

26/05/2017



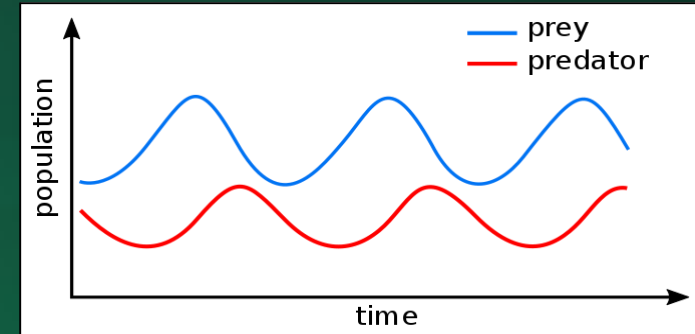
# Oecologia in silico : l'utilisation de simulations pour comprendre les processus écologiques

Louis Donelle & Sylvie Clappe

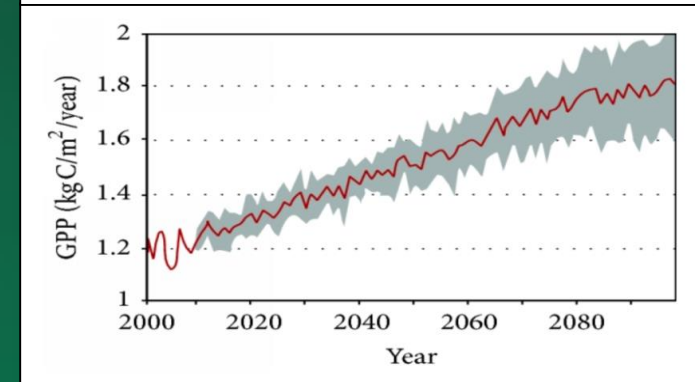


## Simulation : une stratégie commune en écologie ?

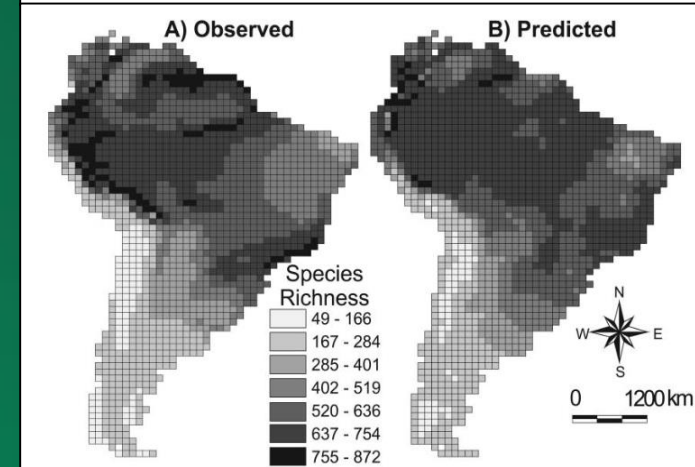
Dynamique des populations



Écologie des écosystèmes

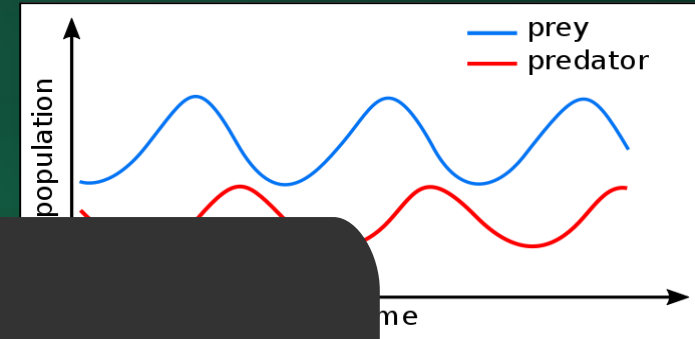


Macroécologie



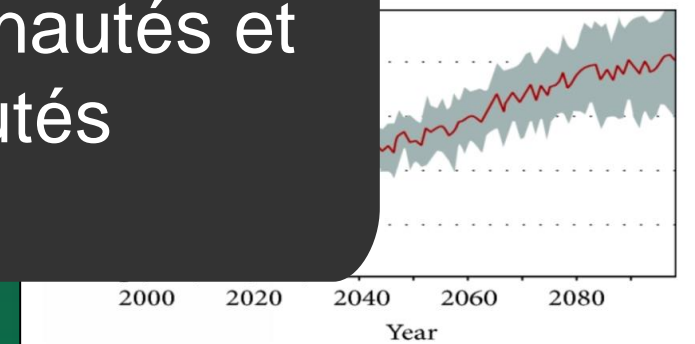
## Simulation : une stratégie commune en écologie ?

Dynamique des populations

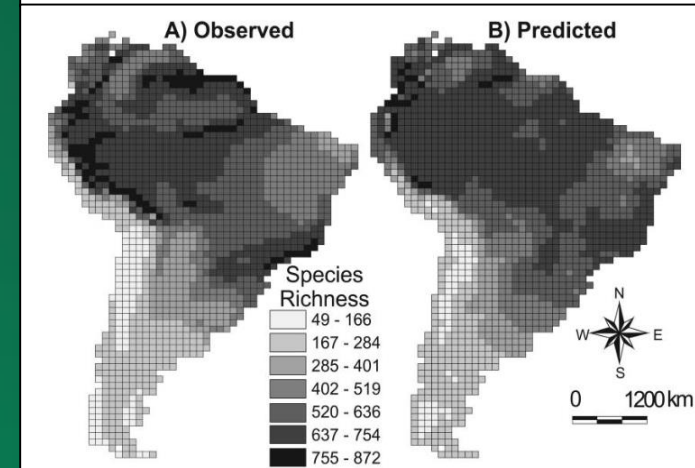


Écologie des

Écologie des communautés et métacommunautés



Macroécologie



## Pourquoi simuler en écologie des communautés et métacommunautés ?

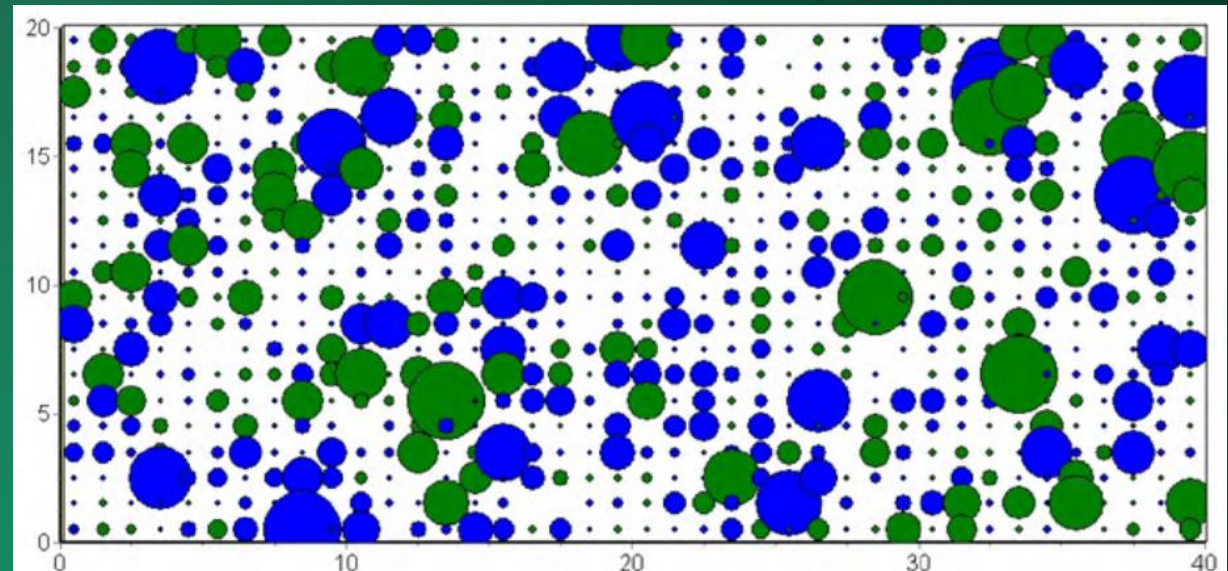
Étude des processus

(Dornelas, 2010 ; Chalamandrier *et al.*, 2013 ; Münkemüller *et al.*, 2015)

