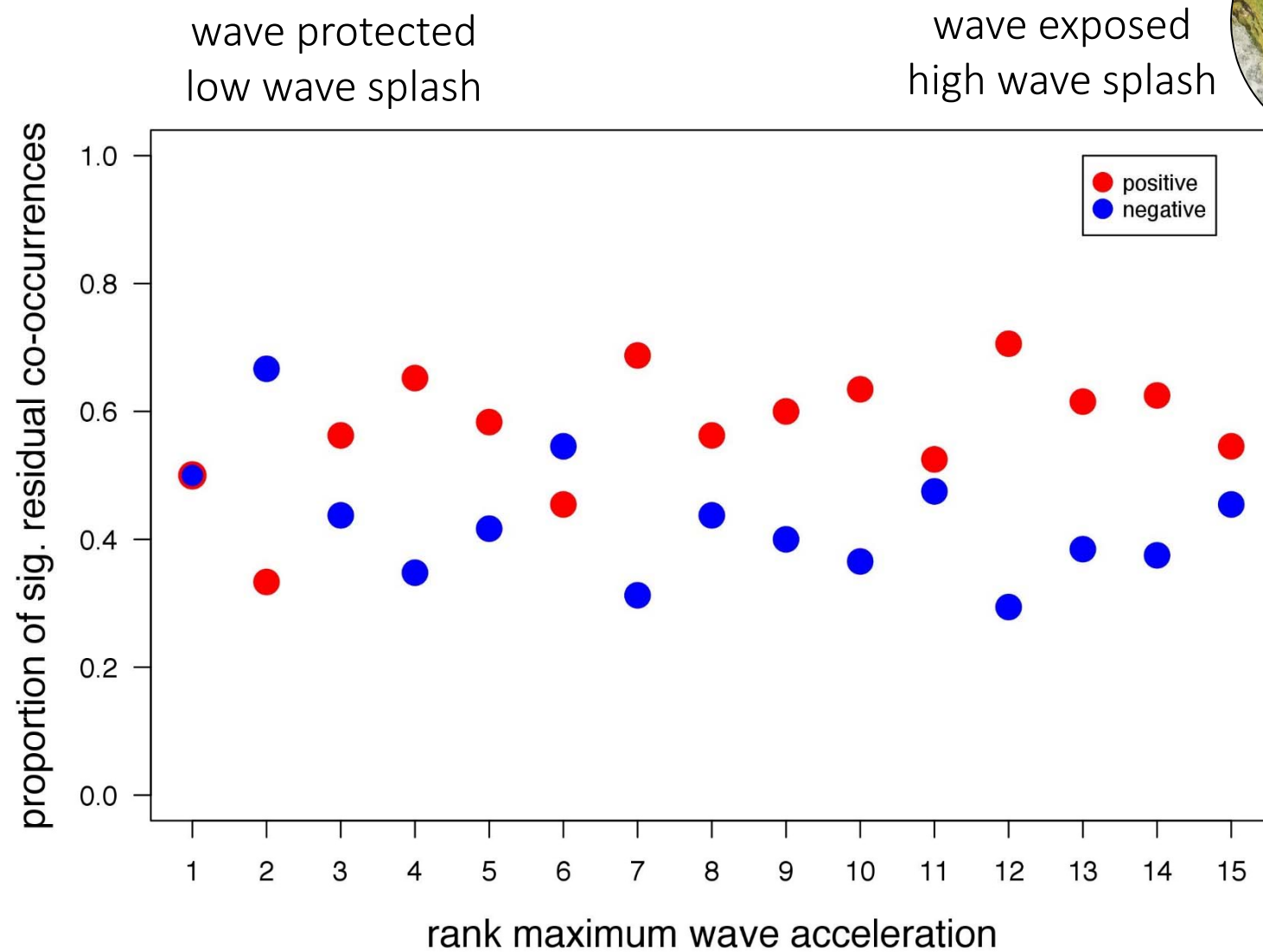
note: different colors = different species pairs

