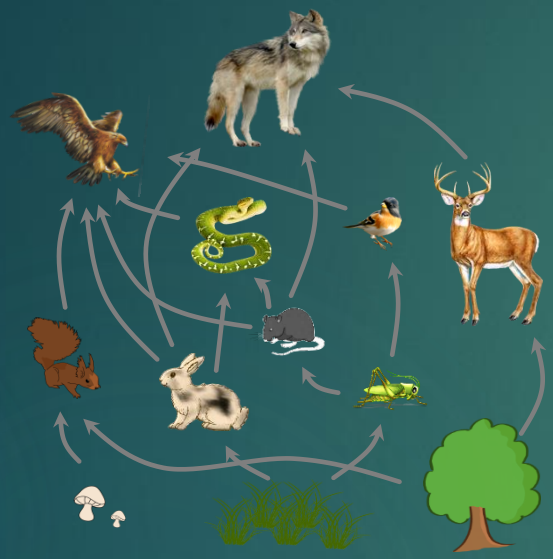
Trophic Theory of Island Biogeography

GENERATING CONSTRAINED FOOD WEBS

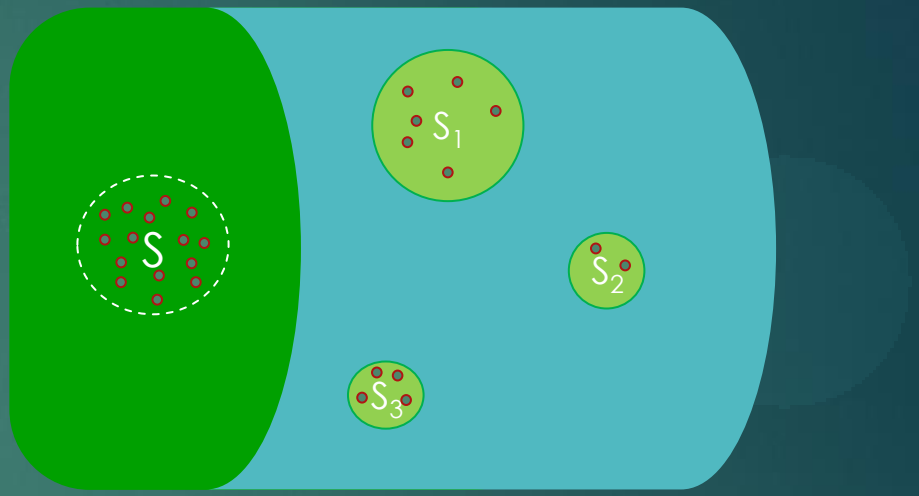
Interaction networks



What are the structural properties exhibited by Interaction networks ?

What are their effects ? Especially on networks stability ?

Theory of Insular Biogeography

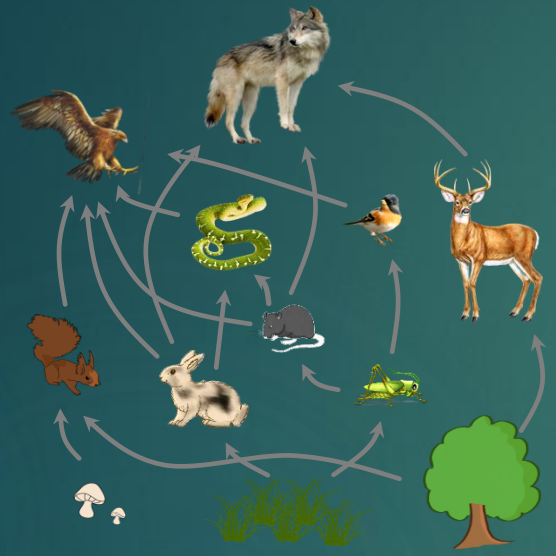


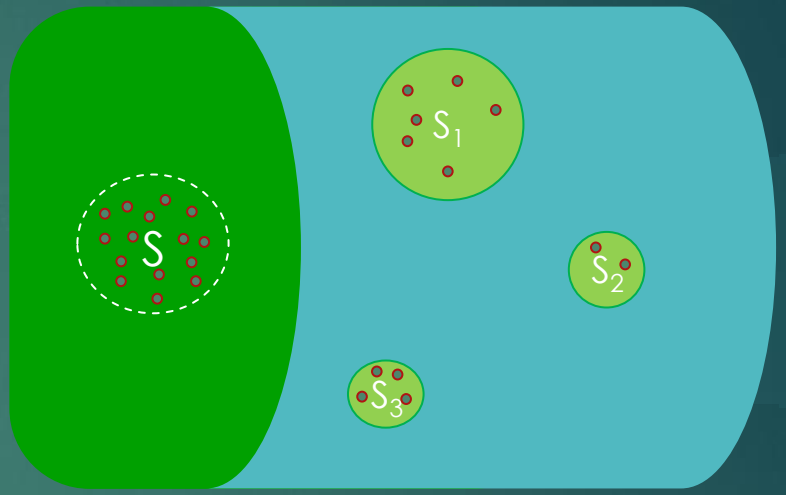
Diversity patterns at large scales ?

Tool for conservation (SAR)

Interaction networks

Theory of Insular Biogeography





What are the effects of **mainland** food web structural properties on colonization/extinction dynamics ?

Generating constrained food webs

- Constraints:
  - Number of species
  - Number of links
  - Proportion of basal species
  - Degree distribution

Cascade model	Niche model	Generalized Cascade model
✓	✓	✓
In expectation	In expectation	In expectation
✗	✗	✗
✗	✗	✗

Generating constrained food webs

- Method
  - **Step I**: Generate an undirected network with a given degree distribution, number of links and number of species
  - **Step II**: Select the basal species
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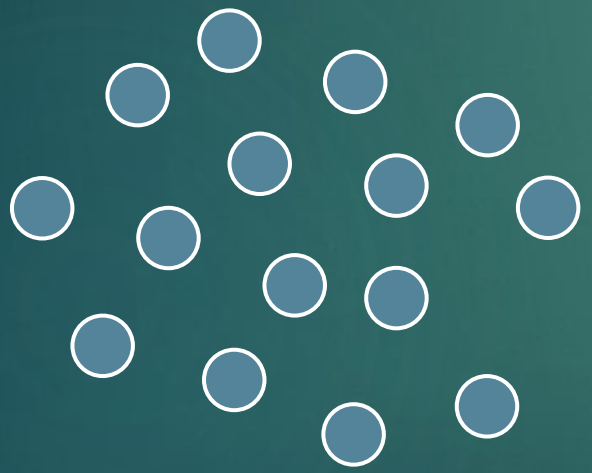
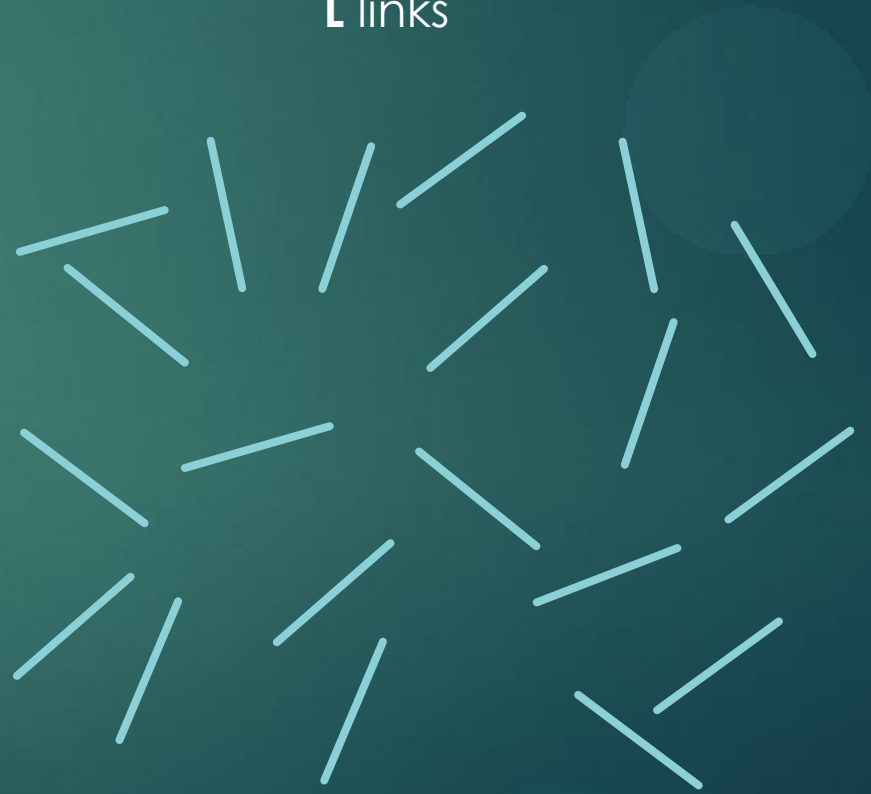
Generating constrained food webs

N vertices



L links



Generating constrained food webs

- **Step I**: Generate an undirected network with a given degree distribution, number of links and number of species
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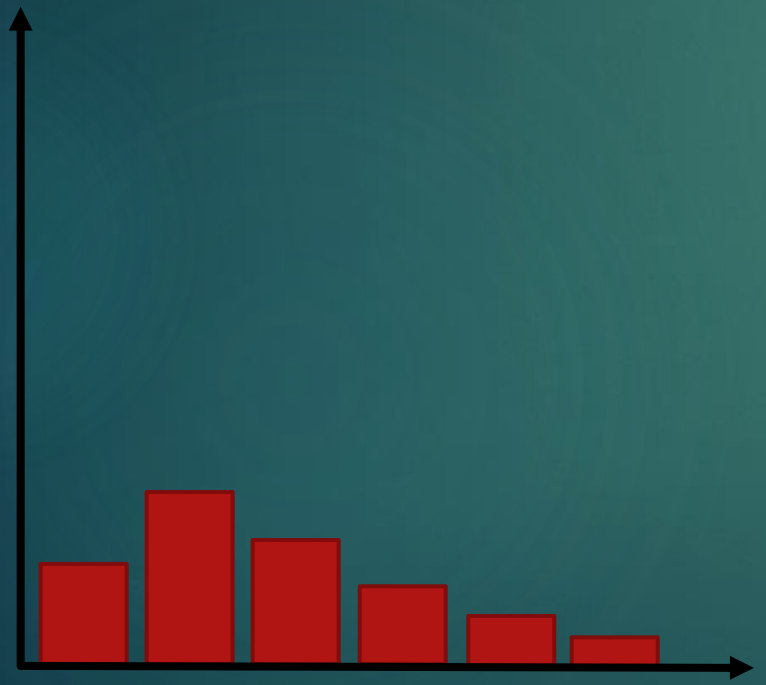

PDF

Generating constrained food webs

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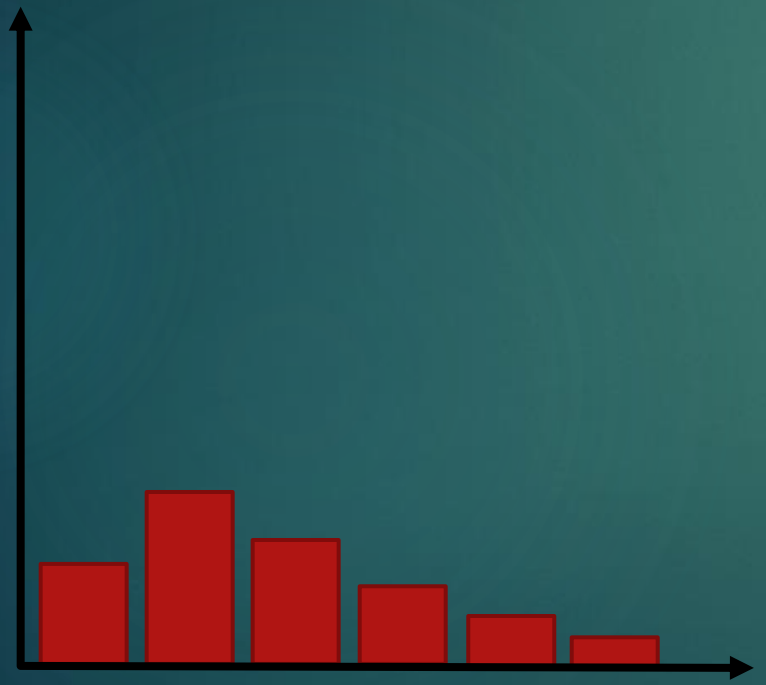

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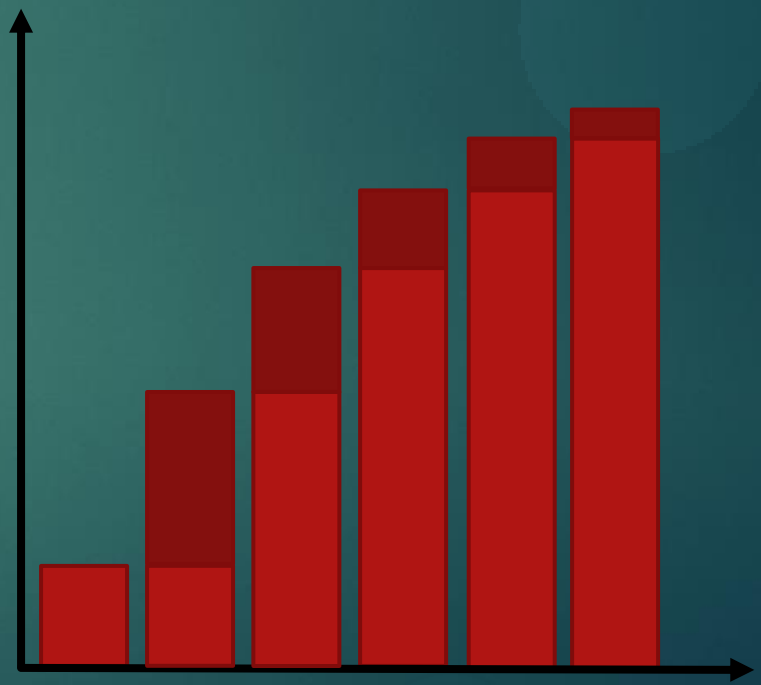

