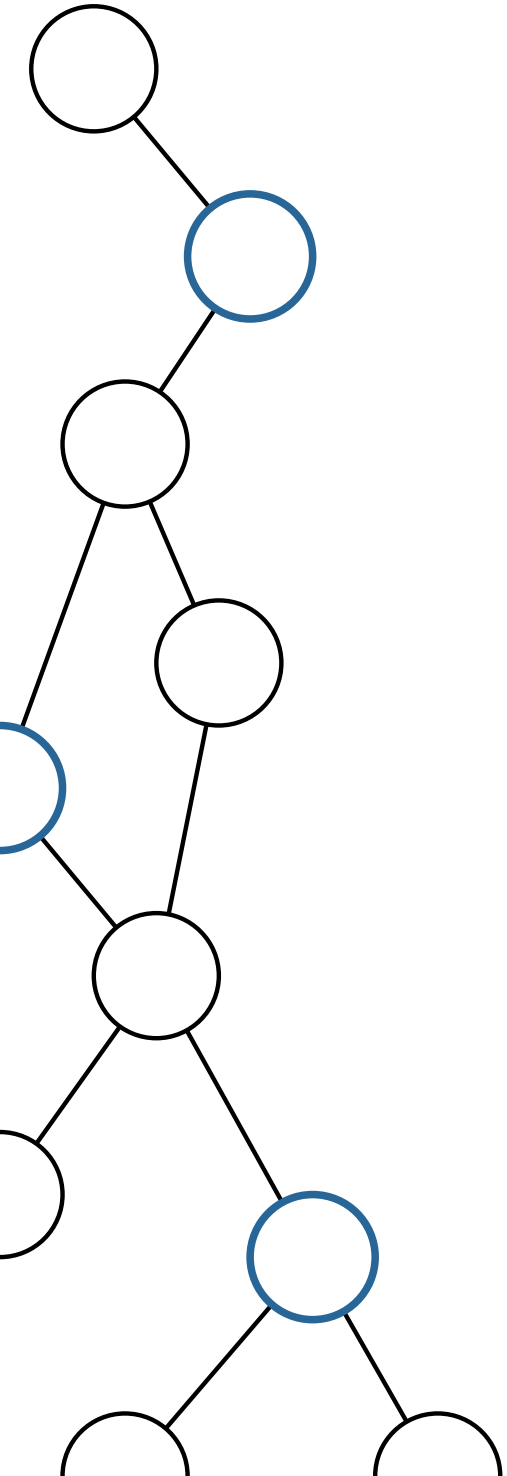

UQAR – Canada Research Chair in Ecosystem ecology

# A quantitative framework for network biogeography

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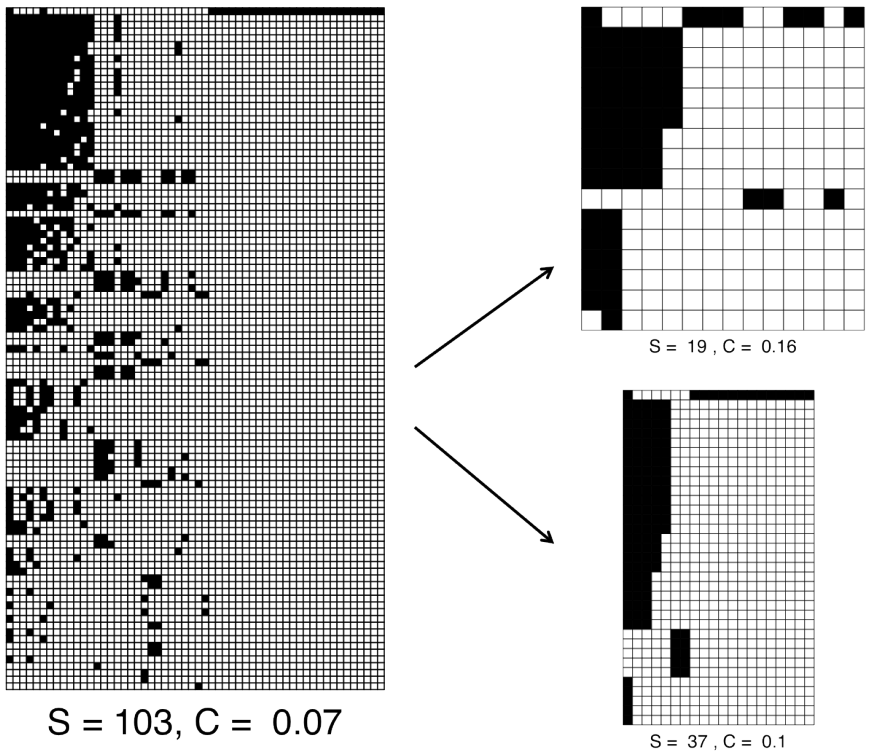
August 13, 2014