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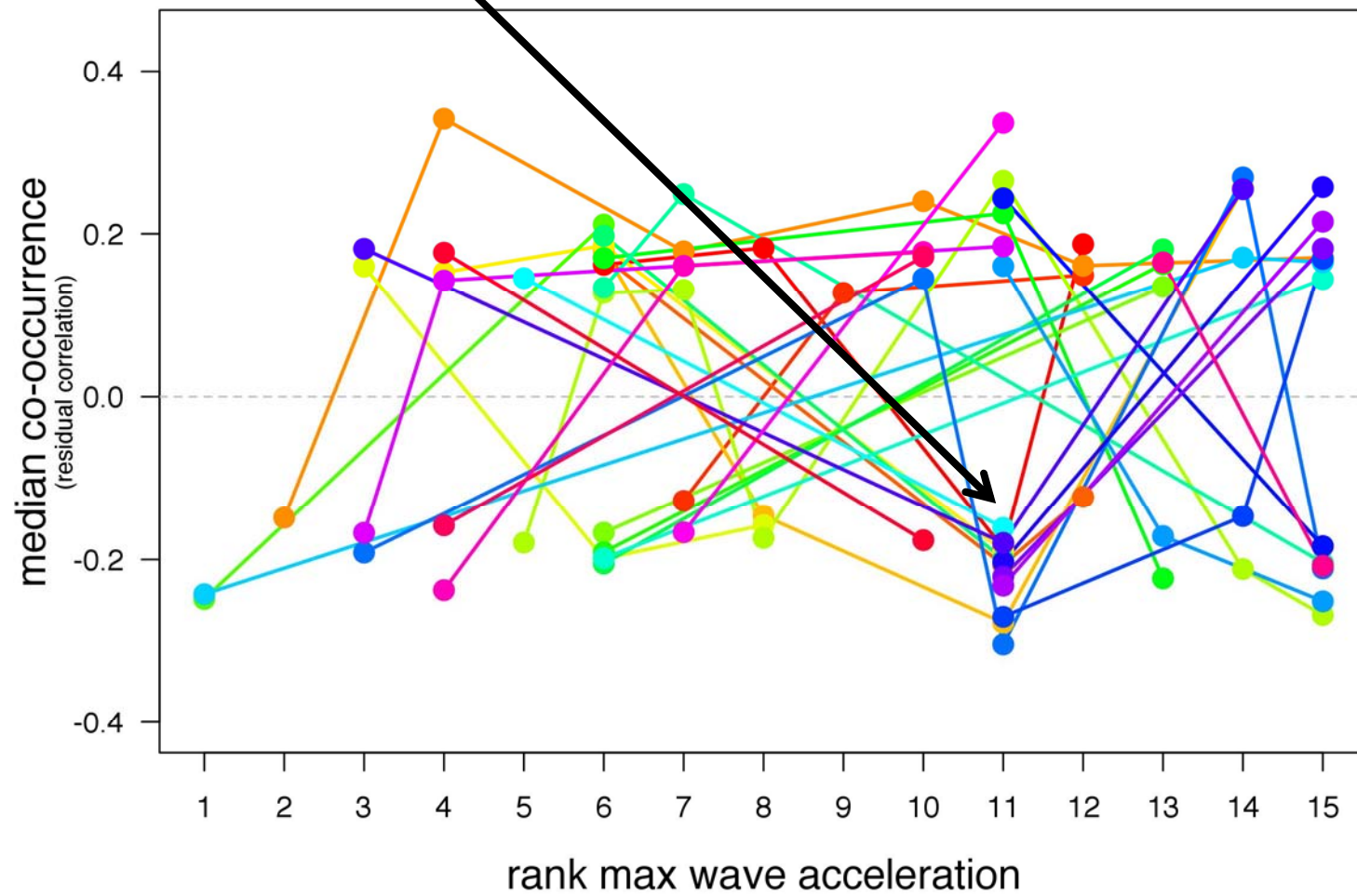
Oceanographic regions