CDF

Generating constrained food webs

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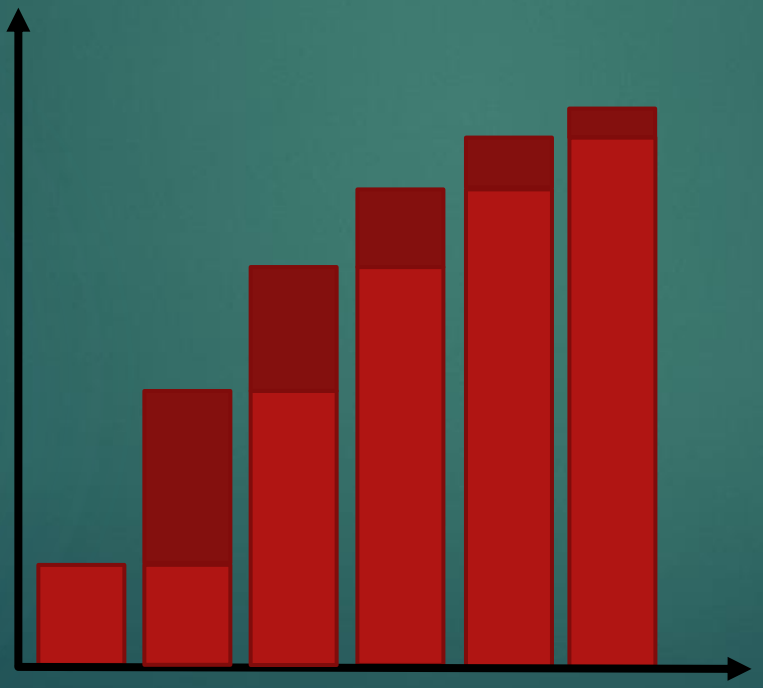

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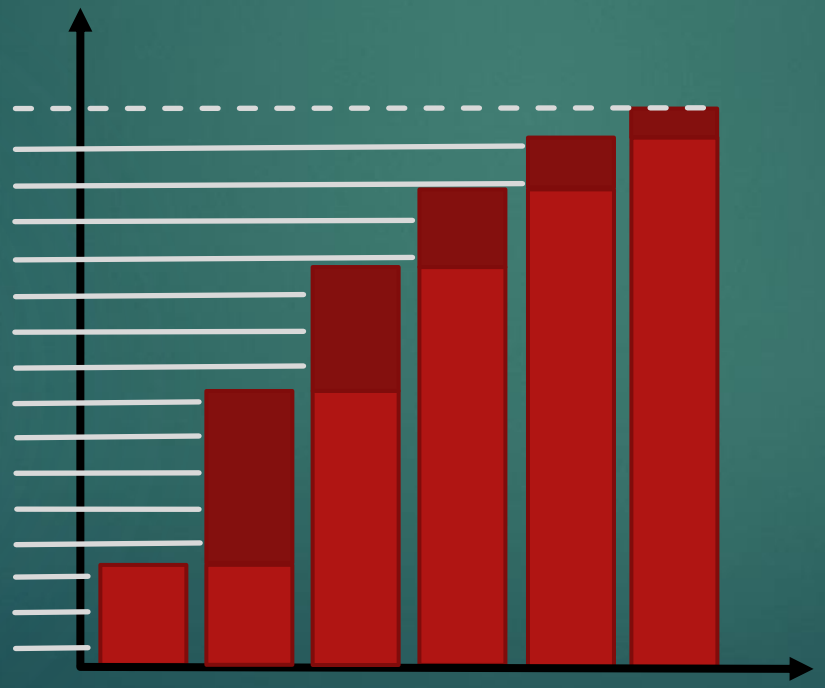

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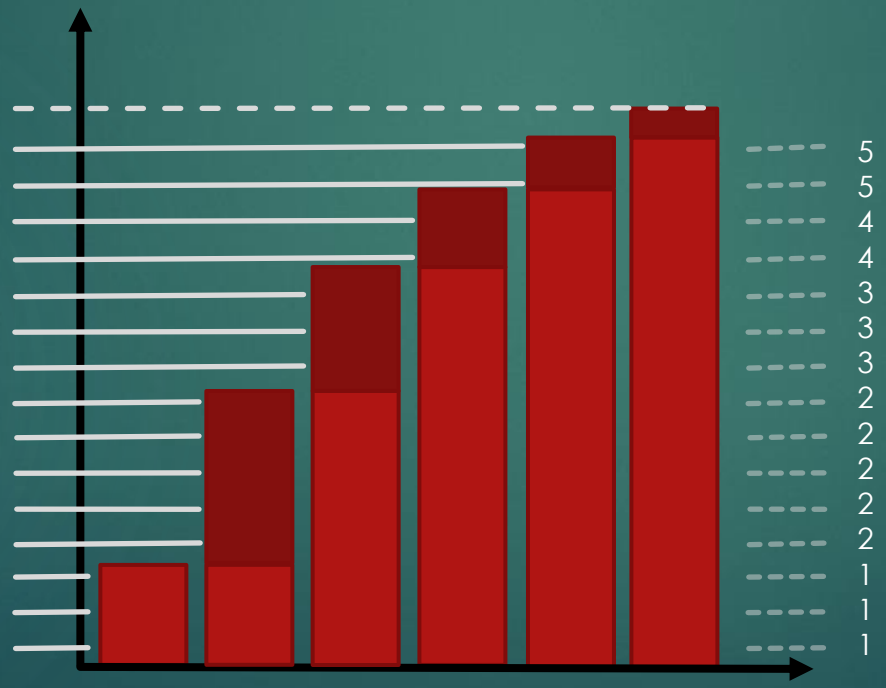

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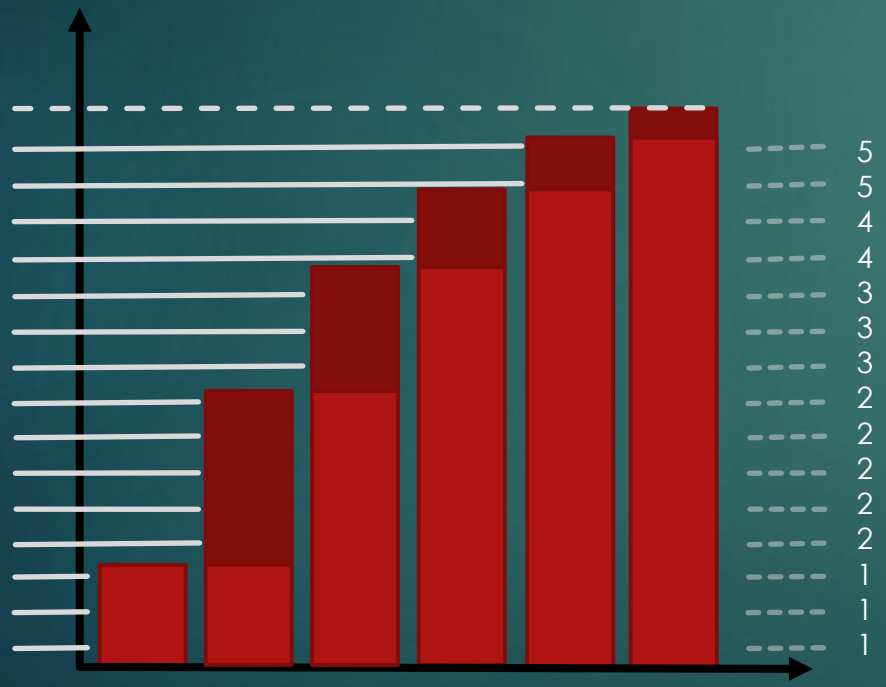

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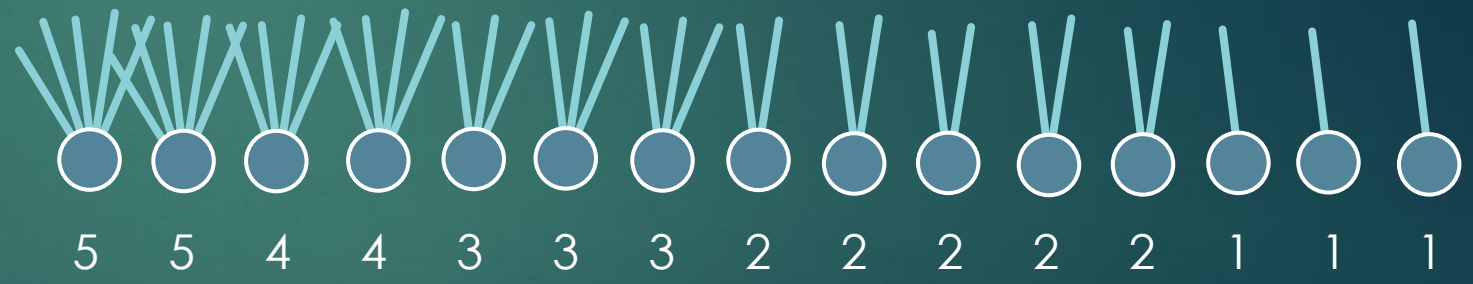

Generating constrained food webs

- **Step I**: Generate an undirected network with a given degree distribution, number of links and number of species
  - Generate a **degree sequence**
  - Is this sequence **graphic**?
    - Hakimi, S. L. (1962) On Realizability of a Set of Integers as Degrees of the Vertices of a Linear Graph. I. *Journal of the Society for Industrial and Applied Mathematics,* ***10, 496-506.***

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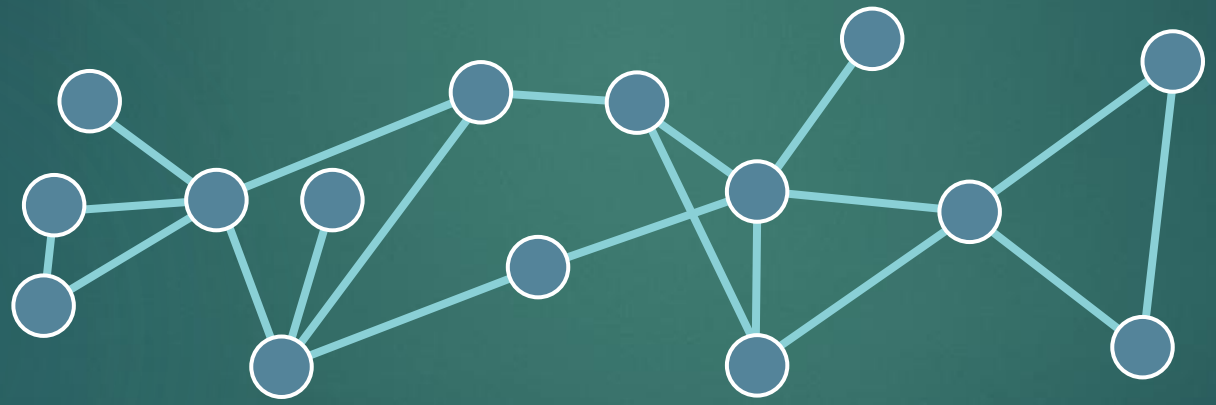
  - Generate random undirected simple connected network
    - Viger, F. & Latapy, M. (2005) Random generation of large connected simple graphs with prescribed degree distribution. *11th International Conference on Computing and Combinatorics.*

Generating constrained food webs

- **Step I**: Generate an undirected network with a given degree distribution, number of links and number of species



Generating constrained food webs

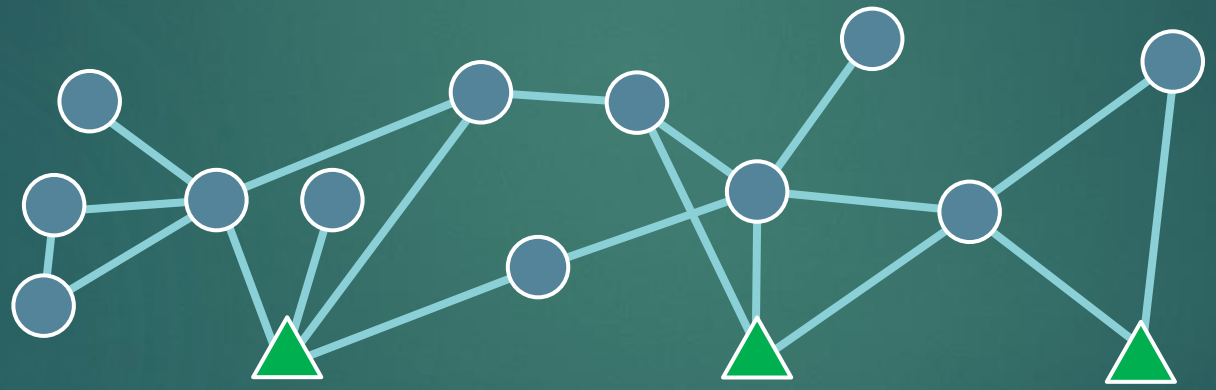
- Method
  - **Step I**: Generate an undirected network with a given degree distribution, number of links and number of species
  - **Step II**: Select the basal species
  - **Step III**: Direct the network

Generating constrained food webs

- **Step II**: Select the basal species: must be disconnected
  - Greedy search algorithm
  - Graph coloring algorithm
    - Blöchliger, I. & Zufferey, N. (2008) A graph coloring heuristic using partial solutions and a reactive tabu scheme. *Computers & Operations Research,* ***35, 960-975***