Prédiction

Modèles nuls

Évaluation des méthodes  
statistiques



(Dislich *et al.*, 2010)

# Pourquoi simuler en écologie des communautés et métacommunautés ?

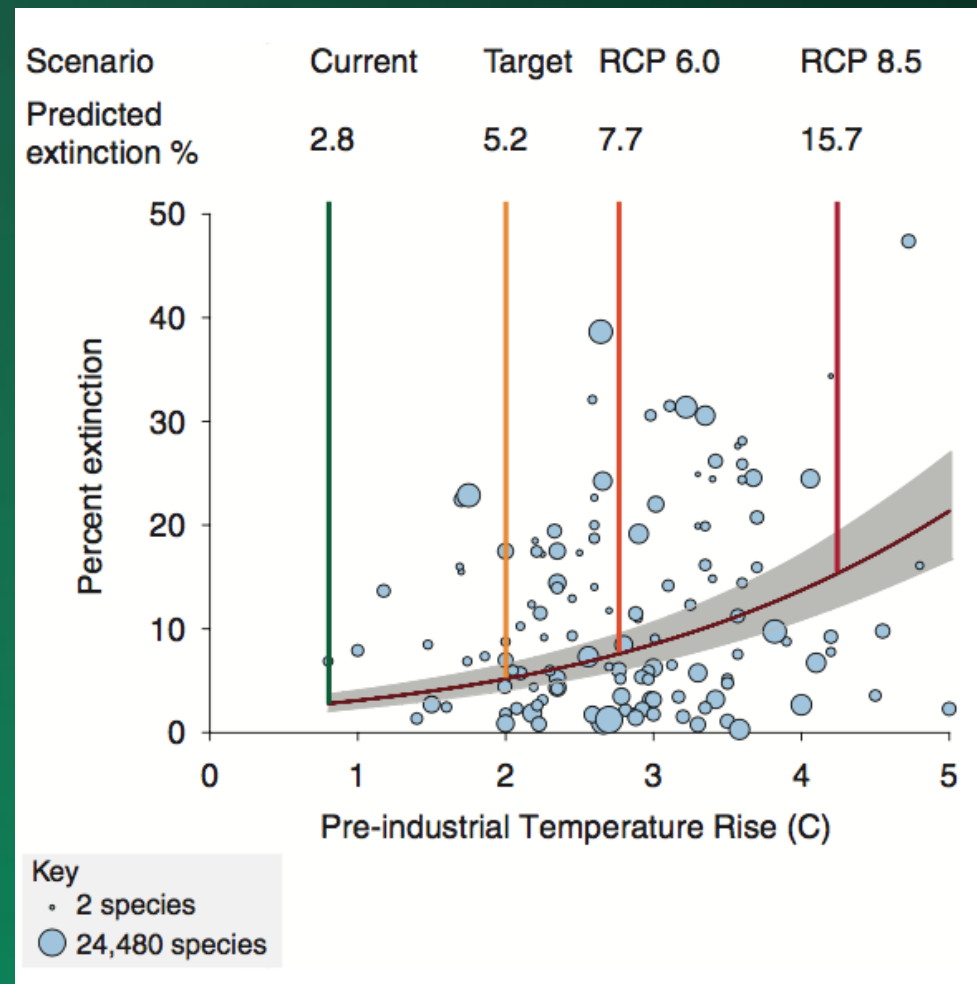
Étude des processus

Prédiction

(Snell *et al.*, 2014 ; Keith *et al.*, 2008 ;  
Elith *et al.*, 2009; Schnell *et al.*, 2013)

Modèles nuls

Évaluation des méthodes  
statistiques



(Urban, 2015)

## Pourquoi simuler en écologie des communautés et métacommunautés ?

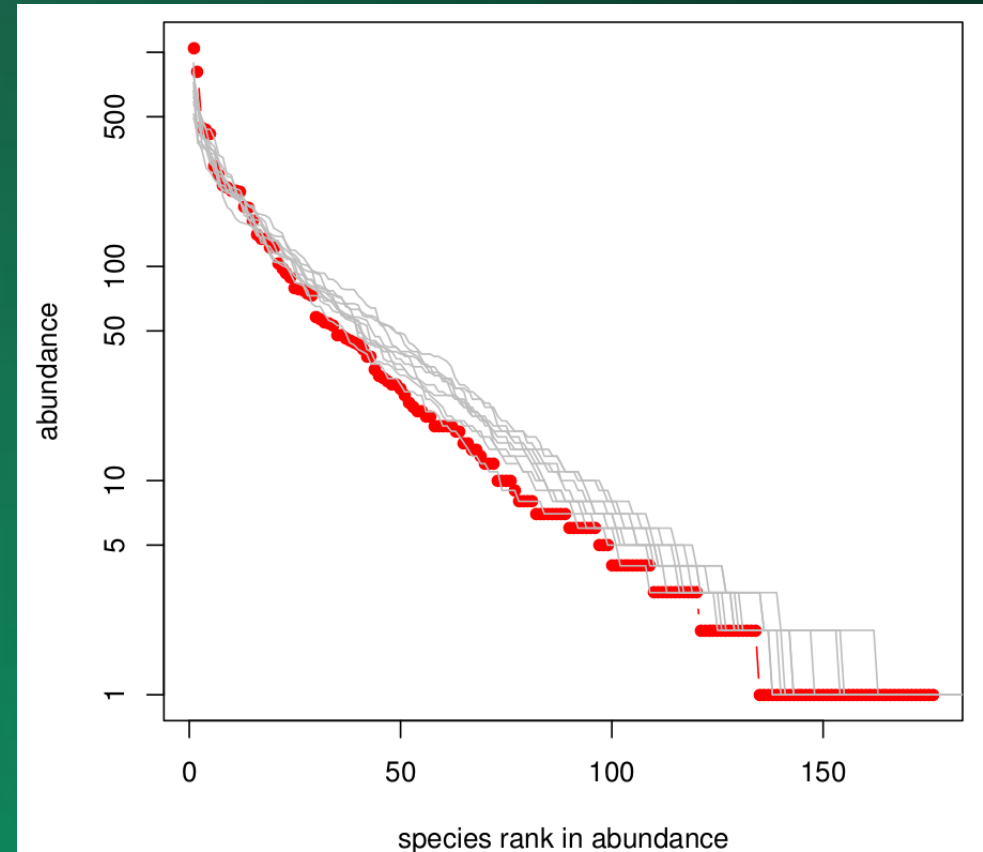
Étude des processus

Prédiction

Modèles nuls

(Caswell, 1976 ; Colwell & Winkler 1984;  
Gotelli & Graves 1996 ; Büschke, 2015 )

Évaluation des méthodes  
statistiques



(Hankin, 2007)