UQAR

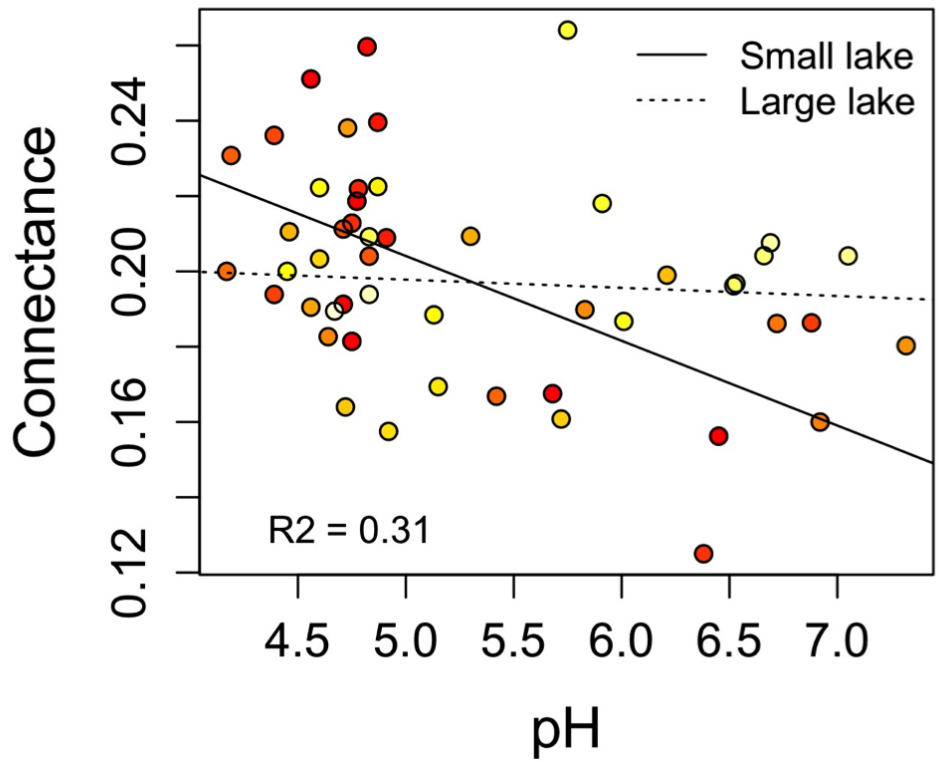
# Biogeography of ecological interactions

## Challenge of getting network data at large spatial scales

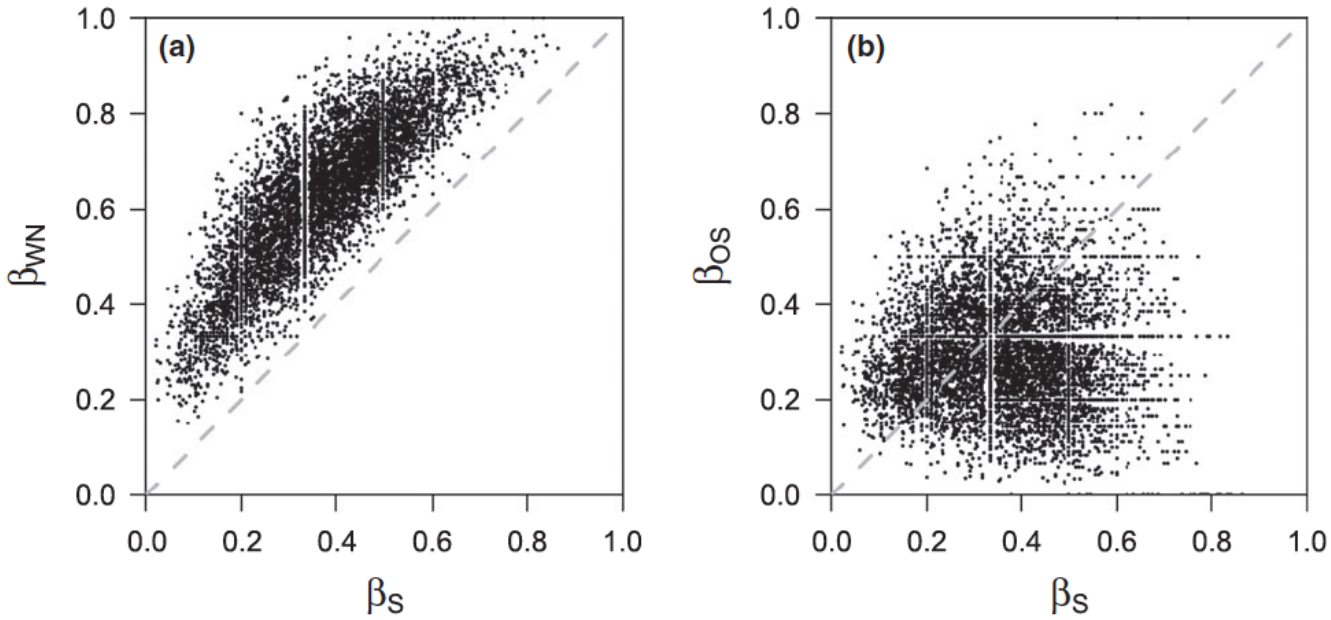
- Hard to document;
- Usually not replicated;
- Applies only to co-occurring species;
- Network structure is deterministic and stationary.