Generating constrained food webs

- **Step II**: Select the basal species: must be disconnected



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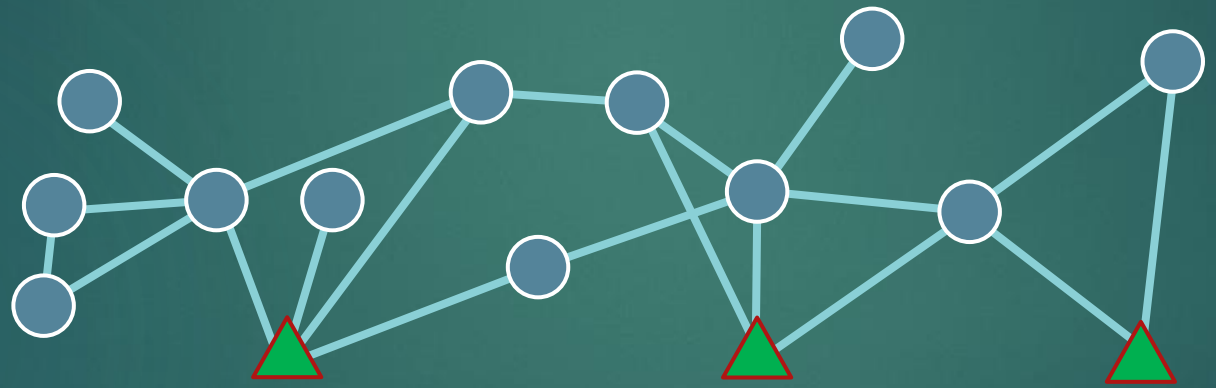
Generating constrained food webs

- **Step III**: Direct the network
  - Breadth-first search on graph



Generating constrained food webs

- **Step III**: Direct the network
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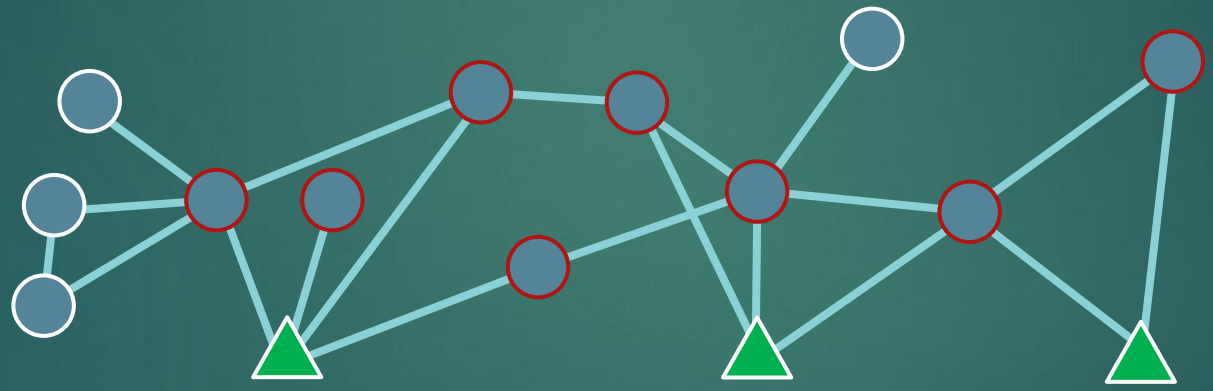
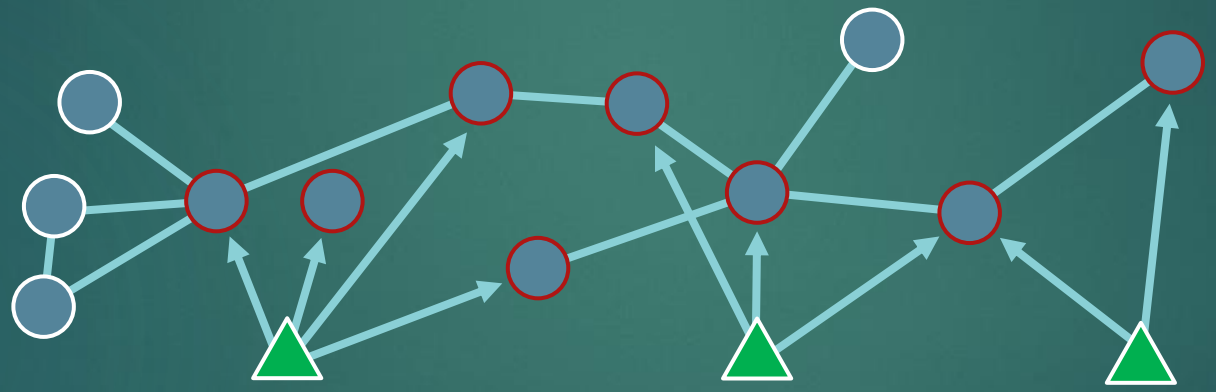


Explore network from basal species

Generating constrained food webs

- **Step III**: Direct the network
  - Breadth-first search on graph



Direct links towards explored species

Generating constrained food webs

- **Step III**: Direct the network
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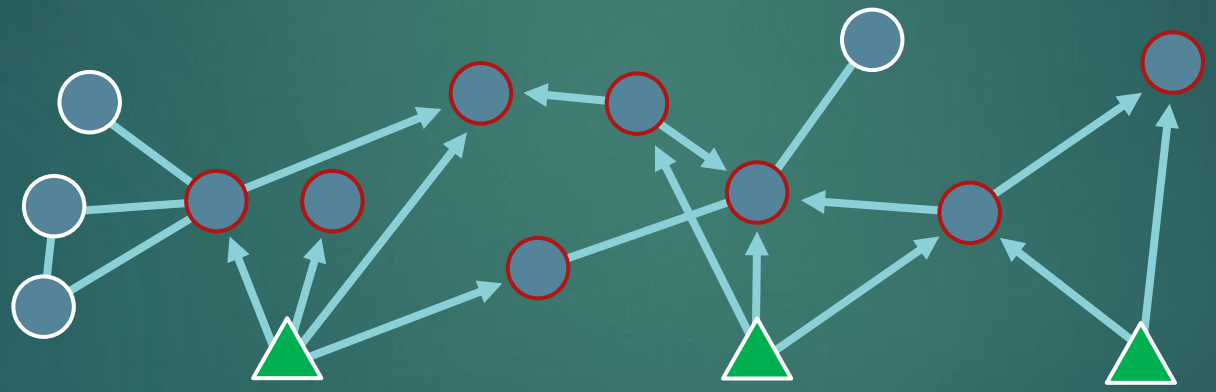
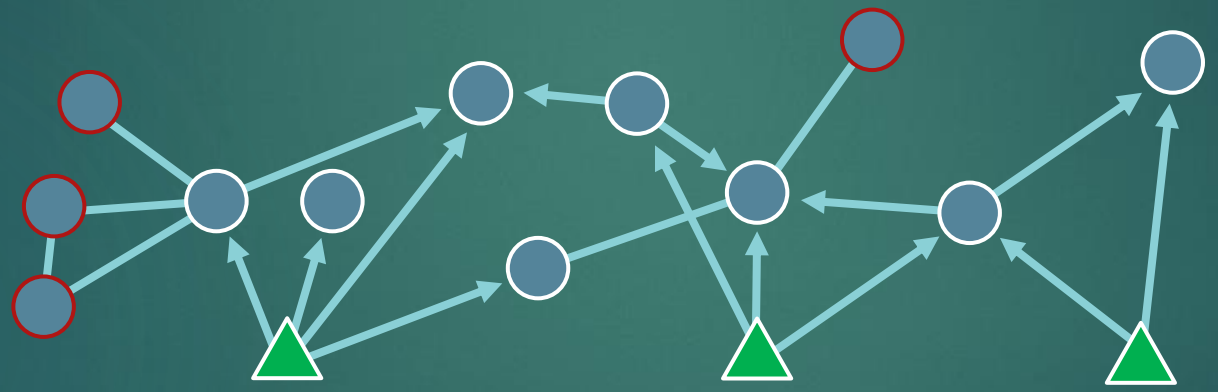


Randomly direct links among explored species

Generating constrained food webs

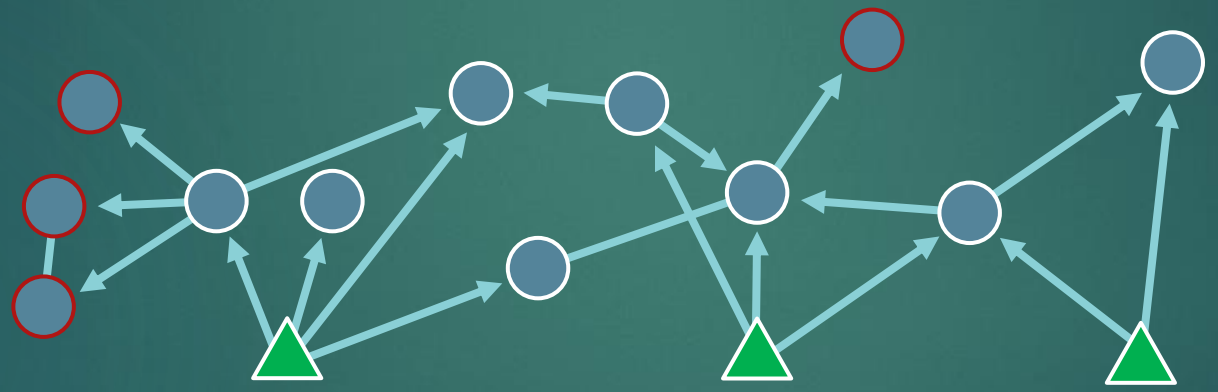
- **Step III**: Direct the network
  - Breadth-first search on graph



Explore one step further

Generating constrained food webs

- **Step III**: Direct the network
  - Breadth-first search on graph



Direct links towards explored species

Generating constrained food webs

- **Step III**: Direct the network
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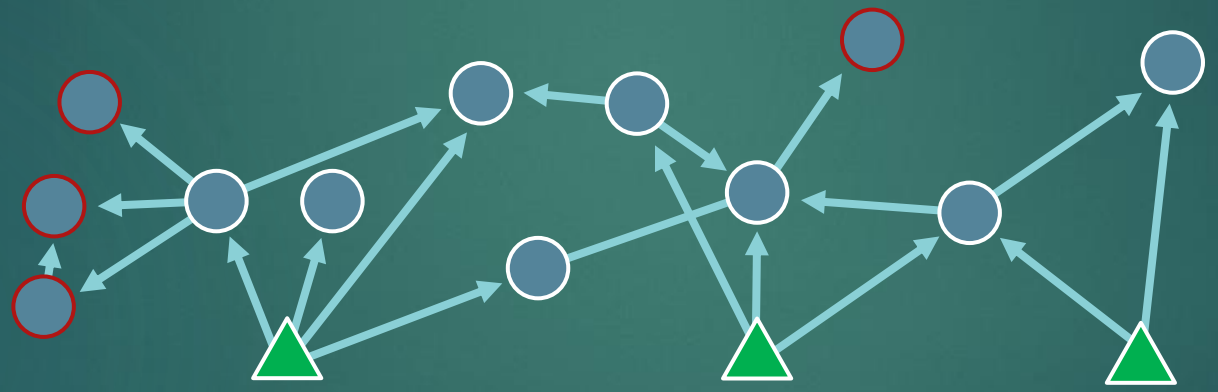
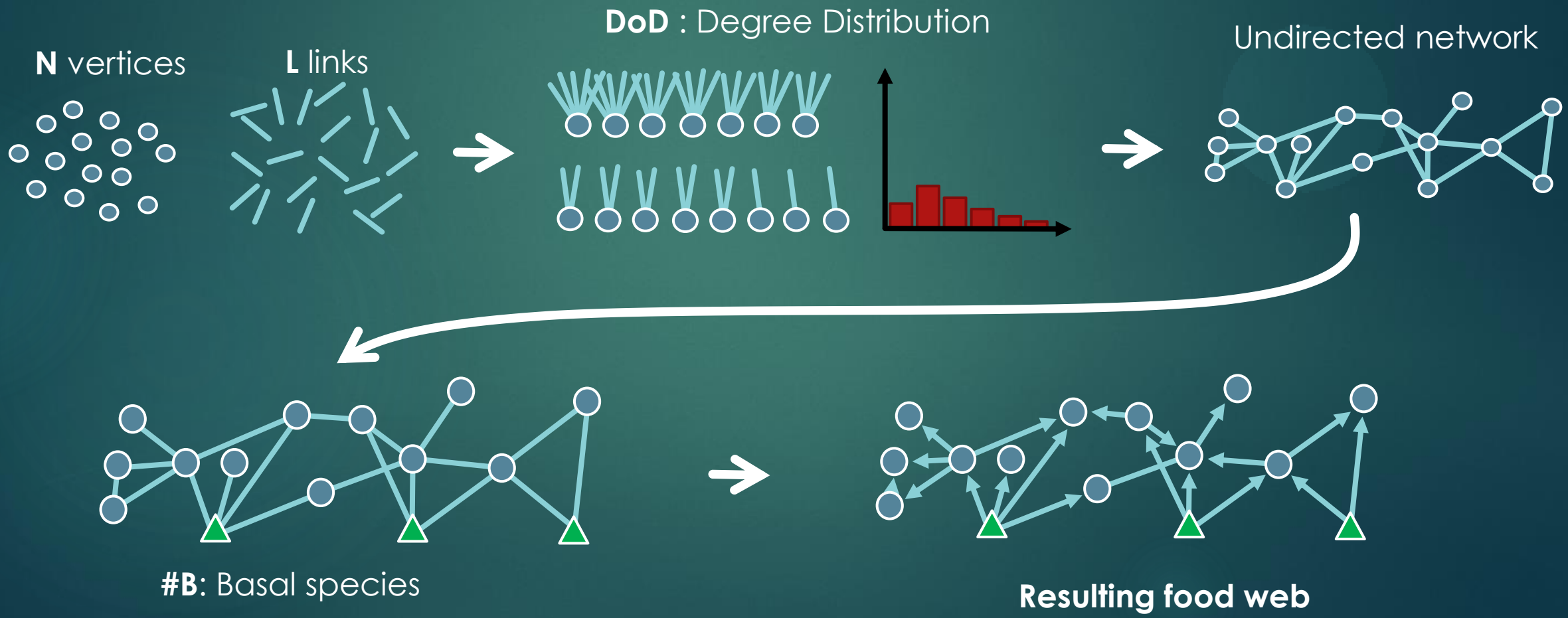


Randomly direct links among explored species

Generating constrained food webs

- Implemented in a C++ framework by Jérôme Duclert



Generating constrained food webs

- Implemented in a C++ framework by Jérôme Duclert
  - Algorithm *Random50*
  - New method in development?