# Pourquoi simuler en écologie des communautés et métacommunautés ?

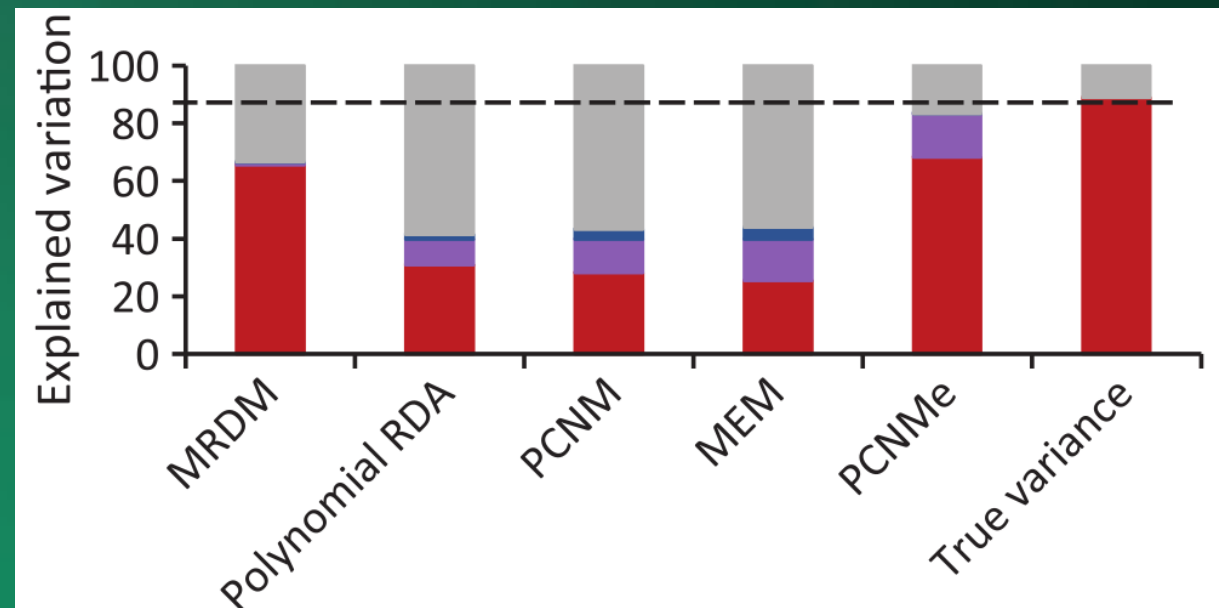
Étude des processus

Prédiction

Modèles nuls

Évaluation des méthodes  
statistiques

(Smith and Lundholm, 2010 ; Botta-Dukat  
and Czucz, 2016 ; Brown *et al.* 2016 ... )



(Gilbert and Bennett, 2010)

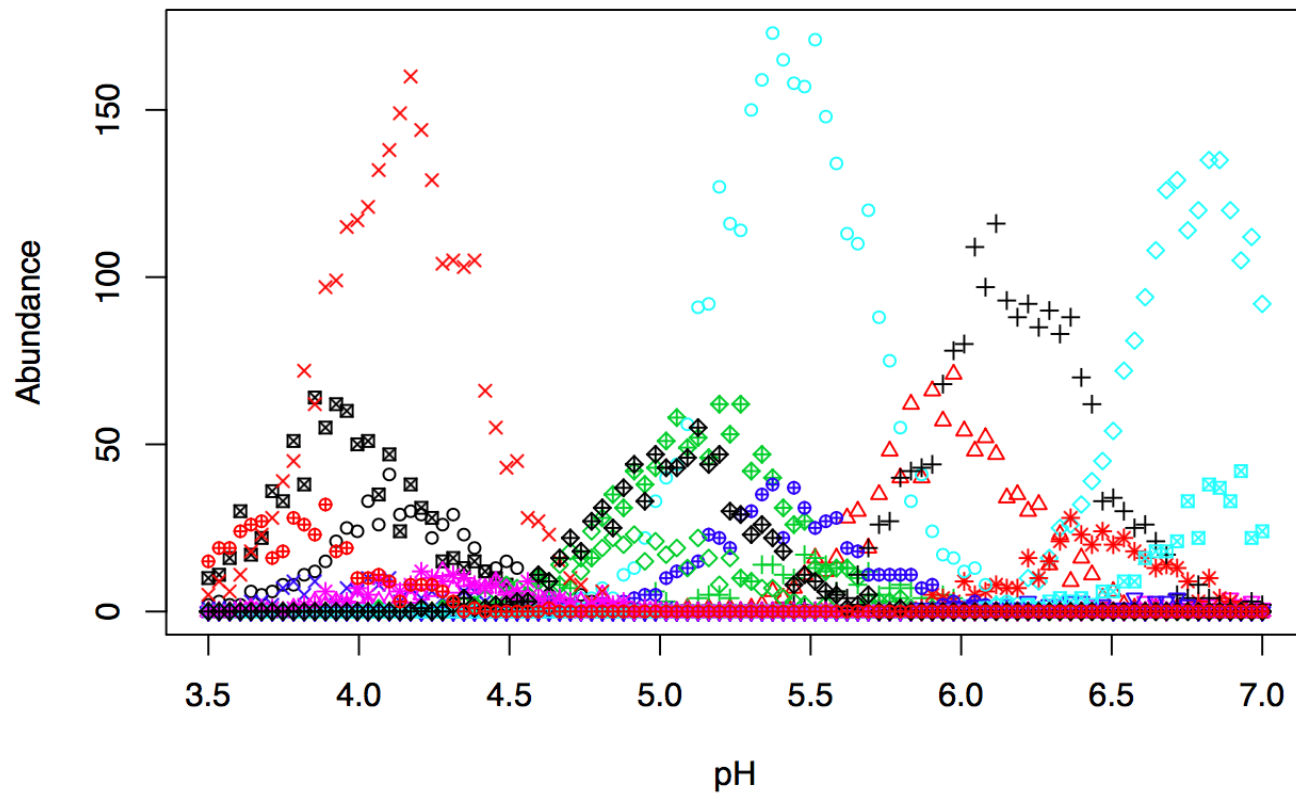
# Simuler dans R : packages disponibles

La catégorie à part...

coenocliner  
(Simpson *et al.*,  
2014)

SimAssem  
(Reese *et al.*, 2013)



Coenocliner (Simpson *et al.*, 2014)

Simulation sur  
gradient

Données  
d'abondance ou  
présence-  
absence

SimAssem (Reese *et al.*, 2013)

File Iterations Parameters Help

Input an encounter history file: Encounter history file  
 Use a fixed seed (deterministic results)

**Species richness parameters**

Number of species: 50 k: 0.5  
 Total abundance: 5000 x: 0.99  
 Abundance model: Particulate-niche Theta: 5.2

**Spatial configuration parameters**

Spatial configuration: Clustered (assemblage-wide)  
**Clustered**  
 Max. number of seeds: 5  
 Omega: 0.001 Site fidelity: 0.9  
 Tau: 0.02 D: 0.9

**Detection probability parameters**

Species third:	Alpha	Beta
Fixed detection probability:		
First	1	3
Second	1	1
Third	6	2

**Survey design parameters**

Survey design: Random  
 Number of cells to survey: 150  
 Minimum number of transects: 5

Output encounter history file for EstimateS: EstimateS encounter history file  
 Output encounter history file for SPADE: SPADE encounter history file  
 Output encounter history file for MARK: MARK encounter history file  
 Output file of estimates: Output file of species richness and other estimates  
 Output file at level of the individual: Output file with individual-level data  
 Output file for accumulation curve: Output file with accumulation curve data

Clark/Evans naive, Donnelly, & cdf aggregation indices: 0.677433012321353, 0.673472210342477, 0.602220884028756  
 Number of surveys with encounters: 17  
 Total # indiv encountered: 36  
 Number of species encountered: 23  
 Bootstrap: 29.2701598844223  
 Bootstrap(sd): 3.09689421407776  
 Bootstrap 95% C.I.: [25.5094444816817, 38.6667761583122]  
 The bootstrapped Bootstrap estimate = 53.5364962180395  
 Jack1: 38  
 Jack1(sd): 5.47722557505166

**SimAssem[1]**

**Interface Virsual Basic**

RUN

EXIT

## Simuler dans R : packages disponibles

La catégorie à part...

coenocliner  
(Gavin L. Simpson)

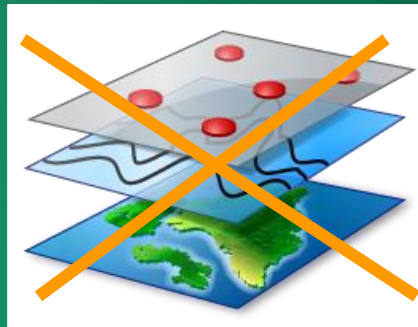
SimAssem  
(Reese *et al.*, 2013)



Aucune  
génération



Non basé  
sur l'individu



Spatialement  
implicite

# Simuler dans R : packages disponibles

La catégorie à part...