Gravel et al. (2011). *Ecol. Lett.*




Gravel et al. (2011). *Ecol. Lett.*




Poisot et al. (2012). *Ecol. Lett.*

Networks do vary in space because of:

- Species turnover;
- Link turnover;

**Propose a quantitative framework to understand and predict the spatial variation in network structure at the biogeographical scale**

Define the stochastic variable $X_{iz}$ representing the occurrence of species $i$ at location $z$.

And the variable $L_{ijz}$ representing the occurrence of an interaction between species $i$ and $j$ at location $z$.

We are looking for the probability that an interaction occurs given the environment $E_z$:

$$P(L_{ijz} = 1, X_{iz} = 1, X_{jz} = 1 \mid E_z)$$

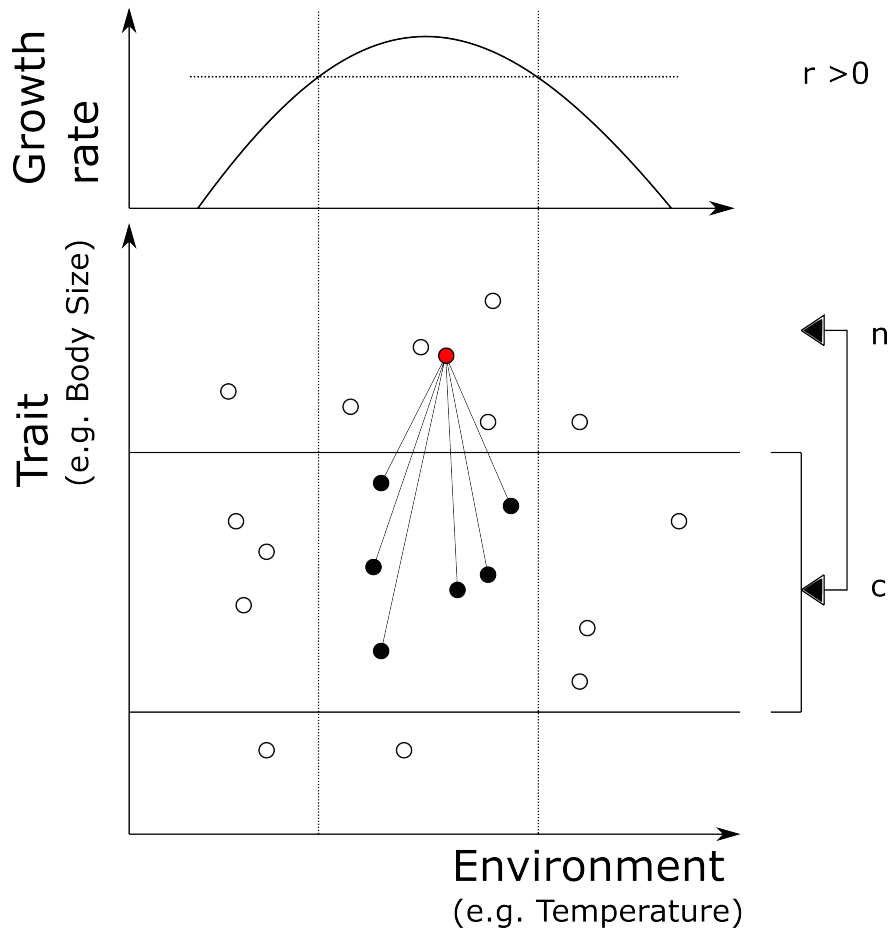
Obtained from the product rule we get:

$$P(L_{ijz}, X_{iz}, X_{jz} | E_z) = P(L_{ijx} | X_{ix}, X_{jx}, E_z) P(X_{ix}, X_{jx} | E_z)$$