Null model of food web

- Networks properties are strongly linked [Vermaat & al, 2009; Riede & al, 2010; Poisot & Gravel, 2014 ; Orsini & al, 2015]
  - Is a property significantly different from a null expectation?
  - What is the null expectation?
  - Effects attributed to one property
    - Spurious correlation?

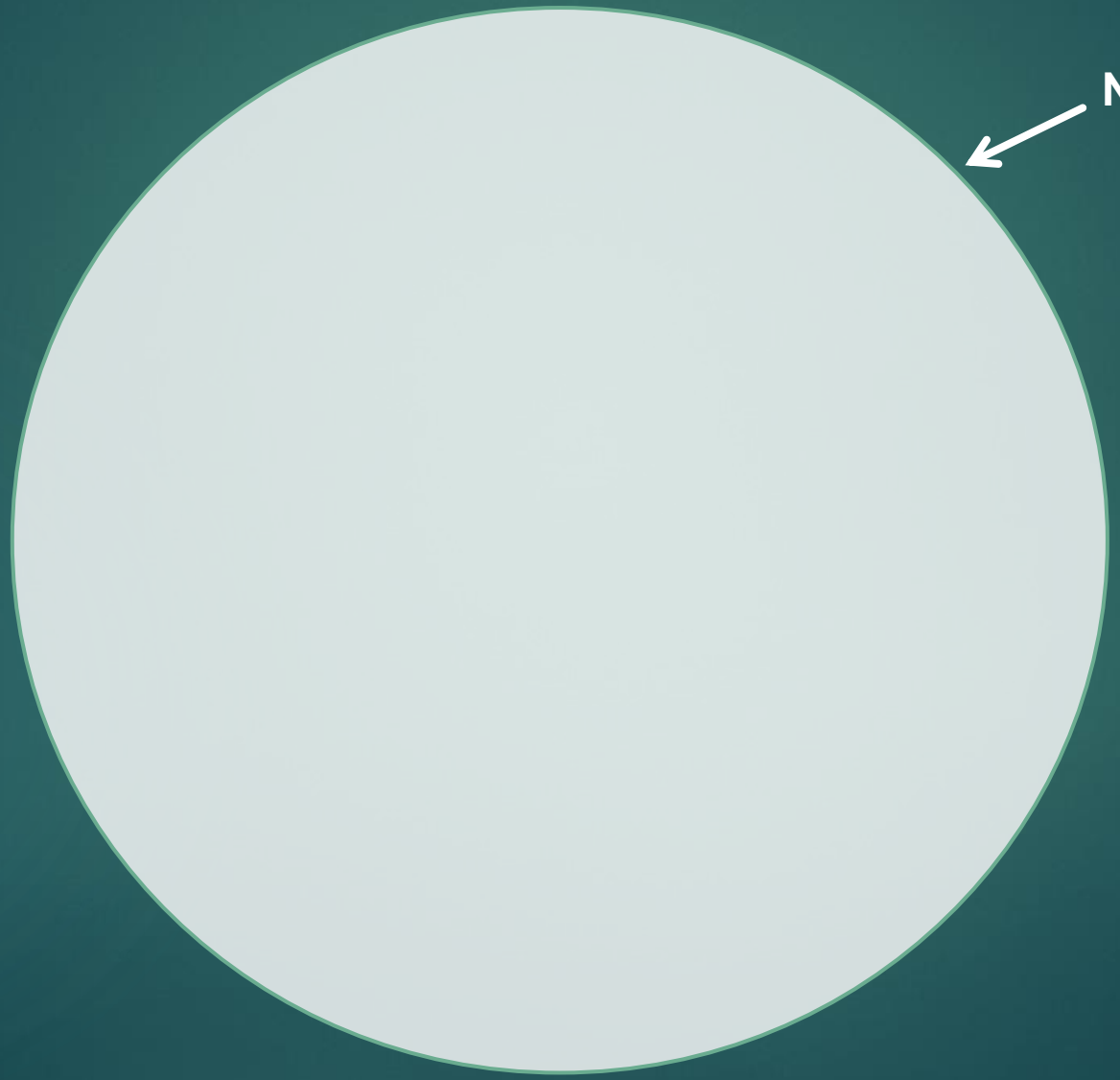
LETTER

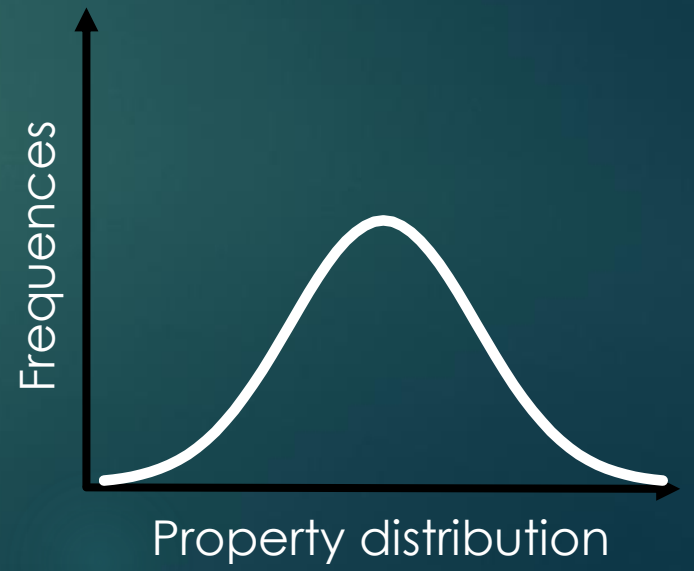
doi:10.1038/nature11214

Disentangling nestedness from models of ecological complexity

Alex James[1], Jonathan W. Pitchford[2] & Michael J. Plank[1]

Null model of food web





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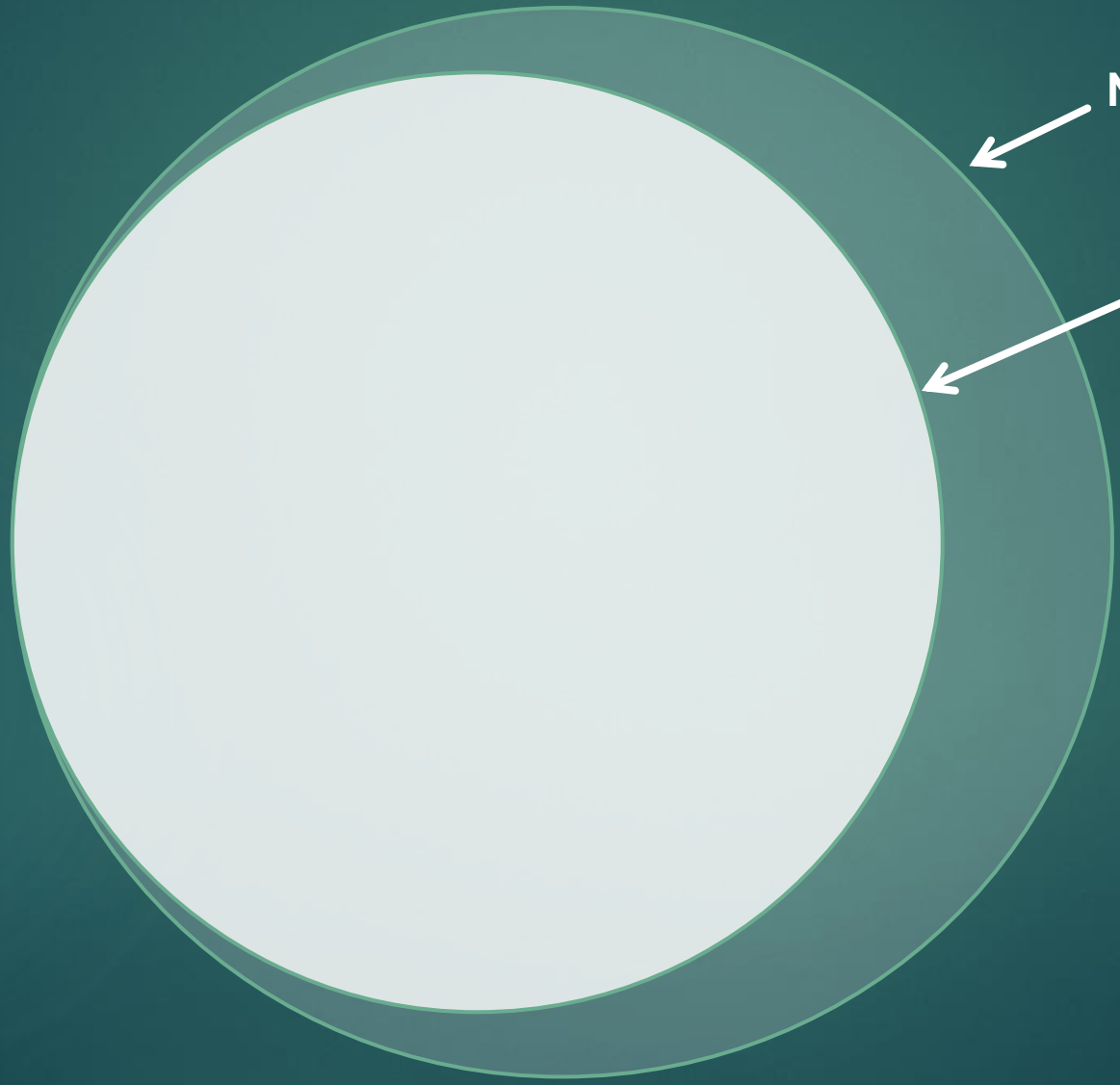