Aucune  
génération

coenocli  
(Gavin L. S)

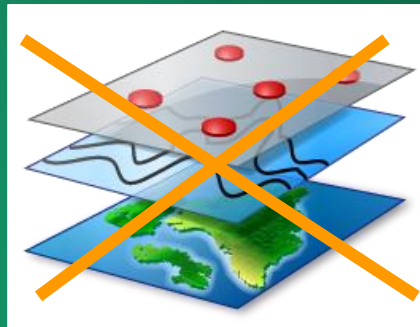
Modèles nuls & évaluation de méthodes

basé  
sur l'individu

SimAssem  
(Reese *et al.*, 2013)






basé  
sur l'individu



Spatialement  
implicite

## Simuler dans R : packages disponibles

La catégorie à part...

	Citations pour simulation	
coenocliner (Simpson <i>et al.</i> , 2014)	2	
		
SimAssem (Reese <i>et al.</i> , 2013)	0	

Modèles nuls &amp; évaluation de méthodes

## Simuler dans R : packages disponibles

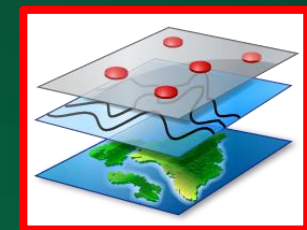
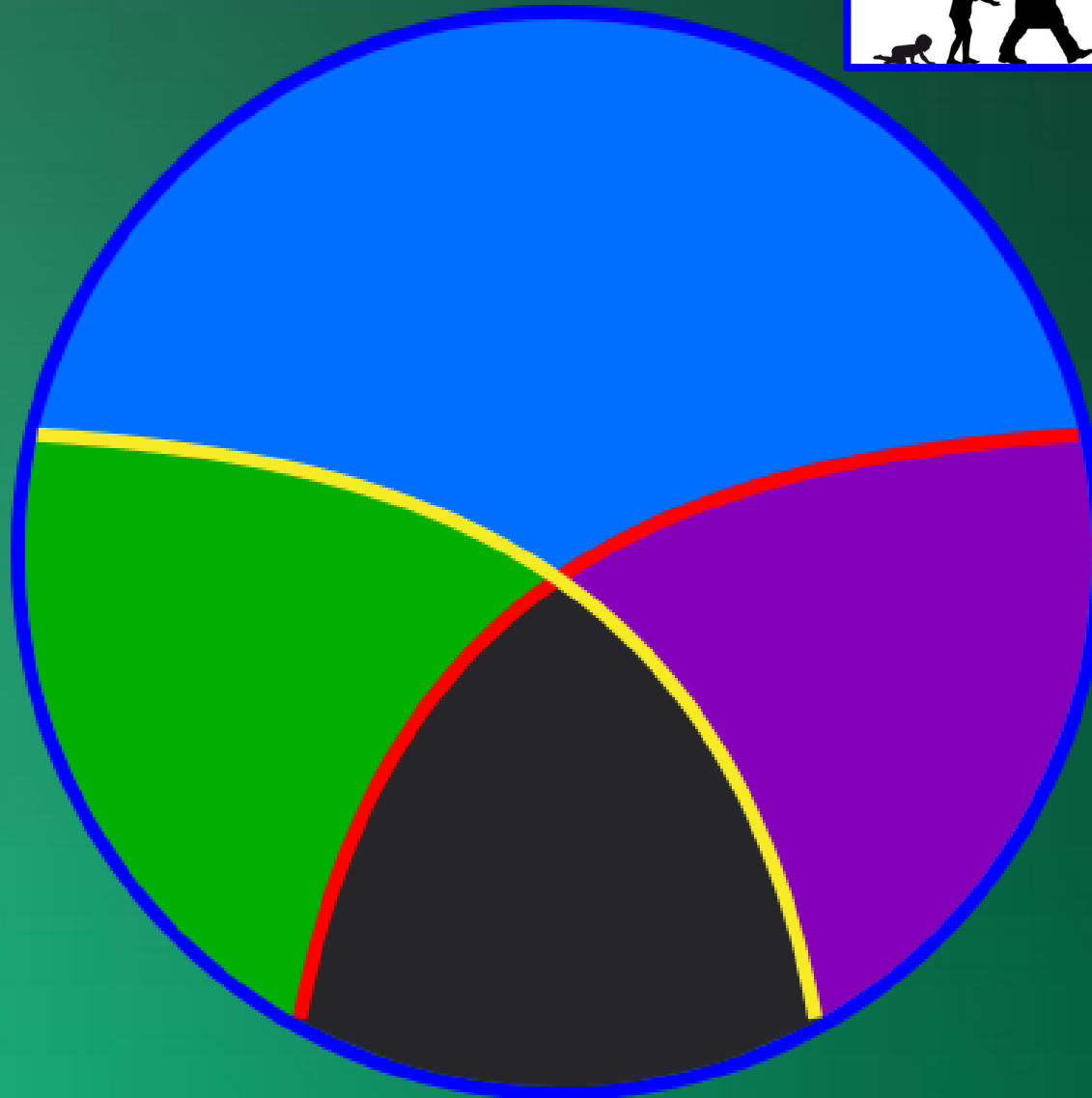
Et les autres ?



Avec  
générations



Basé sur  
l'individu



Spatialement  
explicite

## Simuler dans R : packages disponibles

Et les autres ?



Avec  
générations

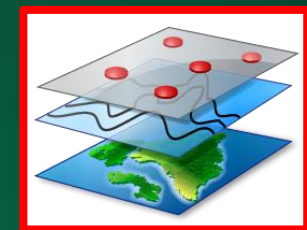
pez  
(Pearse *et al.*, 2015)

untb  
(Hankin, 2007)

mizer  
(Scott *et al.*, 2014)