Where:
$P(L_{ijz} | X_{iz}, X_{jz} | E_z)$ is the metaweb
$P(X_{iz}, X_{jz} | E_z)$ is the co-occurrence matrix

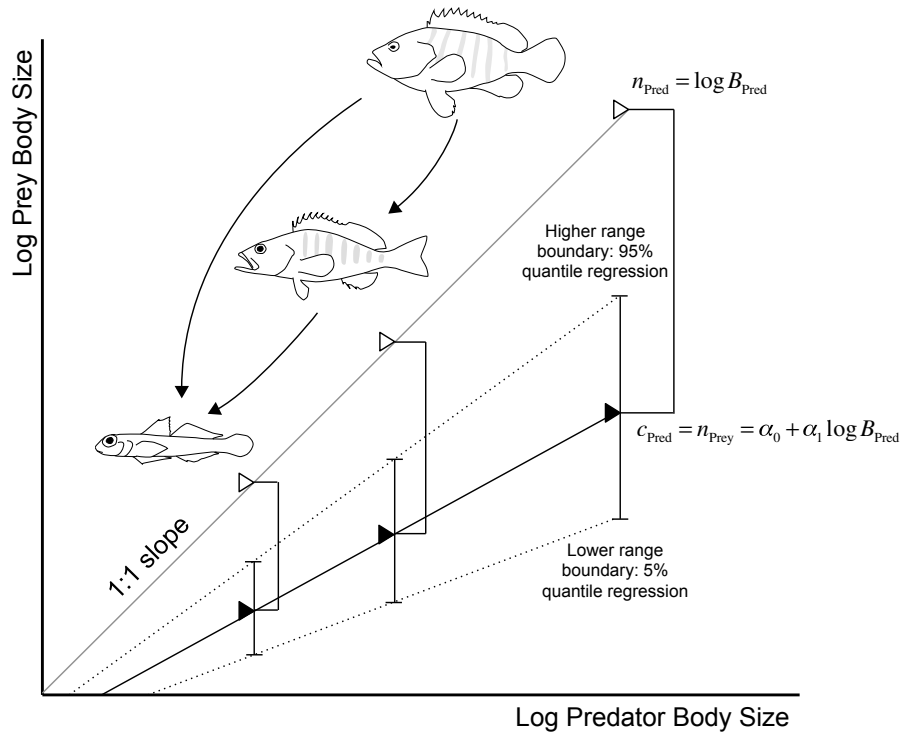
$P(L_{ijx}|X_{iz}, X_{jz}, E_z)$ is the Eltonian niche