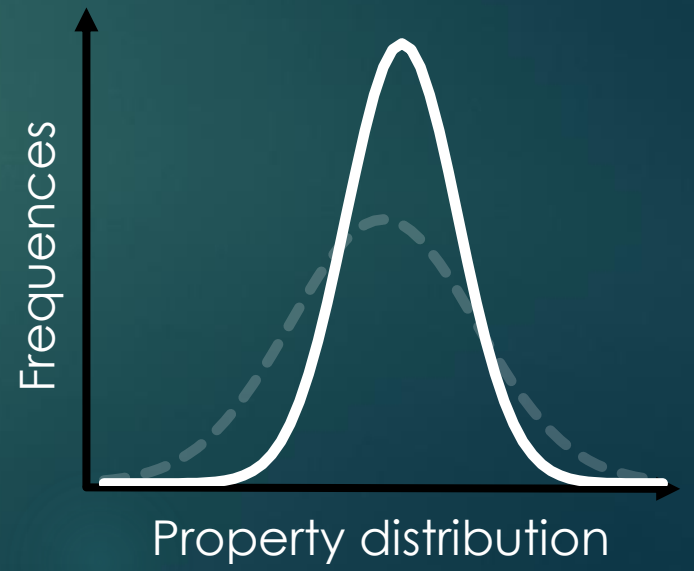

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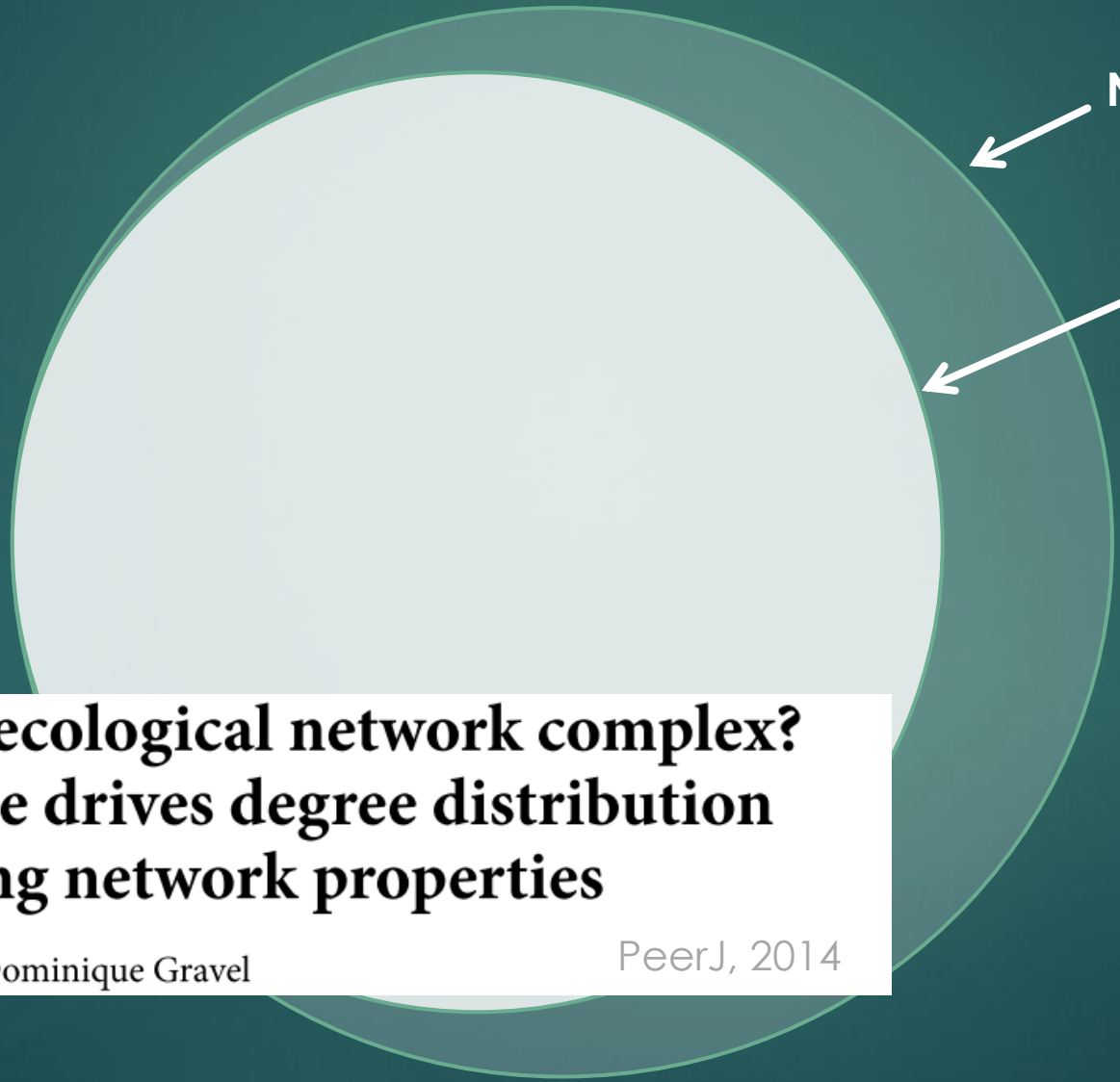
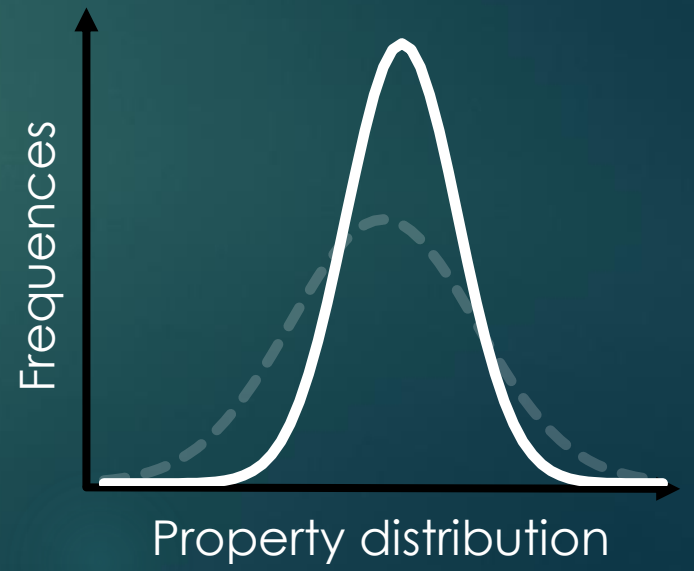


When is an ecological network complex? Connectance drives degree distribution and emerging network properties

Timothée Poisot and Dominique Gravel

PeerJ, 2014



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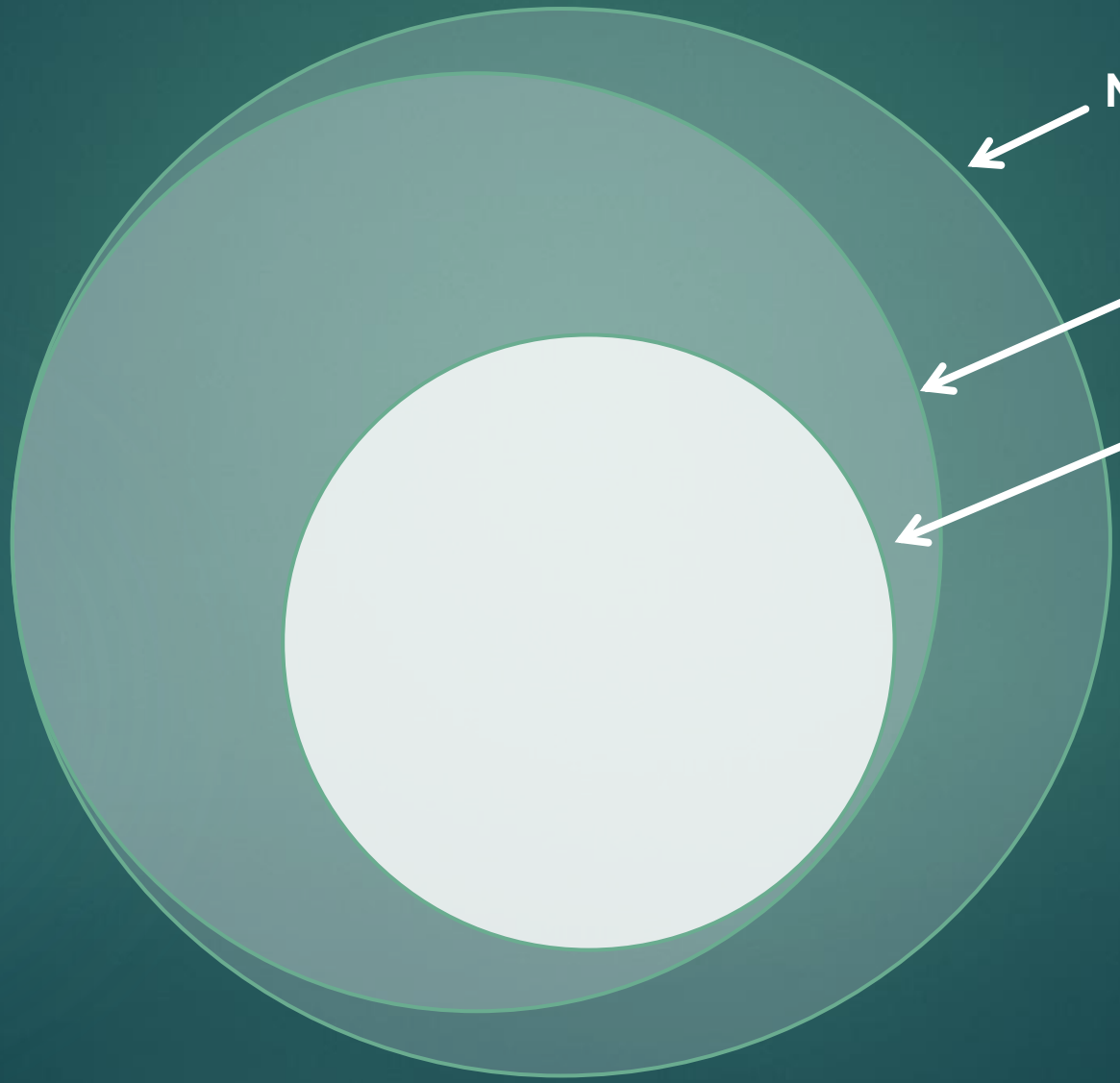

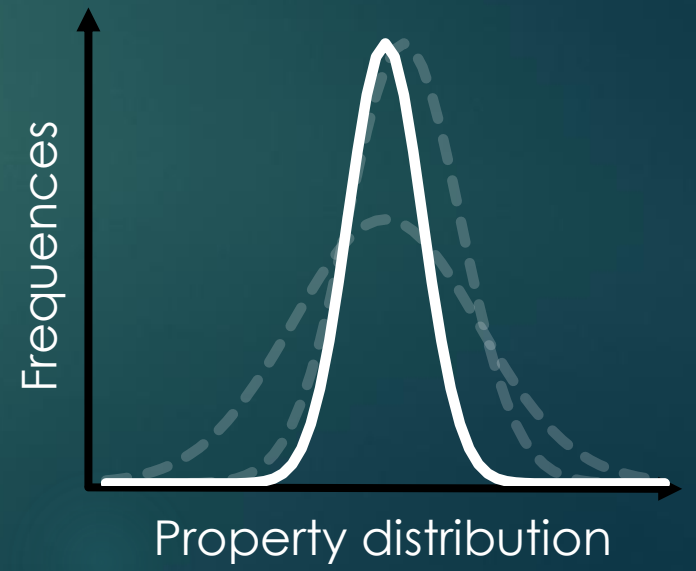

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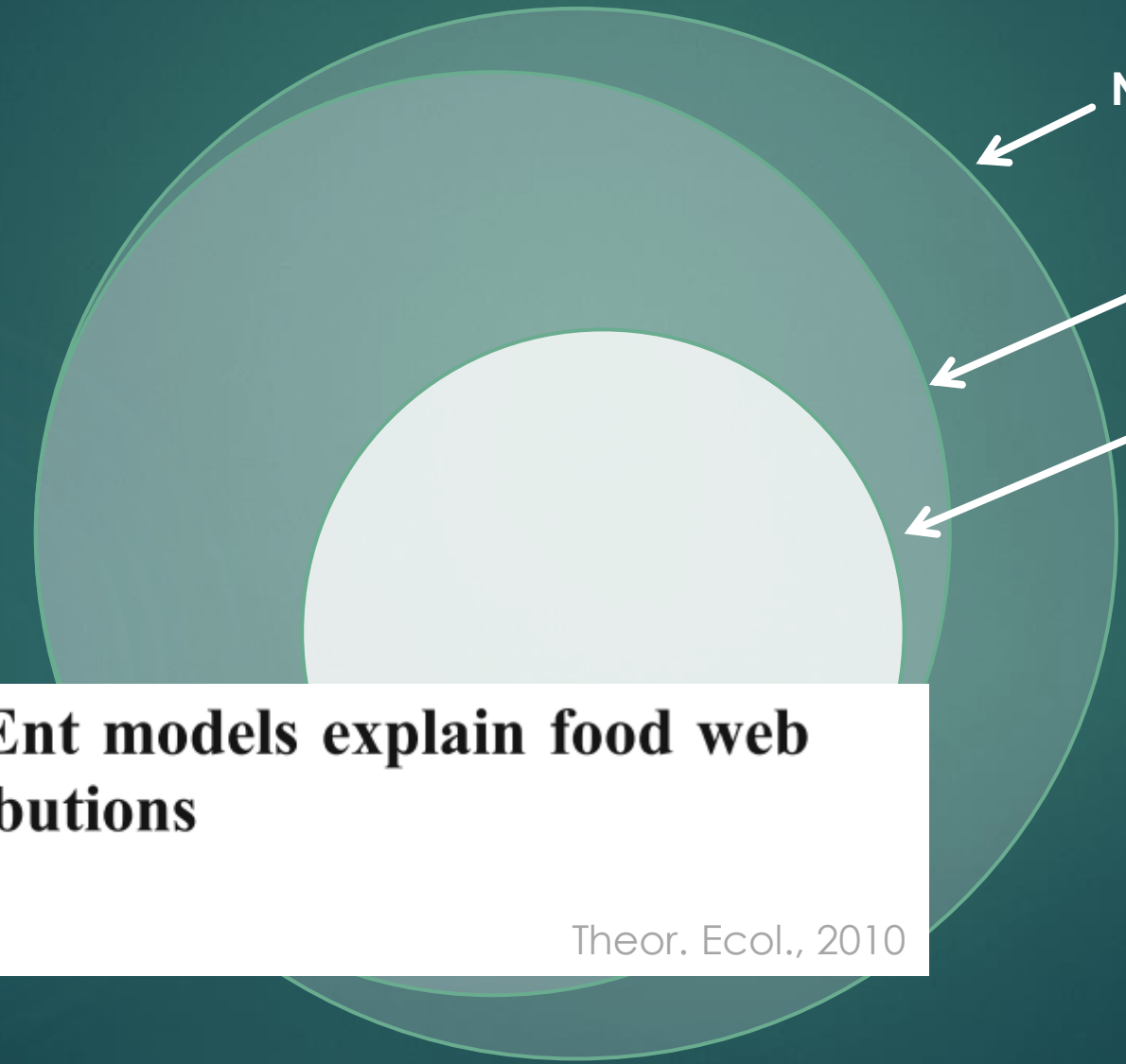
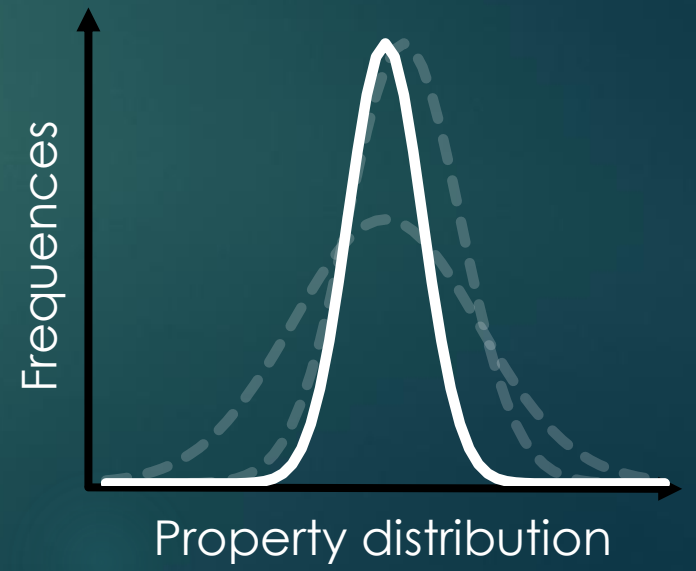