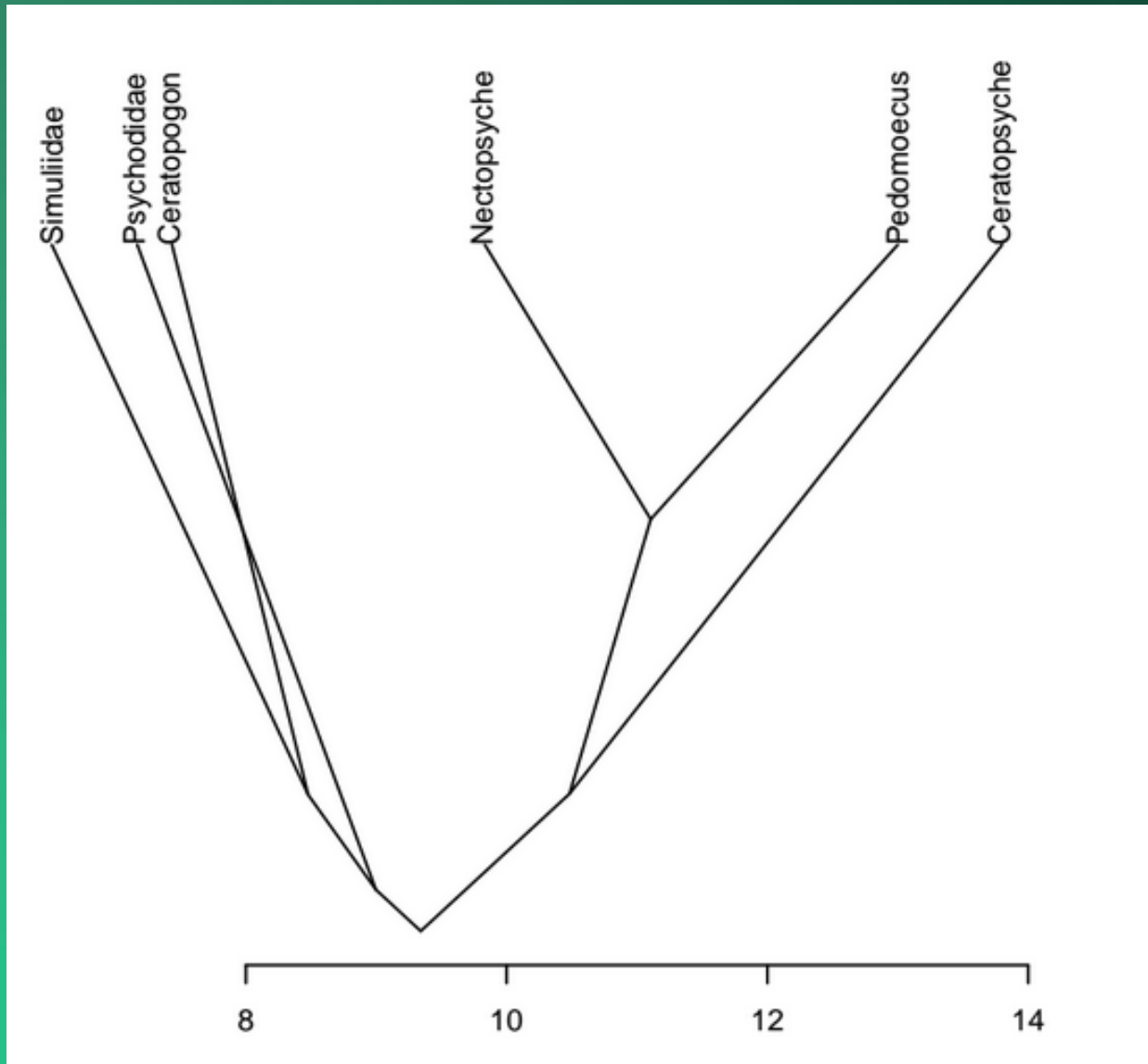


Basé sur  
l'individu



Spatialement  
explicite

pez (Pearse *et al.*, 2015)



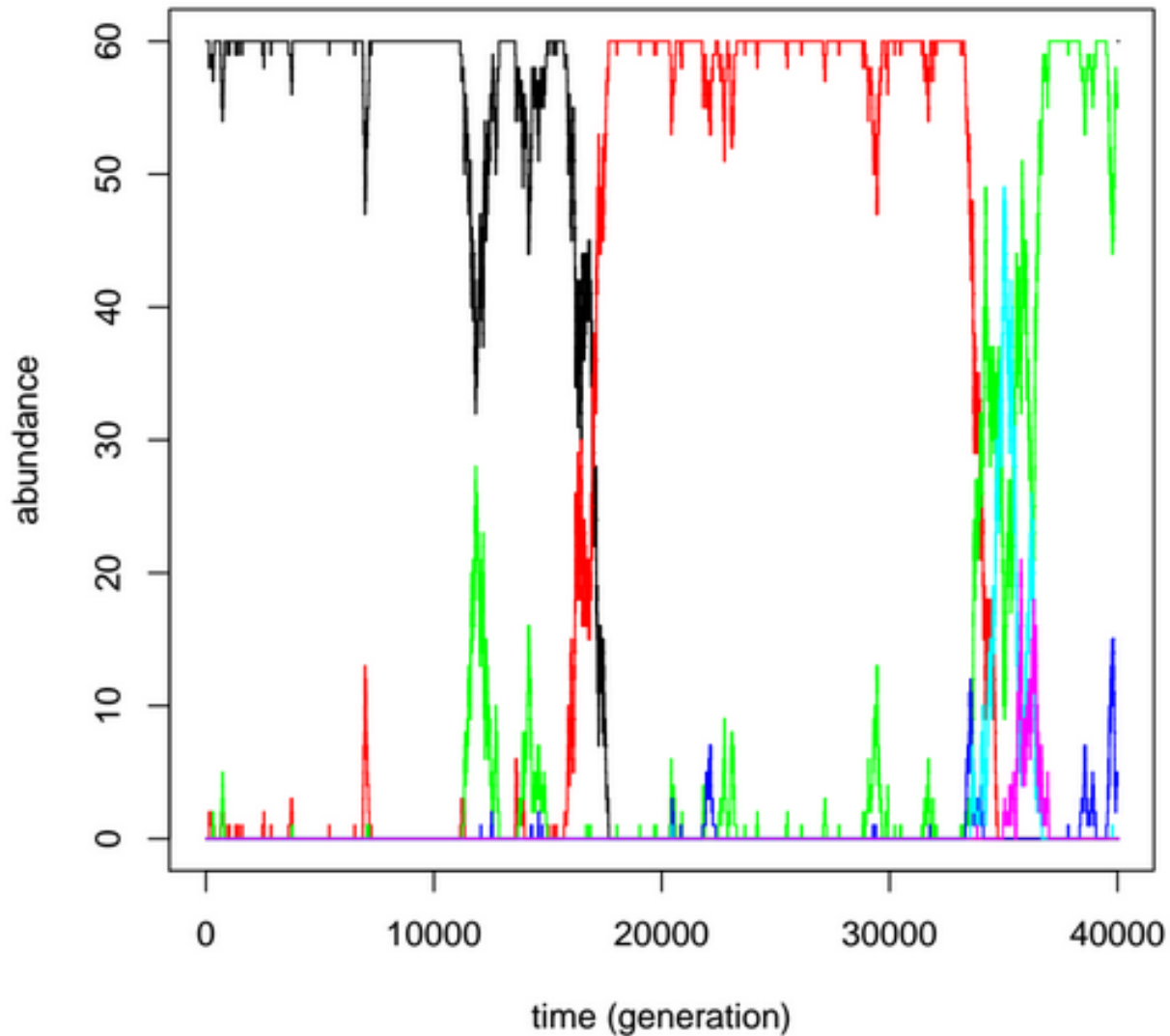
`sim.meta()`

`sim.phy()`

`scape()`



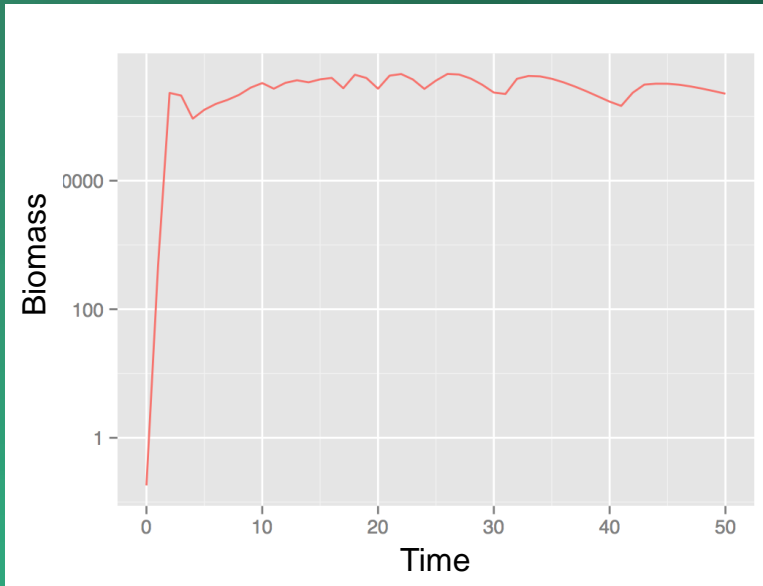
## untb (Hankin, 2007)