$P(X_{ix}, X_{jz}|E_z)$ is the Grinnellian niche



**The problem: inferring interactions for species that never co-occurred and with incomplete data**

# Inferring the metaweb from traits

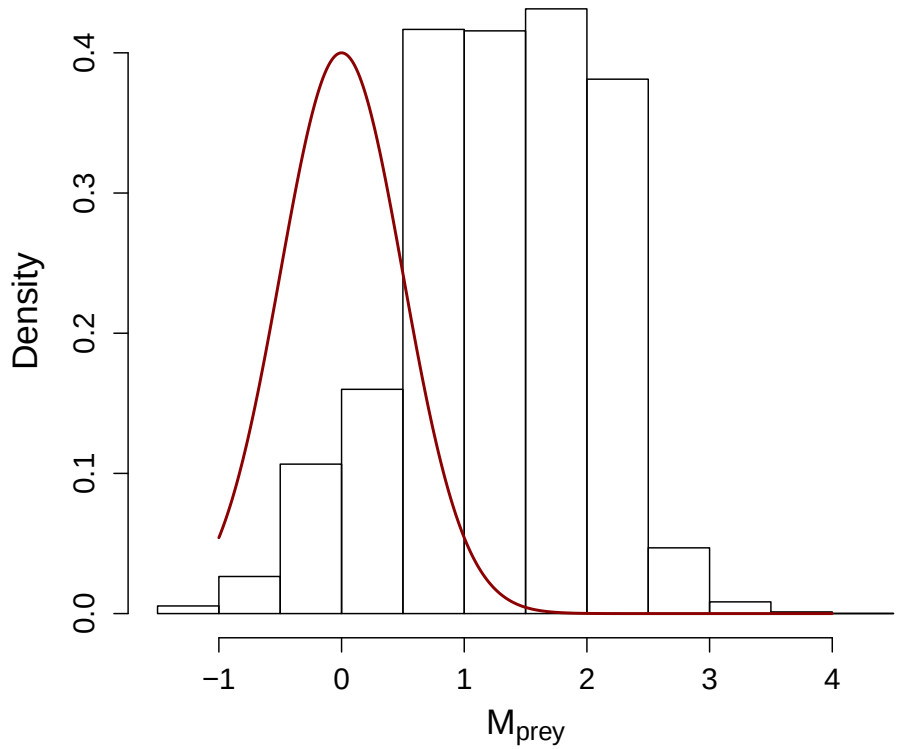



Gravel et al. (2013). *Meth. Ecol. Evol.*

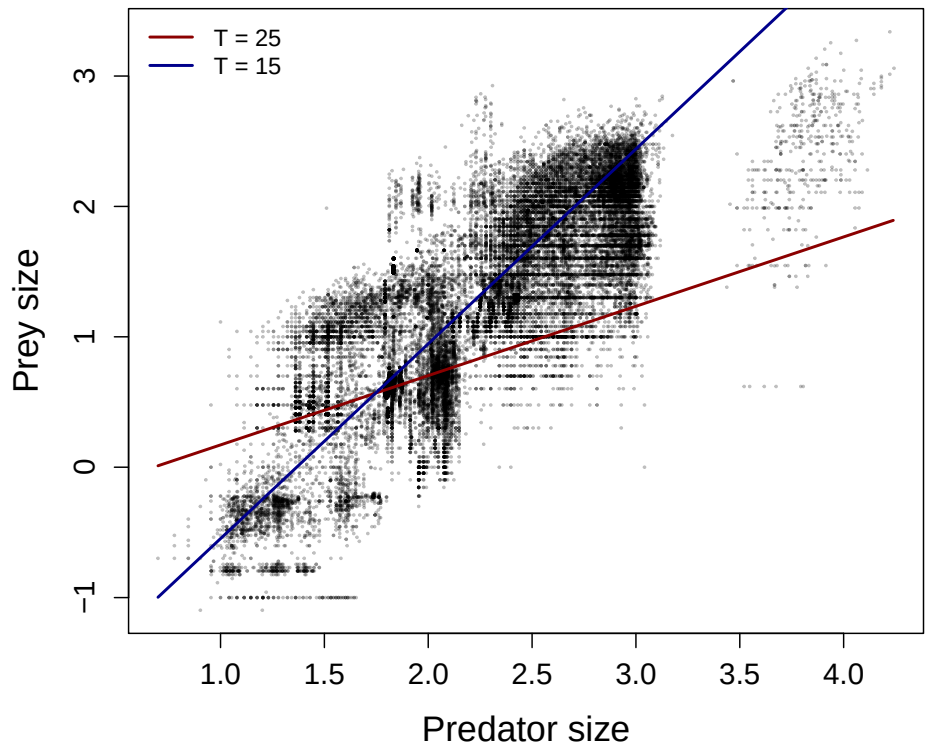
# Bayesian formulation of the interaction probability

The likelihood function:

$$P(M_{prey} \mid L, E_z) = \frac{P(L_{ijz} \mid M_{prey}, M_{pred}, E_z) P(M_{prey})}{P(L \mid M_{pred})}$$