Simple MaxEnt models explain food web degree distributions

Richard J. Williams

Theor. Ecol., 2010



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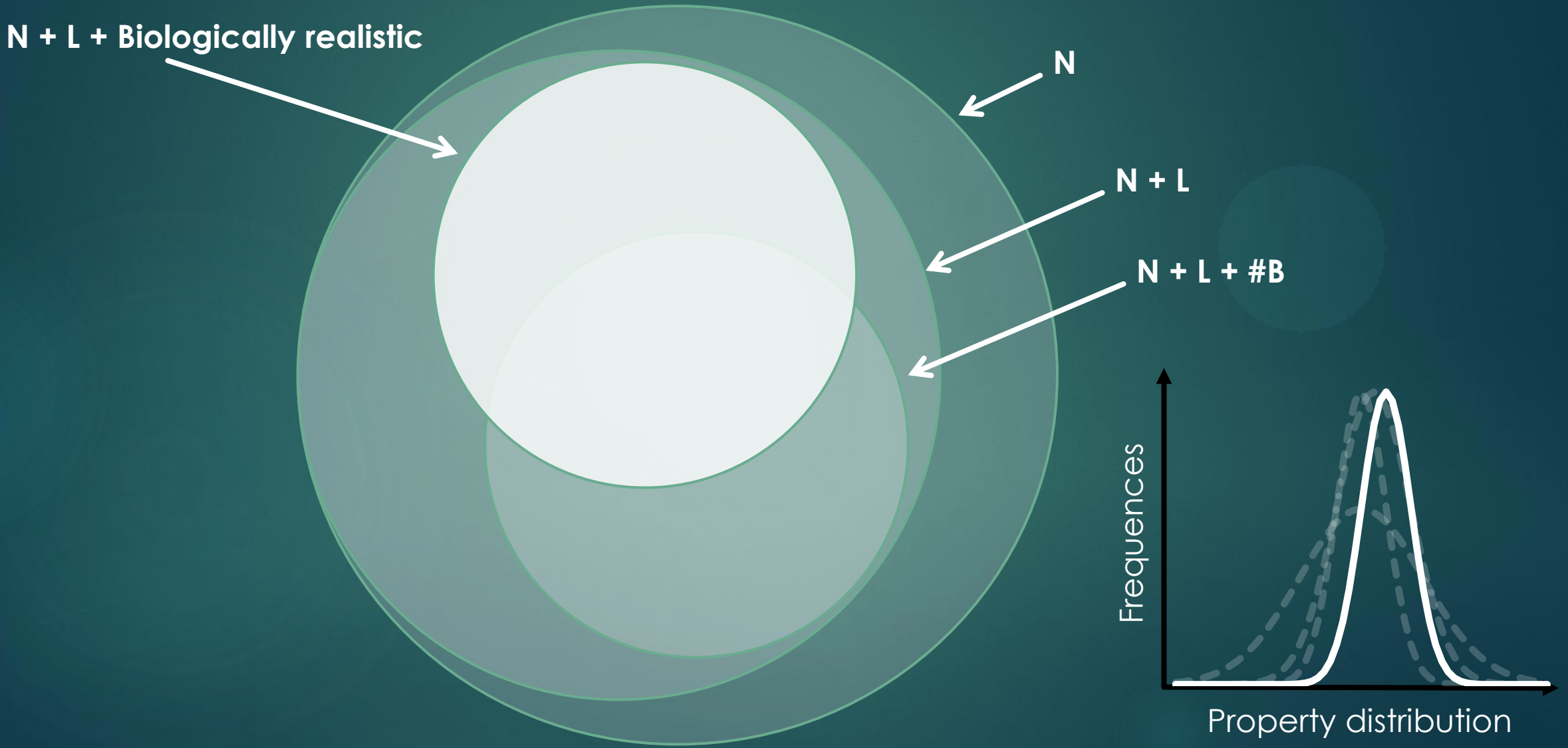

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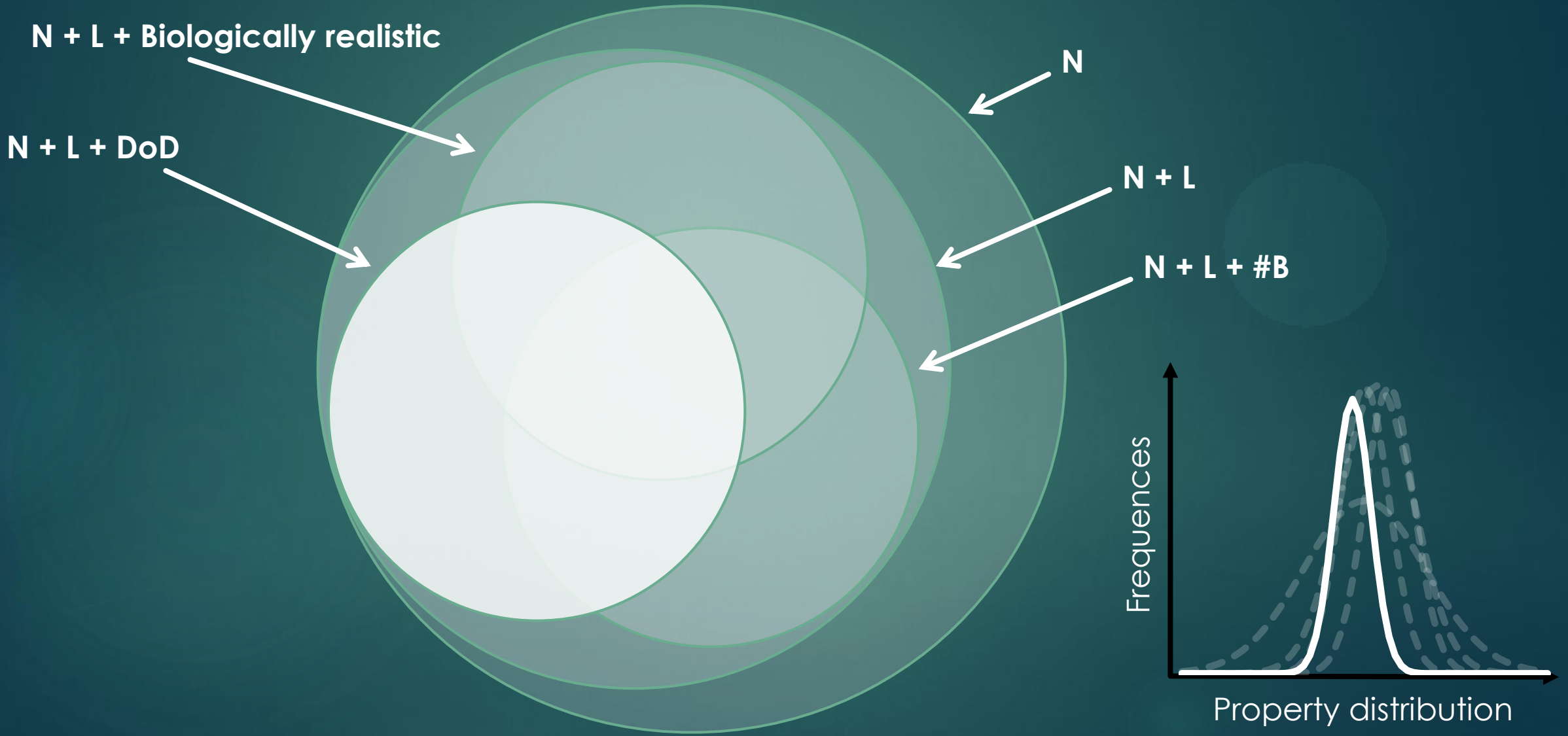

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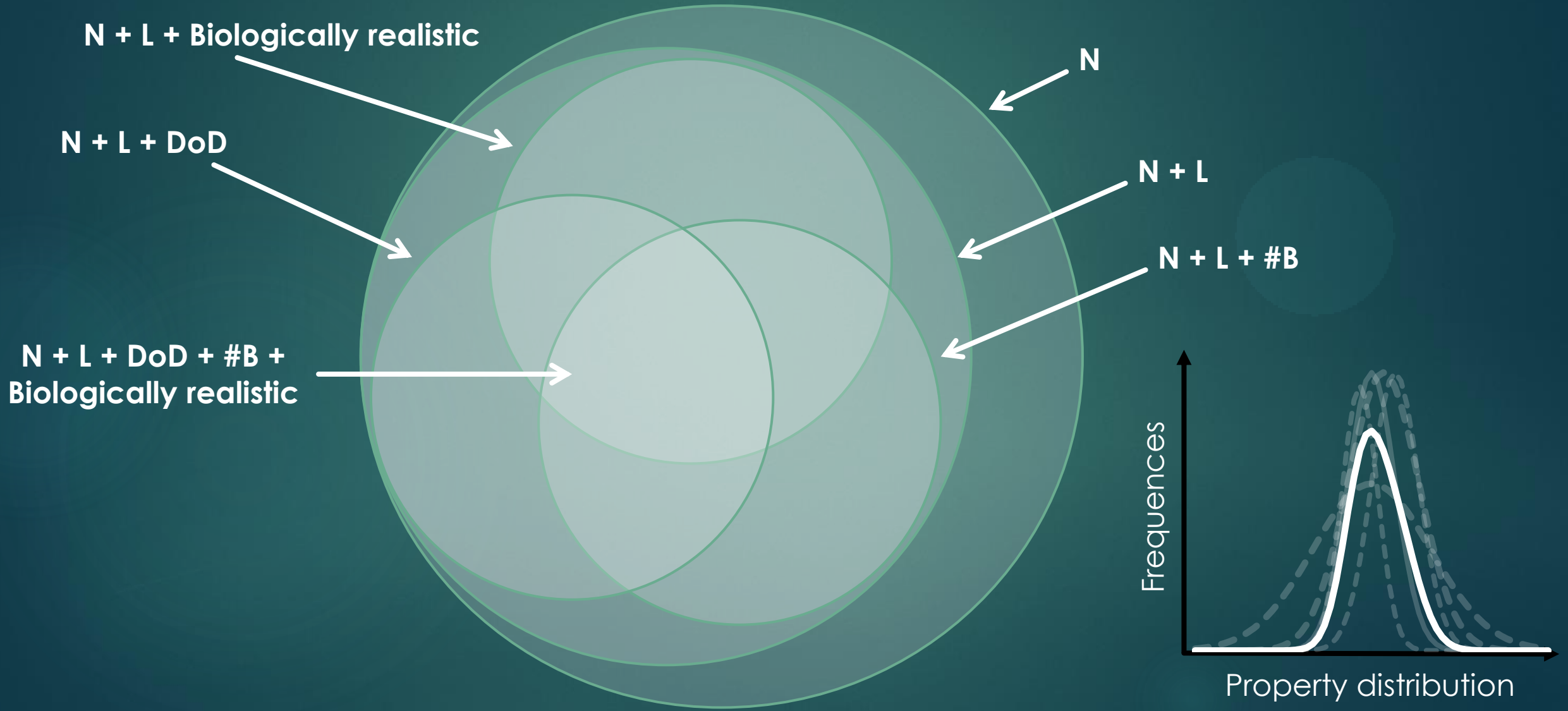

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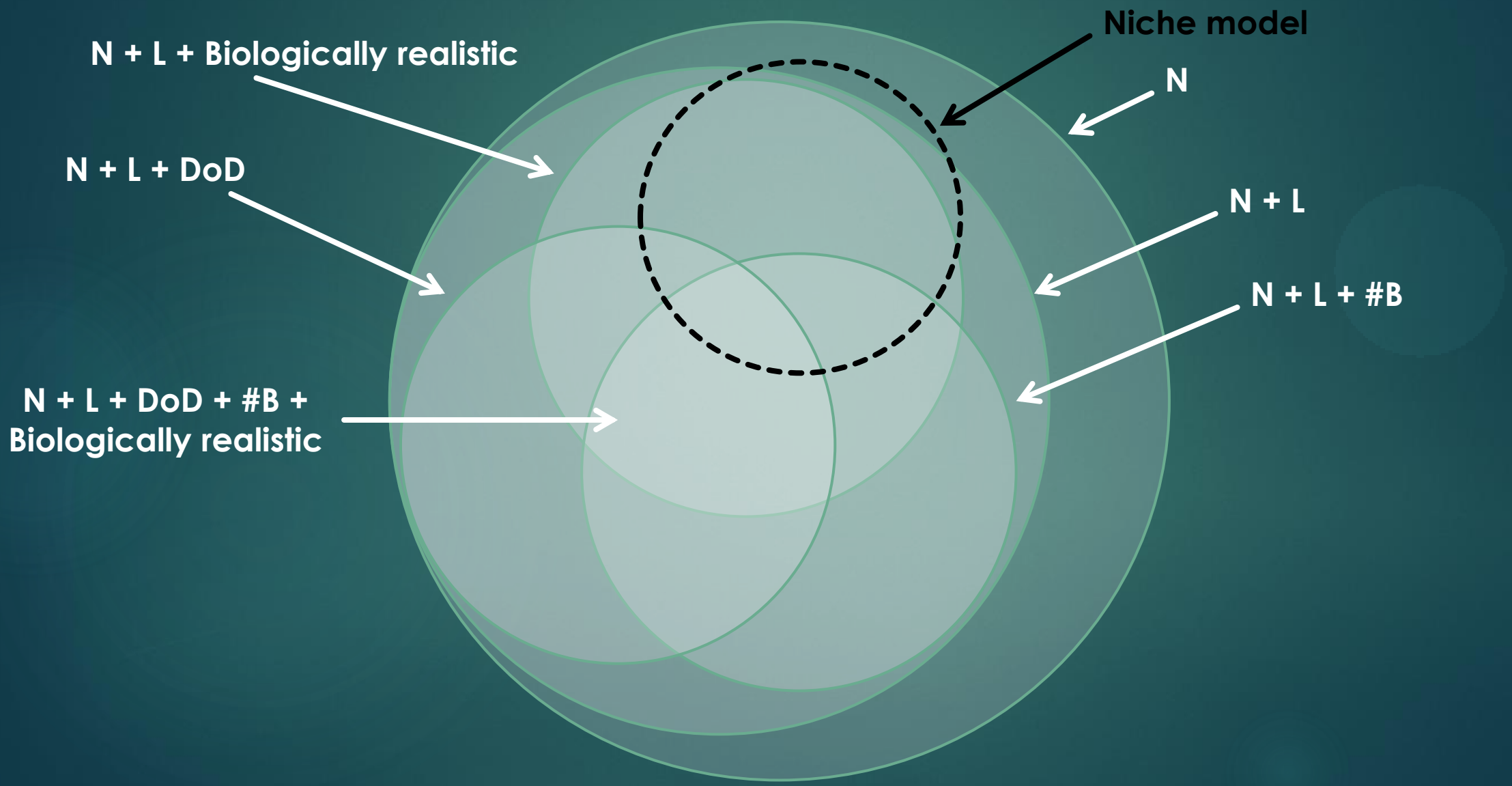