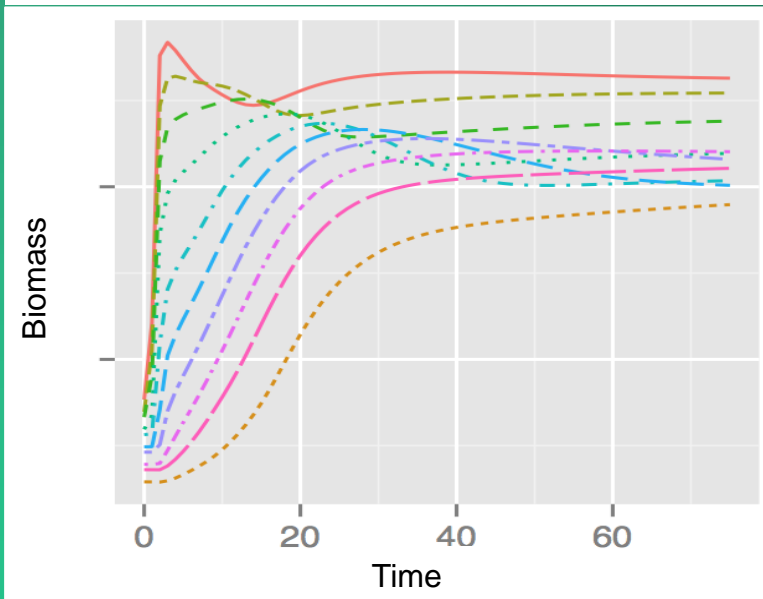
simulations de  
communautés neutres

untb()

mizer (Scott *et al.*, 2014)



Simulation mono-  
espèce



Simulation avec  
traits

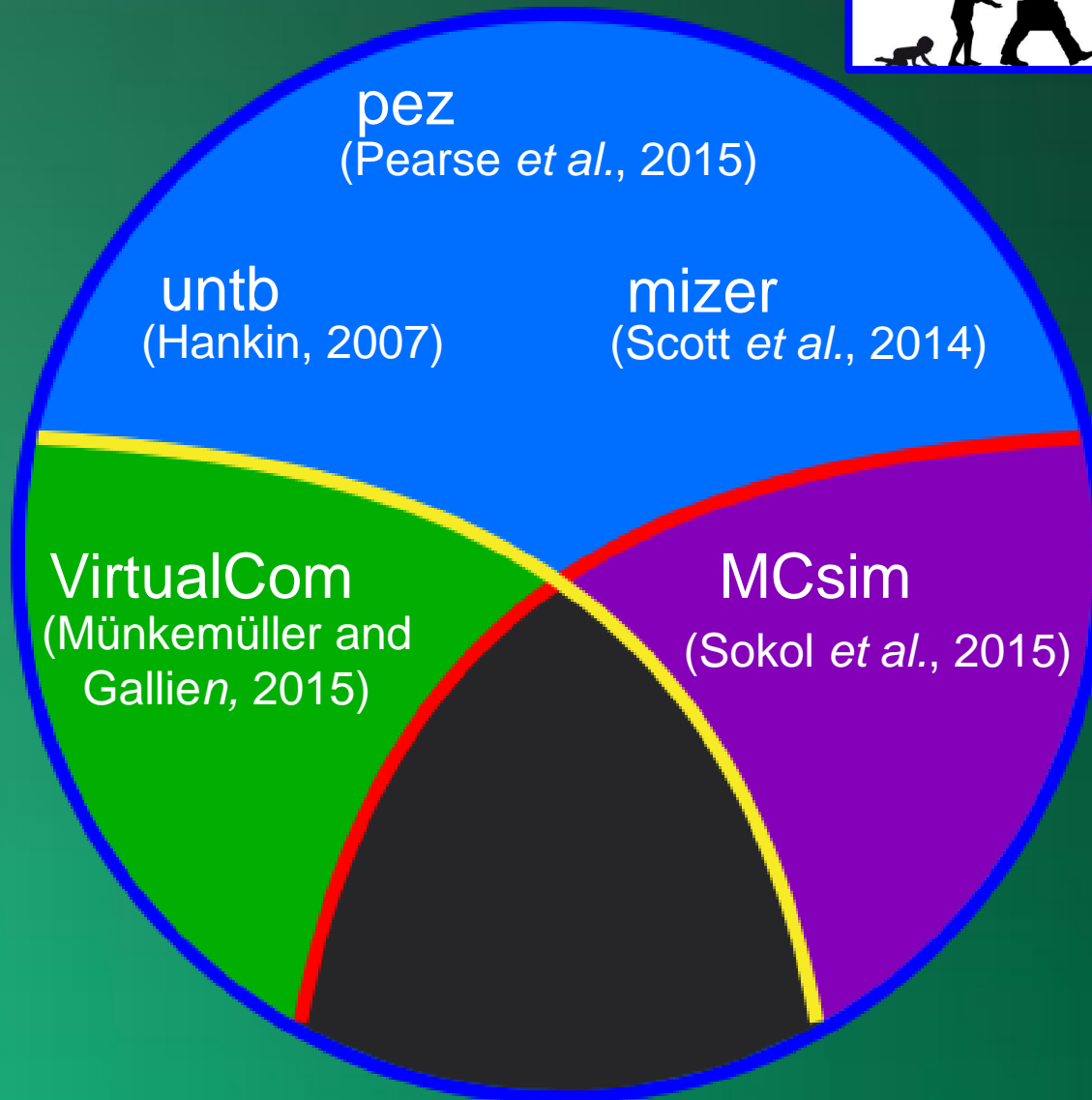
Simulation multi-  
espèces

# Simuler dans R : packages disponibles

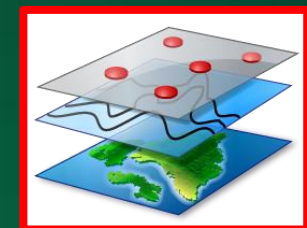
Et les autres ?



Avec  
générations



Basé sur  
l'individu



Spatialement  
explicite

## Simuler dans R : packages disponibles

Et les autres ?



Avec  
générations

pez  
(Pearse *et al.*, 2015)

untb  
(Hankin, 2007)

mizer  
(Scott *et al.*, 2014)

VirtualCom  
(Münkemüller and  
Gallien, 2015)

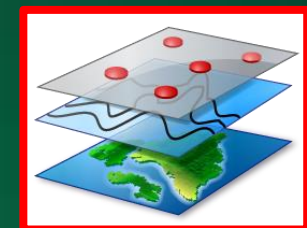
MCsim  
(Sokol *et al.*, 2015)

RNETLOGO  
(Thiele, 2016)

neutral.vp  
(Smith and Lundholm,  
2010)



Basé sur  
l'individu



Spatialement  
explicite

## RNetLogo (Thiele., 2014)

The image displays two overlapping windows. The left window is RGui, showing the R Console with the following text:

```
Platform: i386-pc-mingw32/i386 (32-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> library(RNetLogo)
Loading required package: rJava
> NLStart("C:/Program Files/NetLogo 4.1.2")
> NLLoadModel("C:/Program Files/NetLogo 4.1.2/models/Sample Models$
> NLCommand("set density 77")
> NLCommand("setup")
> NLCommand("go")
> NLCommand("print \"Hello NetLogo, I called you from R.\")
> density_in_r <- 88
> NLCommand("set density ", density_in_r, "setup", "go")
> NLDoCommand(10, "go")
> NLReport("ticks")
[1] 11
> ticks <- NLReport("ticks")
> print(ticks)
[1] 11
>
```

The right window is NetLogo, titled "Fire - NetLogo [C:\Program Files\NetLogo 4.1.2\models\Sample Models\Earth Science]". It shows a 3D view of a forest fire simulation. The interface includes a "density" slider set to 88%, a "percent burned" display showing 4, and a "ticks: 11" indicator. The simulation area is mostly green with a vertical red strip on the left. The Command Center at the bottom shows the message "Hello NetLogo, I called you from R." and the prompt "observer >".