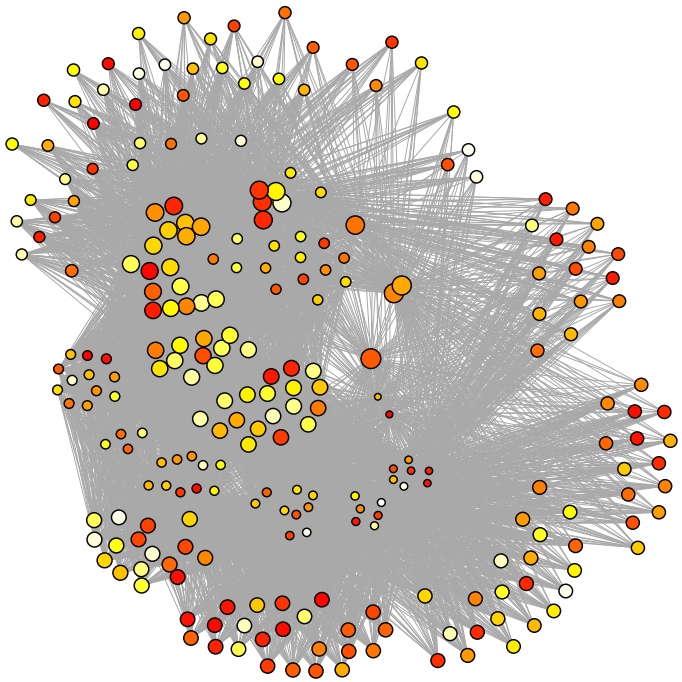


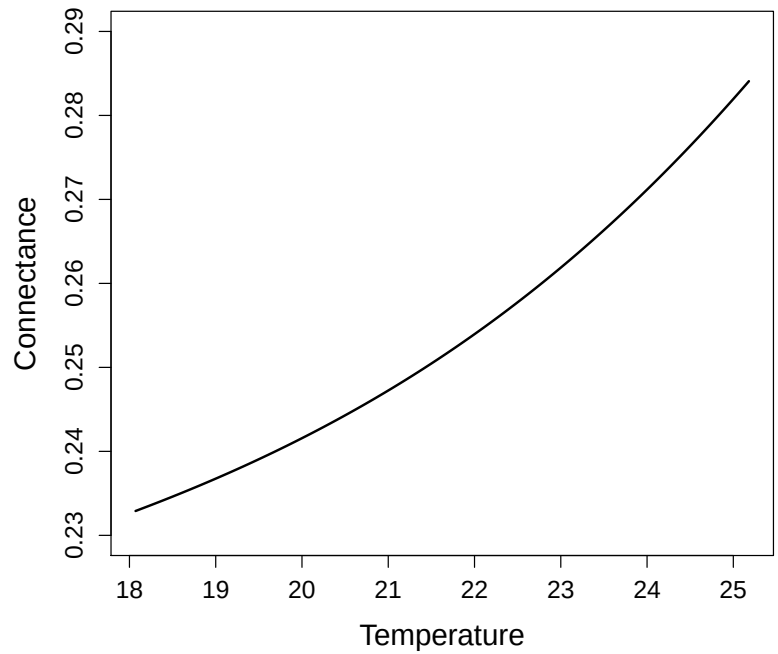
- Data from Barnes et al. (2008), Predator and prey body sizes in marine food webs, Ecology 86: 881;
- 34 931 recorded interactions;
- 25 sites.