Wave exposure



mean species turnover (β_{div}) = 0.58

Yachats Beach exposed



note: different colors = different species pairs

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

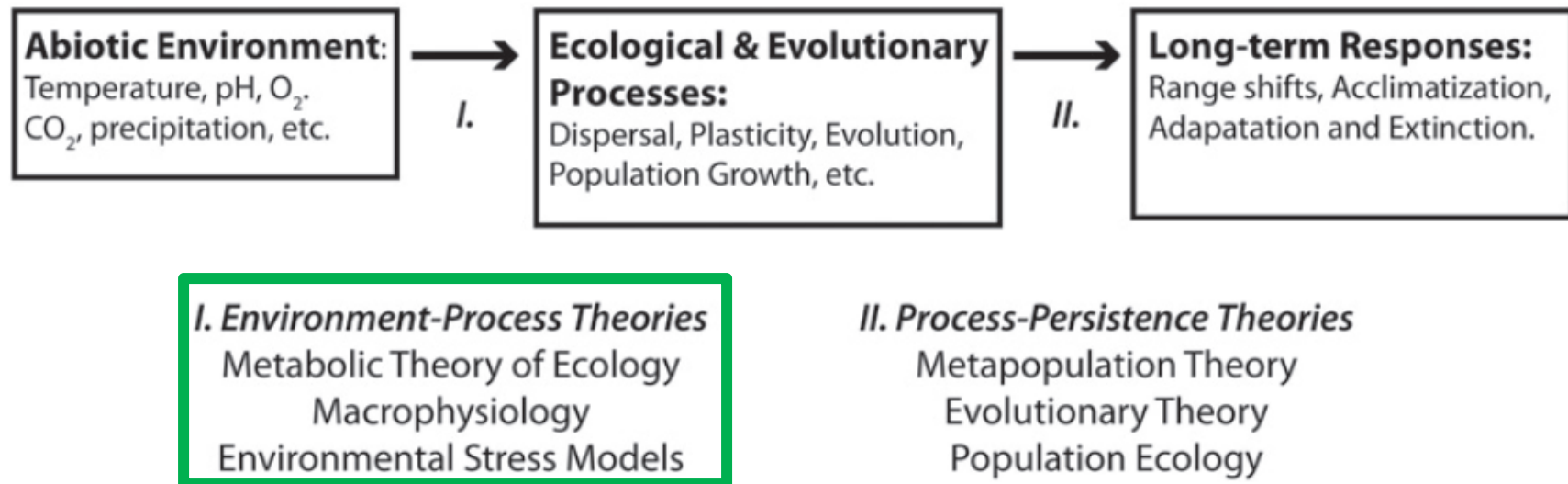
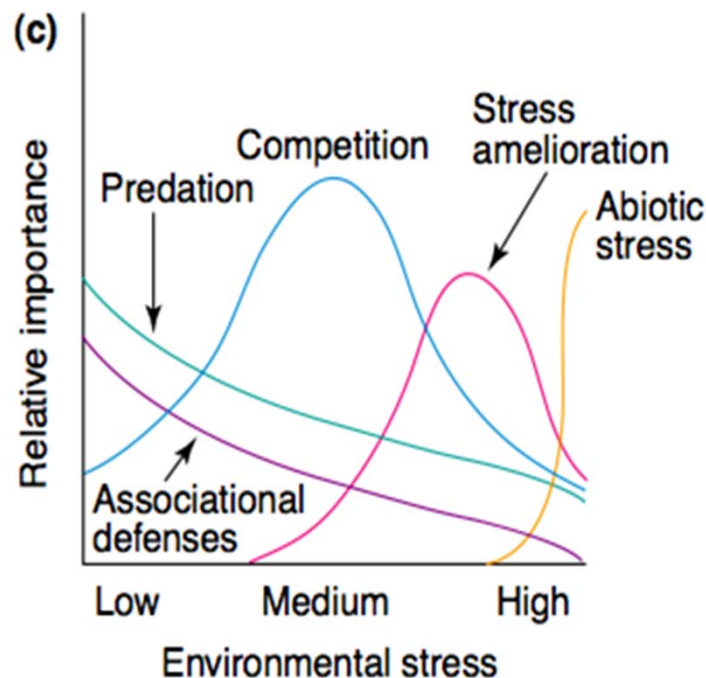


Fig. 1 from O'Connor et al. 2012 *GEB*

Environmental Stress Models and the Stress Gradient Hypothesis



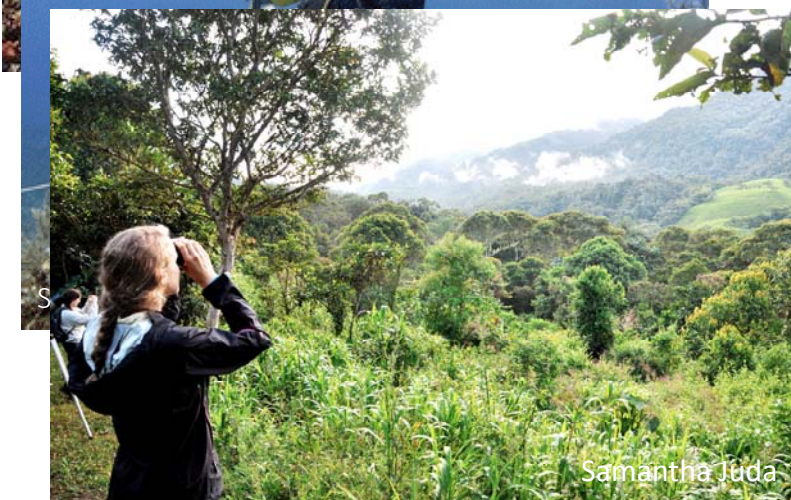
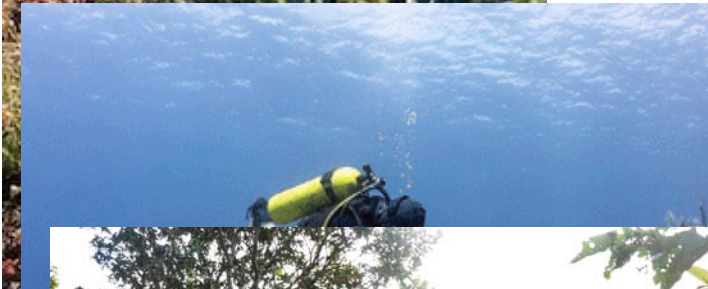
Preliminary analysis:
ESM does not adhere
for *wave stress* or
thermal stress in this
system

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



eBird

neon

National Ecological Observatory Network, Inc.