# Simuler dans R : packages disponibles

Et les autres ?



Avec  
générations

pez  
(Pearse *et al.*, 2015)

Études des processus  
Modèles nuls  
Évaluation de méthodes



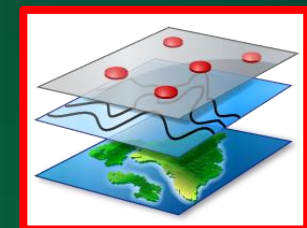
Basé sur  
l'individu

virtualCOM  
(Münkemüller and Gallien, 2015)

MCSIM  
(Sokol *et al.*, 2015)

RNETLOGO  
(Thiele, 2016)

neutral.vp  
(Smith and Lundholm, 2010)



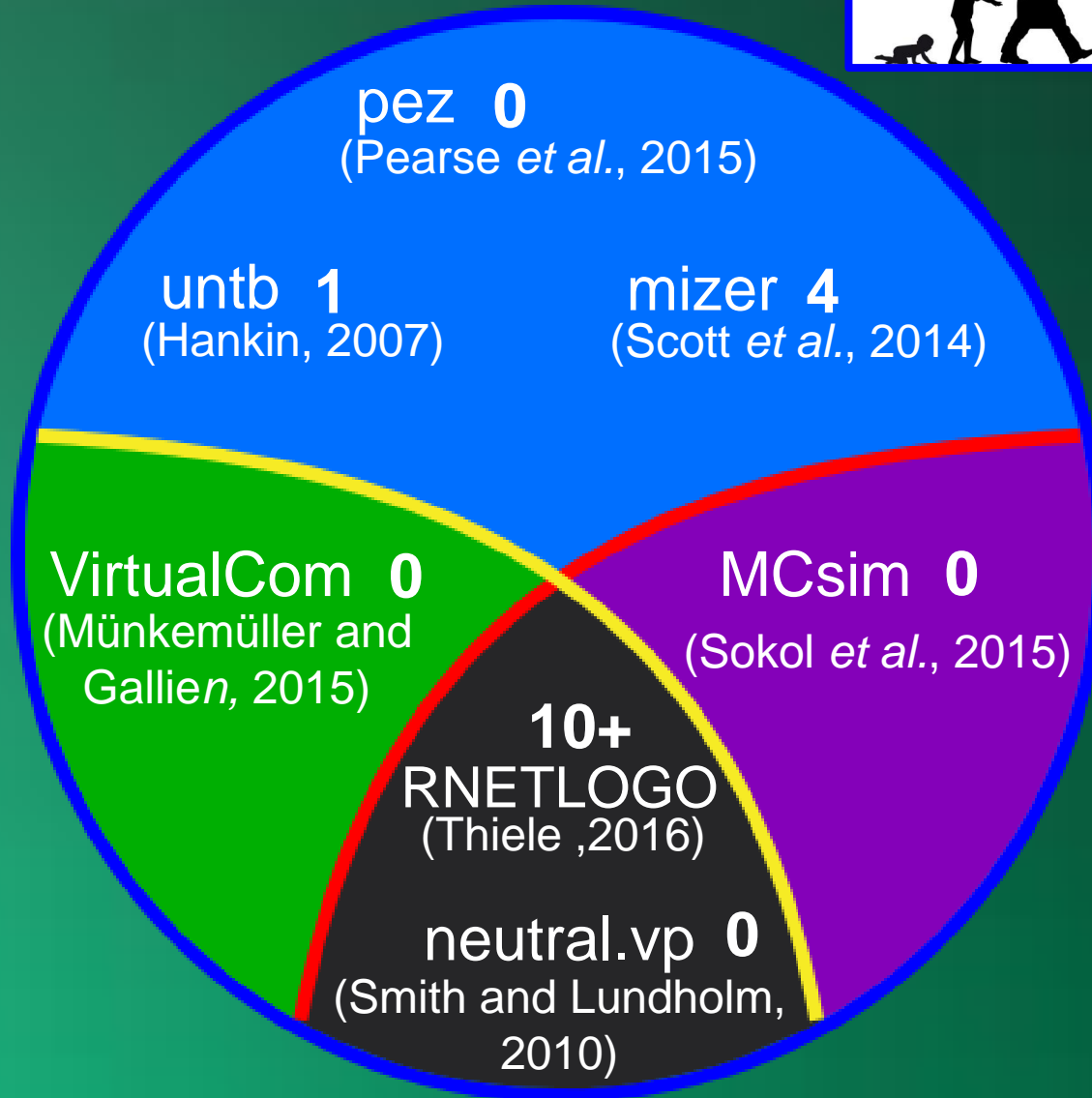
Spatialement  
explicite

## Simuler dans R : packages disponibles

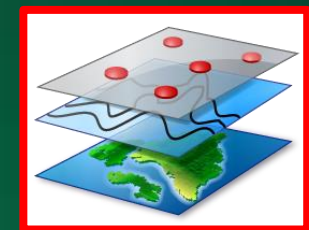
Et les autres ?



Avec  
générations



Basé sur  
l'individu



Spatialement  
explicite

# Simuler dans R : packages disponibles

Facile d'utilisation ?

untb MCsim

pez

mizer

neutral.vp

VirtualCom

RNETLOGO

Simplicité

Flexibilité





# Simuler dans R : packages disponibles

Facile d'utilisation ?