Gibert and Delong (in press) *Bio. Lett.*

# Effect of temperature on the metaweb



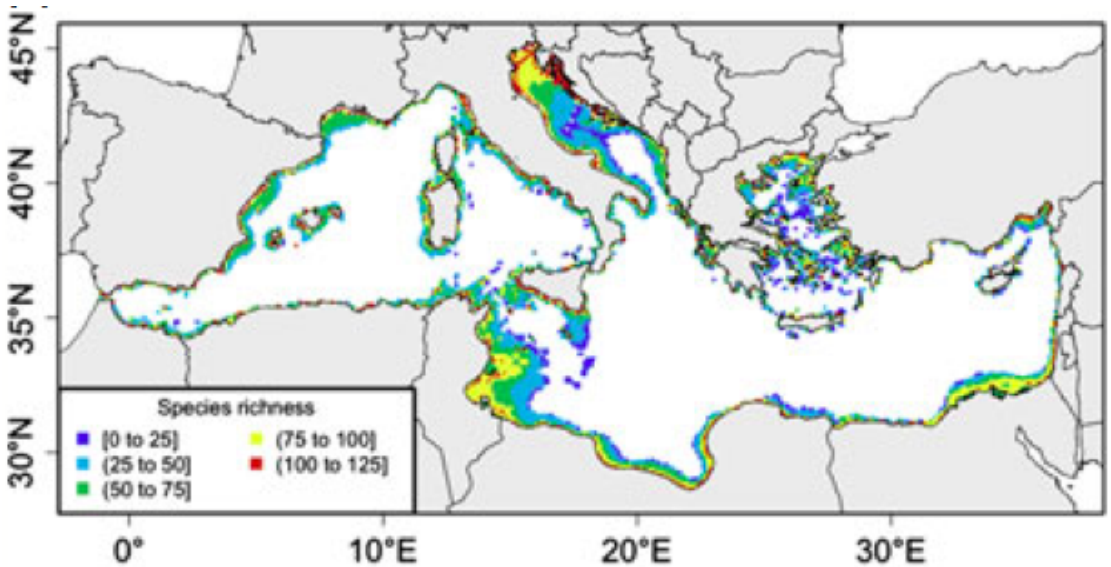


**How to add the effect of species distribution on the network properties?**

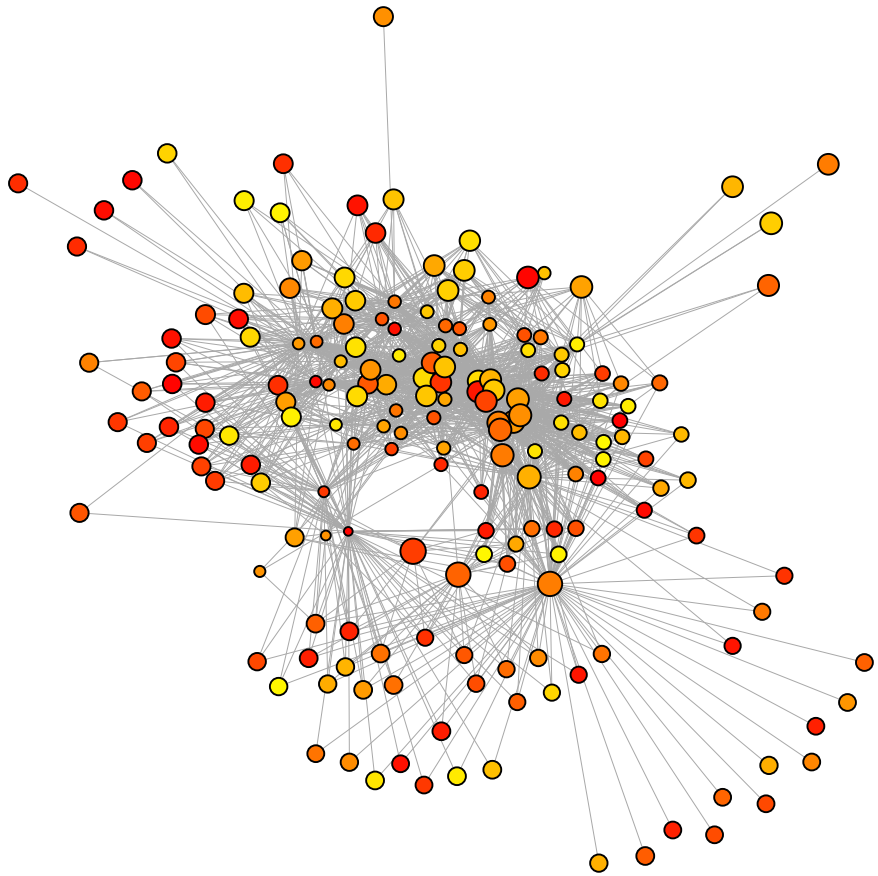
# Distribution of Mediterranean fish networks

Neutral species distribution:

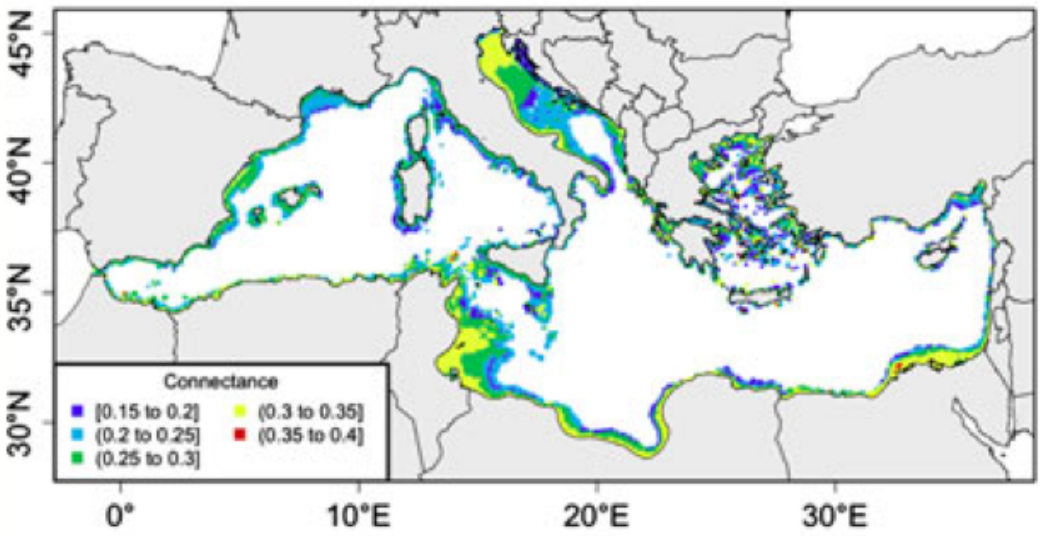
$$P(X_{iz}, X_{jz} | E_z) = P(X_{iz} | E_z) P(X_{jz} | E_z)$$