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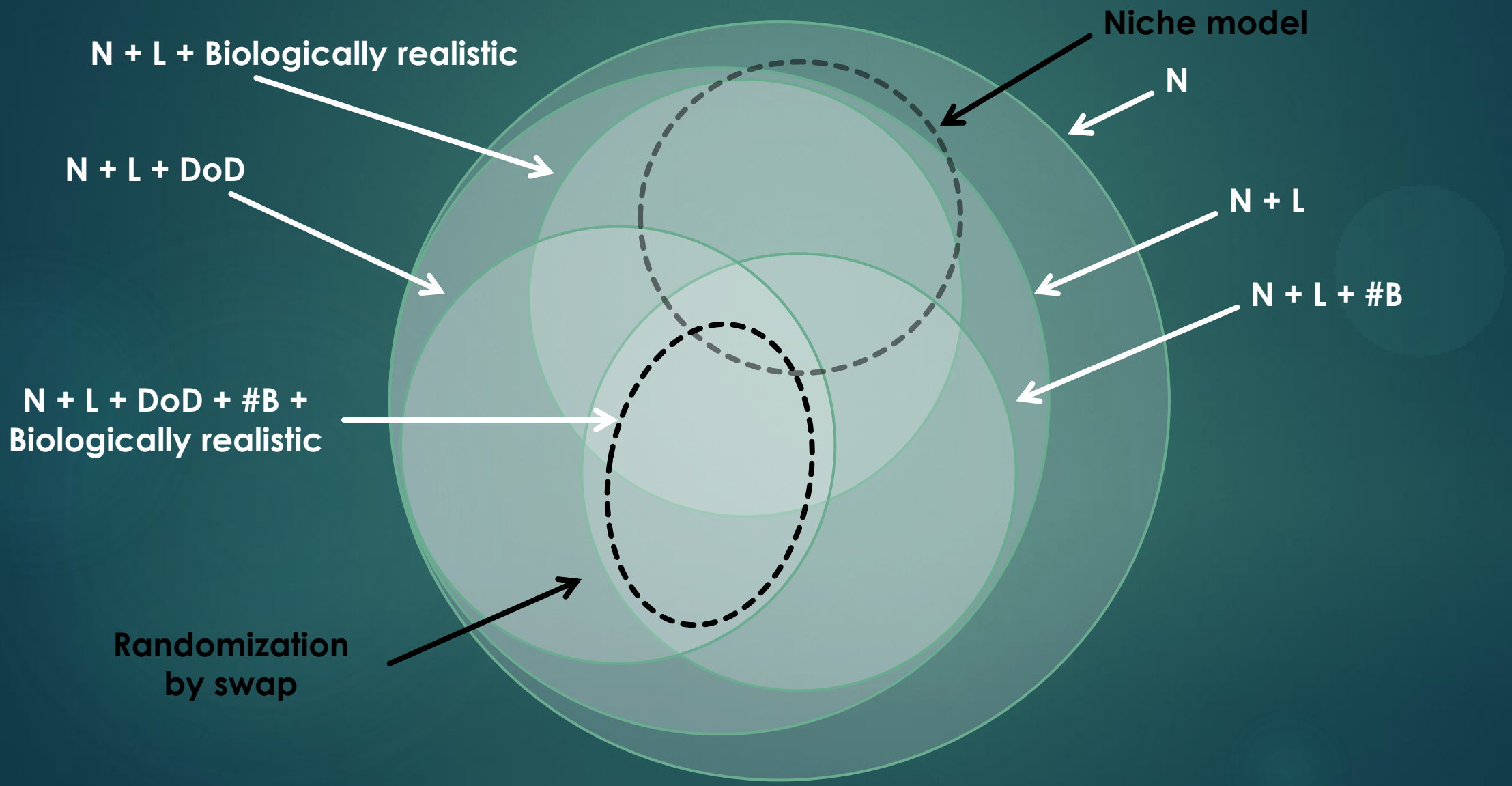

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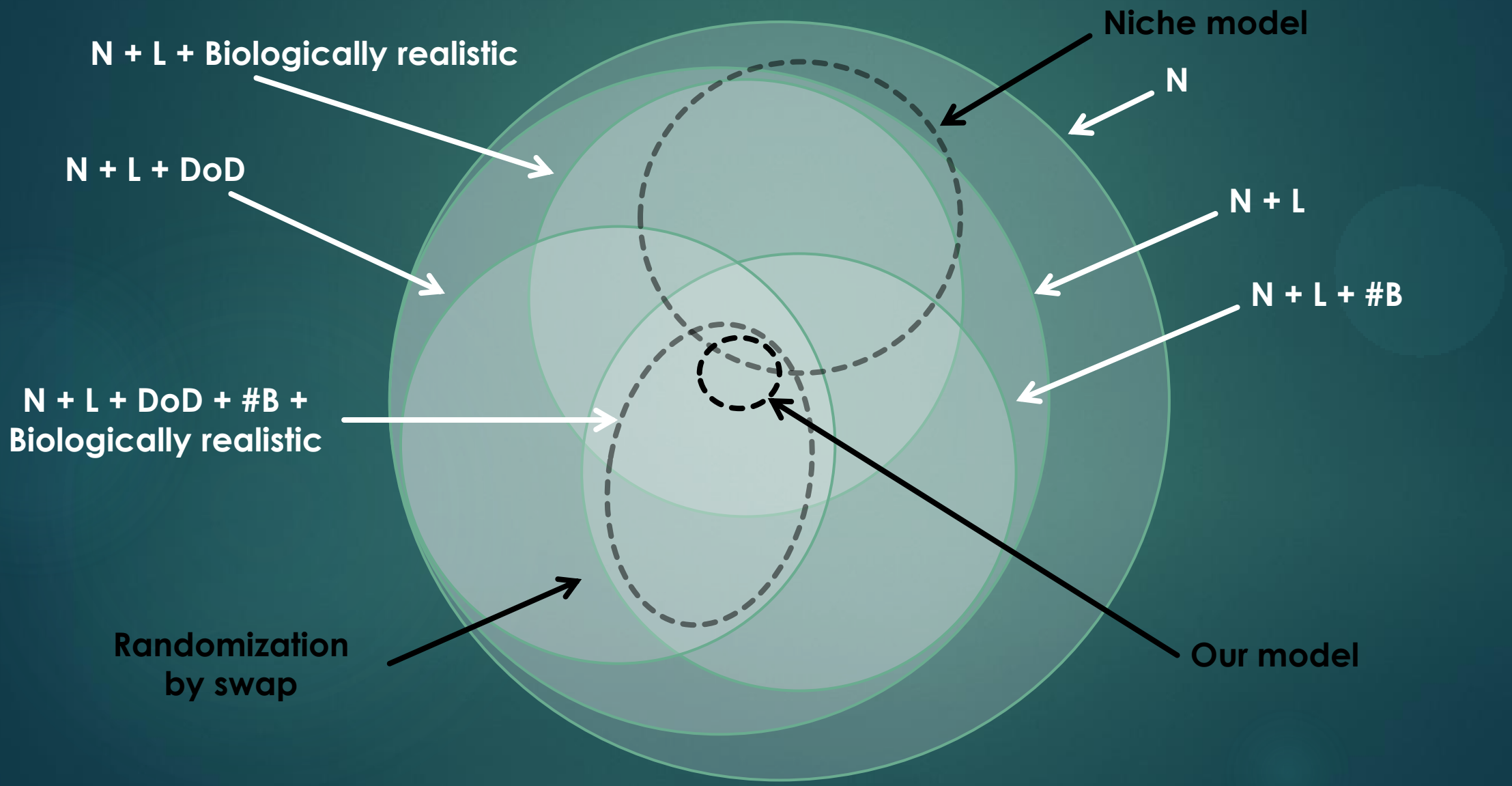

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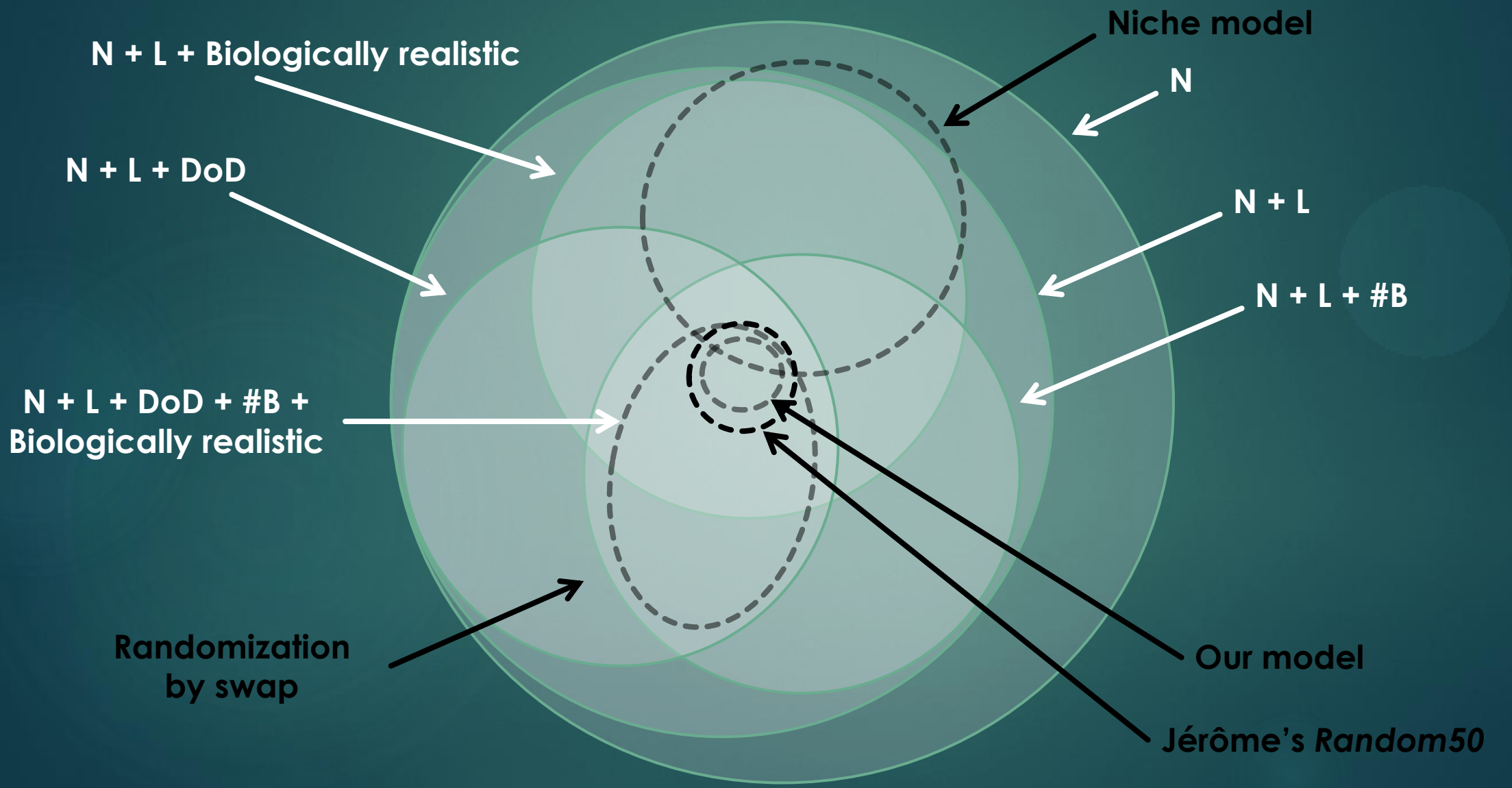