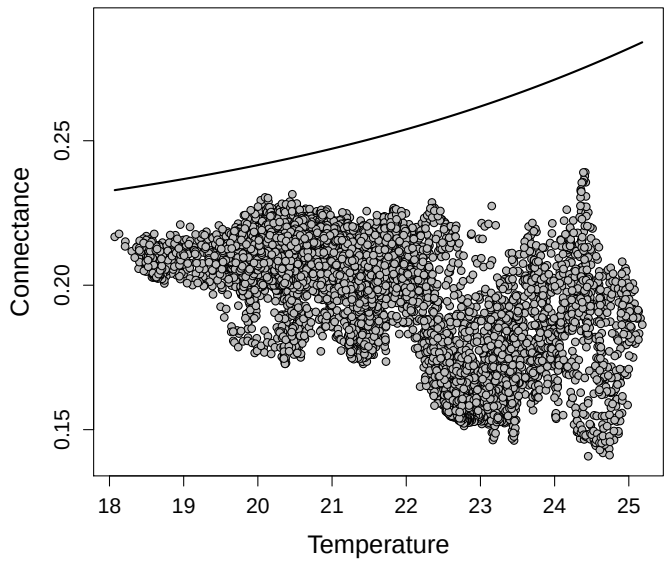



Albouy et al. (2014). *Glob. Change Biol.*



# Mapping connectance



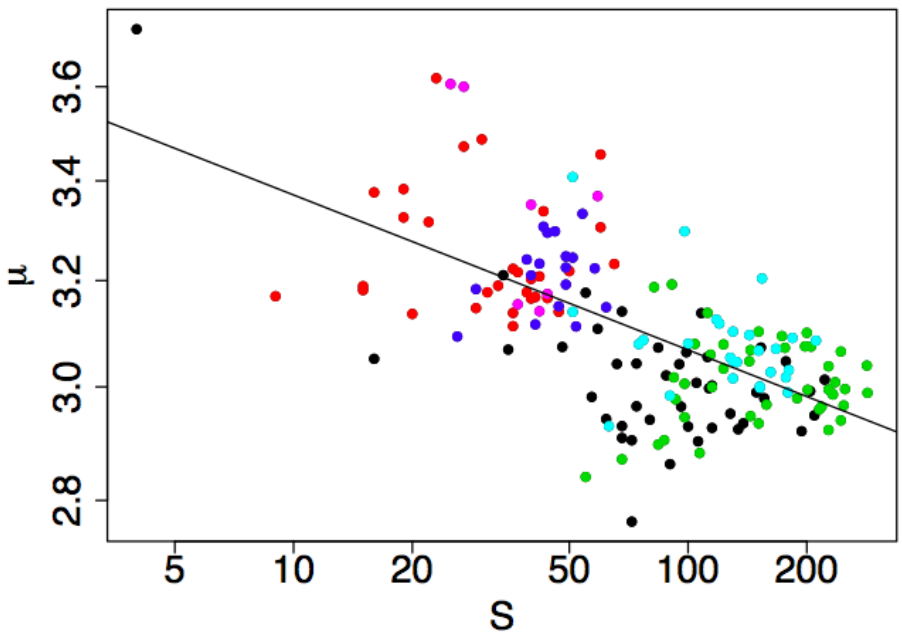

Albouy et al. (2014). *Glob. Change Biol.*

The multiple roles of the environment on network structure:

- Predator-prey body size relationship
- Regional species pool
- Species distribution

Additional sources of information:

- Phylogeny
- Feedback between interactions and co-occurrence
- Habitat area and isolation



# Acknowledgements

**Co-authors:** Camille Albouy, Timothée Poisot, SFI Working group on gradient-based network research; CIEE Working group on spatial variation in network structure

**Funding:** NSERC, FRQNT, Canada Research Chair program, Quebec Center for Biodiversity Sciences, Santa Fe Institute, UQAR, CIEE.