Null model of food web

- Limitations
  - Cannibalist links
  - Reciprocity
  - Uniformity of generation

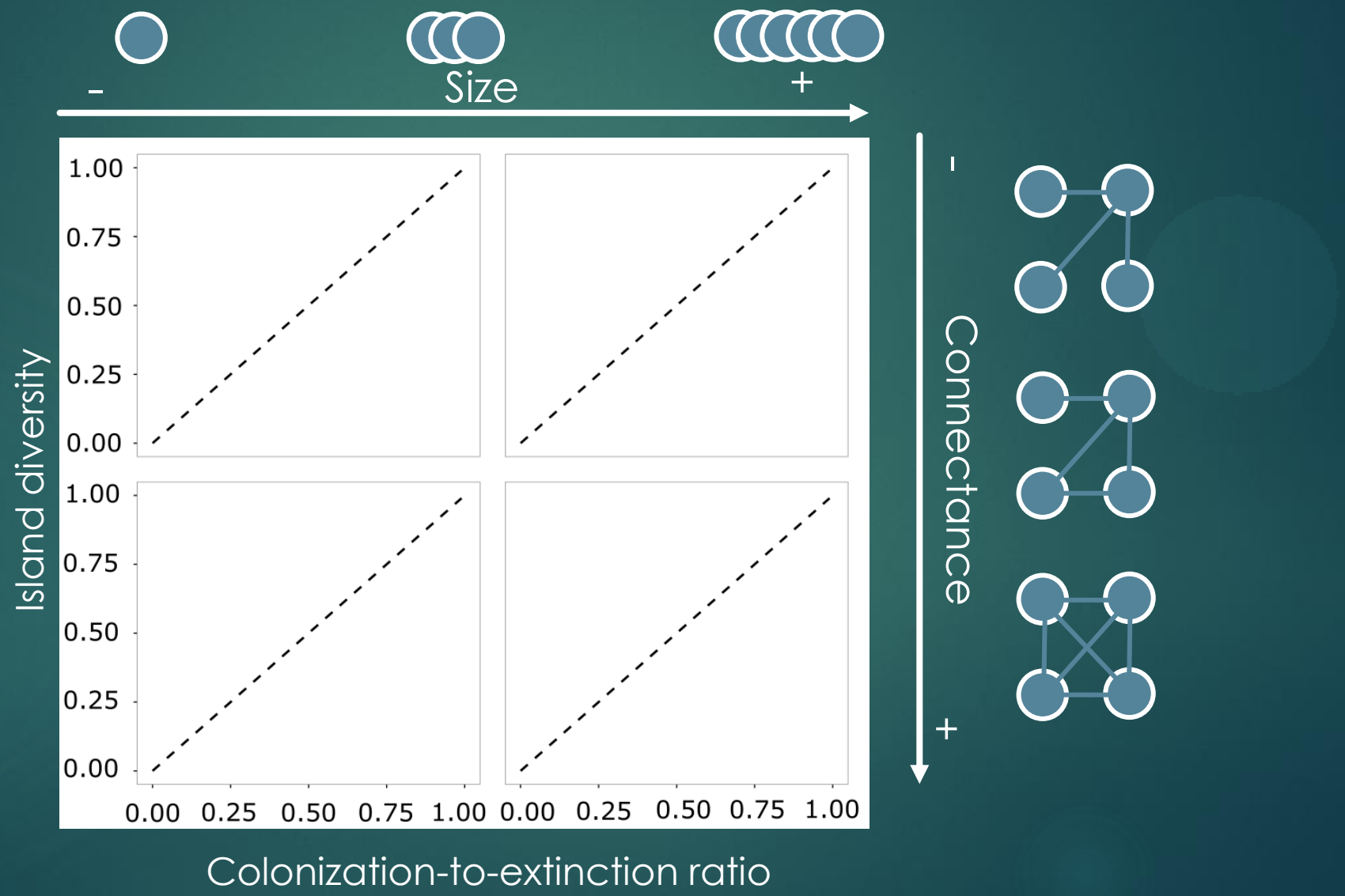
Some results on TTIB

- Simulating colonization / extinction dynamic

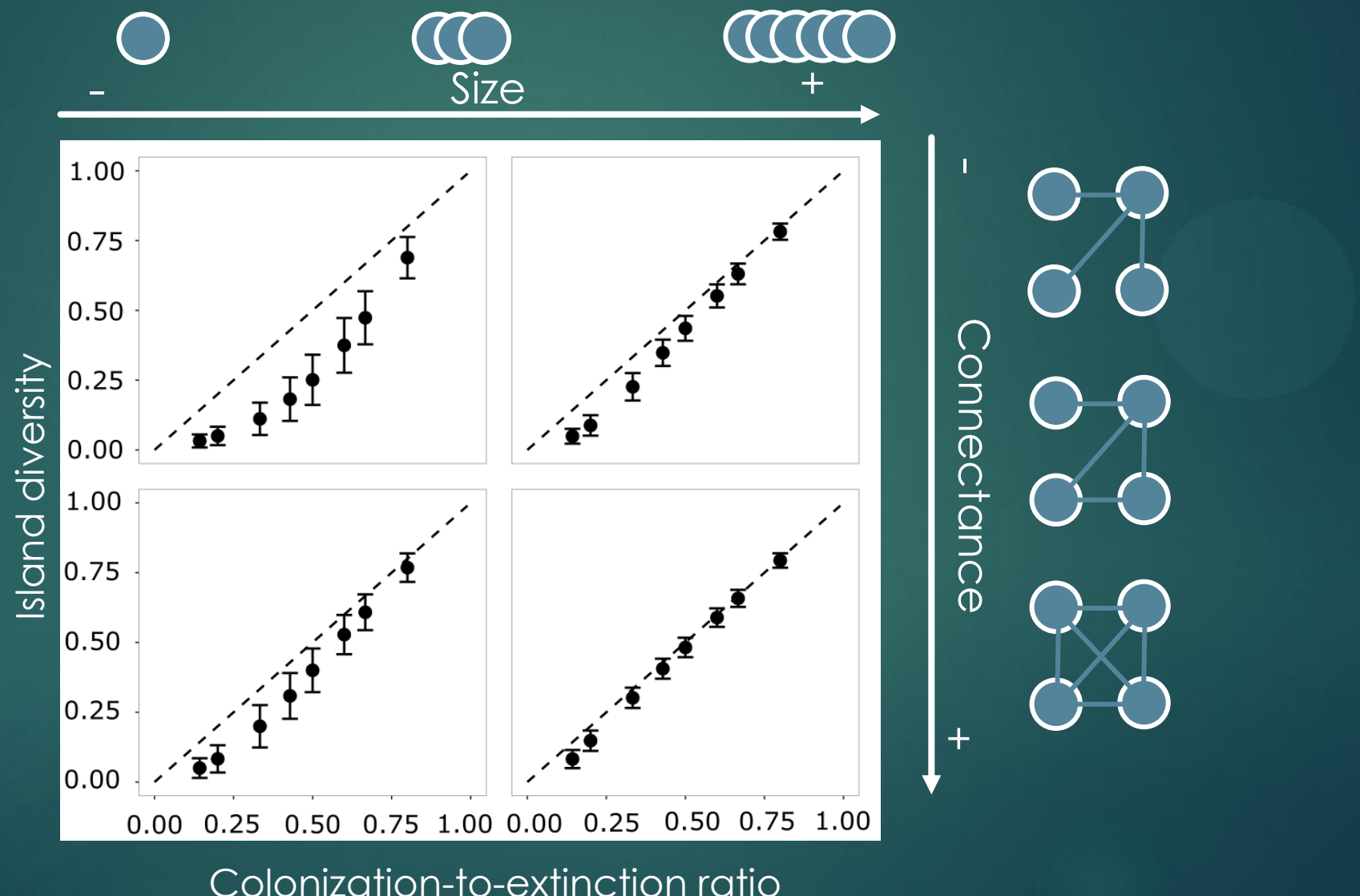
Some results on TTIB

- Simulating colonization / extinction dynamic
- Results:
  - Size and connectance effects
  - Degree distribution effects

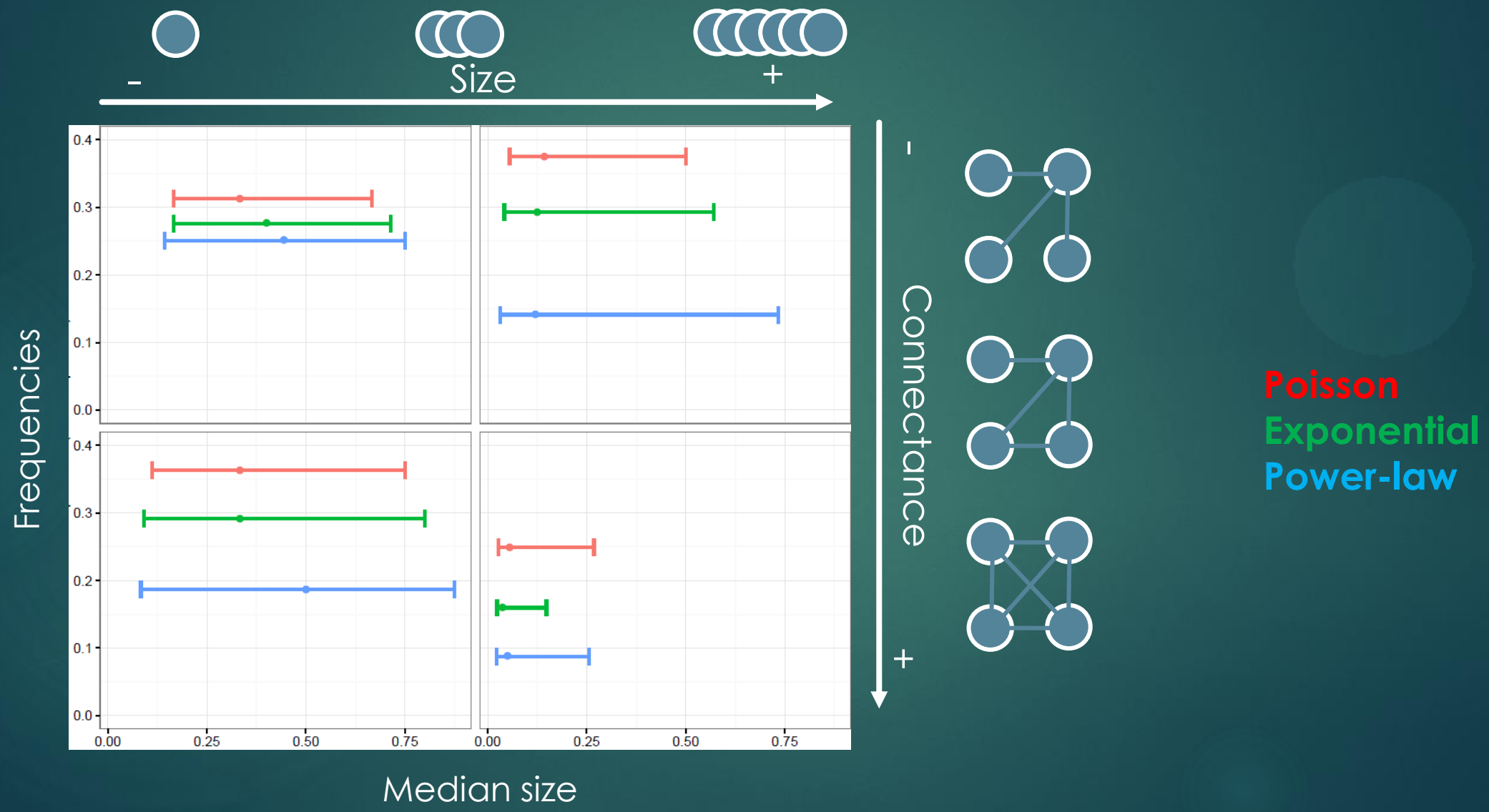
Some results on TTIB: Island diversity



Some results on TTIB: Island diversity



Some results on TTIB: Extinction



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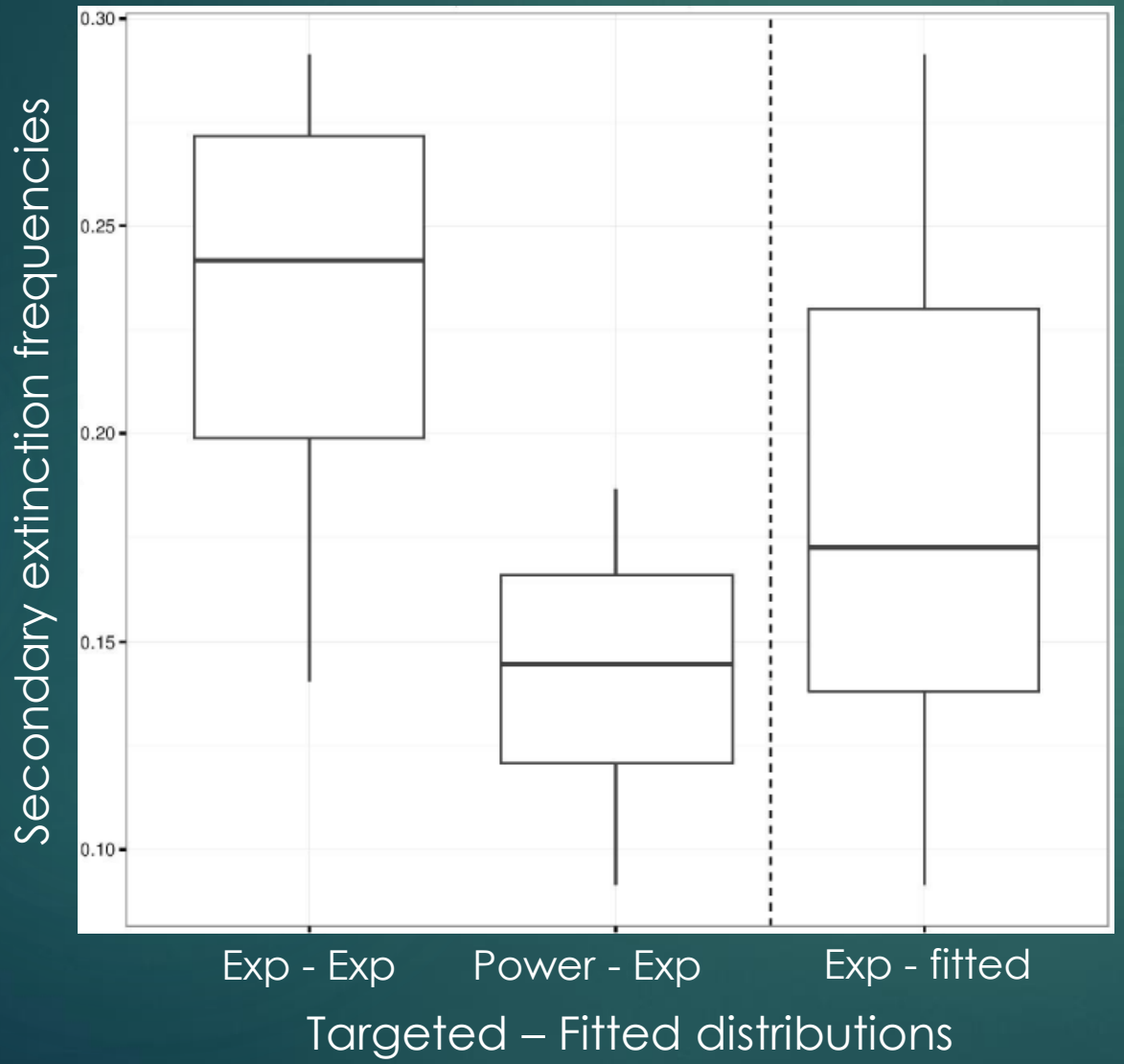

Thanks