Simplicité

untb MCsim

pez  
mizer

neutral.vp

VirtualCom  
RNETLOGO

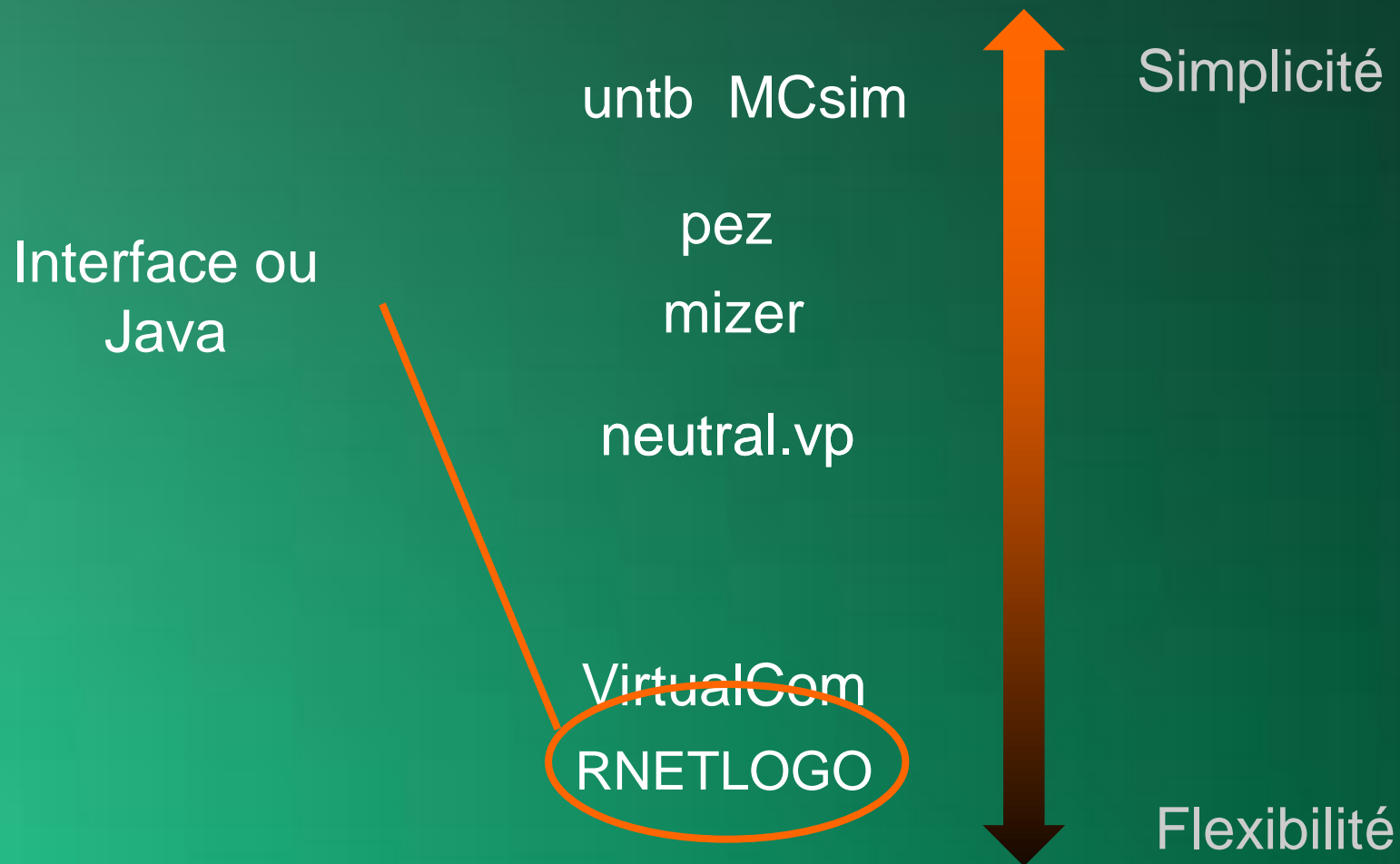
Flexibilité

Pas de vignette  
disponible



# Simuler dans R : packages disponibles

Facile d'utilisation ?



# Simuler dans R : packages disponibles

Facile d'utilisation ?

Simplicité

untb MCsim

pez

mizer

neutral.vp

VirtualCom

RNETLOGO

Flexibilité



Plus disponible sur R



# Simuler dans R : packages disponibles

Facile d'utilisation ?

Simplicité

untb MCsim

pez

mizer

simCom

VirtualCom

RNETLOGO

Flexibilité

Disponible bientôt...  
(Clappe *et al.*, 2017, en  
préparation)



## lottery package: simulation and assessment of neutral and niche-based dynamics in ecological communities

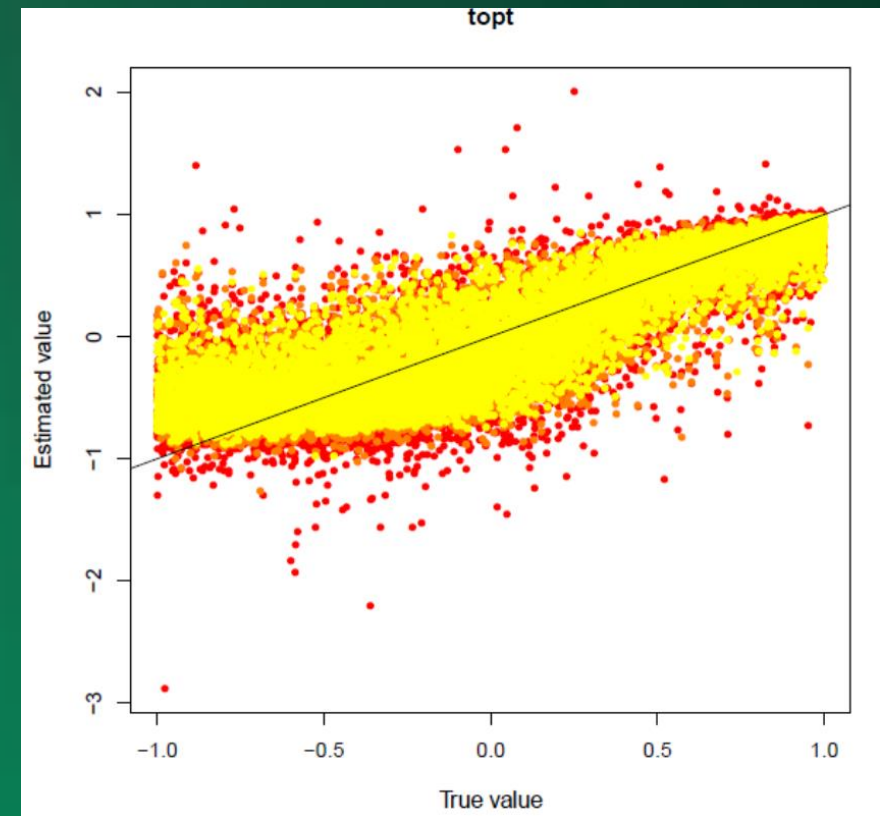
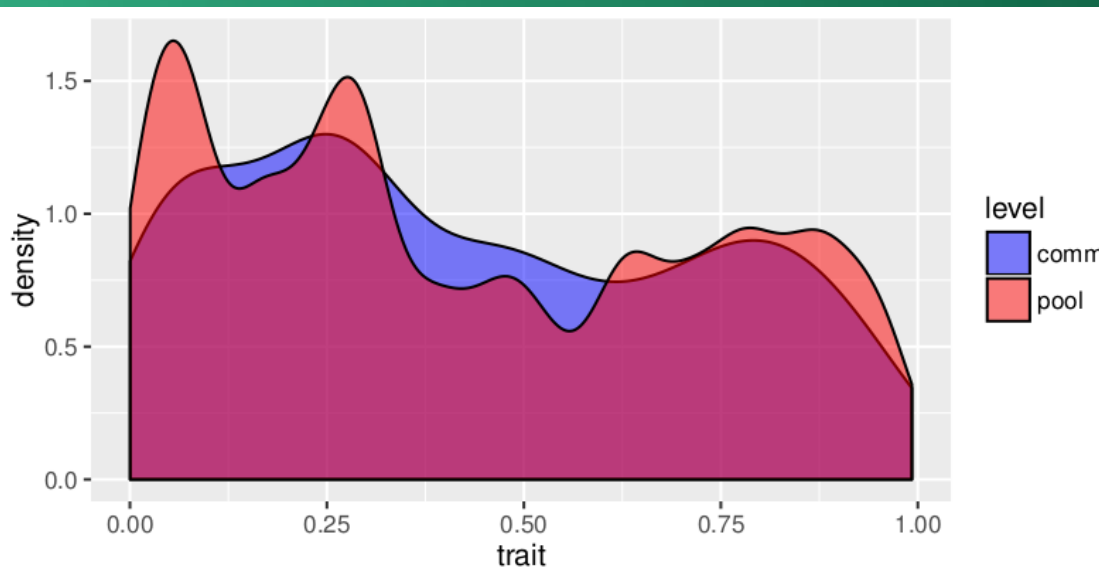
François Munoz<sup>1,2</sup>, Adrien Taudière<sup>3</sup>, Fabien Laroche<sup>3,4</sup>, Matthias Grenié<sup>3</sup>, Pierre Denelle<sup>3</sup>, Caroline Tucker<sup>3</sup> and Cyrille Violle<sup>3</sup>

<sup>1</sup> University of Montpellier, AMAP, Bd. de la Lironde, Montpellier, France

<sup>2</sup> French Institute of Pondicherry, 11 Saint Louis Street, 605001 Pondicherry, India

<sup>3</sup> Centre d'Ecologie Fonctionnelle et Evolutive, 1919 route de Mende, Montpellier, France

<sup>4</sup> Irstea, UR EFNO, Centre de Nogent-sur-Vernisson, France



## Packages disponibles peu utilisés

## Nouveaux modèles continuellement développés

### Simulation model of a subdivided community

To verify the statistical properties of tests of community phylogenetic structuring, **I developed an individual-based model** of a locally neutral community subdivided into  $n$  sites. Each

(Hardy, 2008)

(Jabot, 2010)

### A B S T R A C T

**I present a model of stochastic community dynamics** in which death occurs randomly in the community, propagules disperse randomly from a regional pool, and recruitment of new individuals of a species is proportional to the species local abundance multiplied by its local competitive ability. The

connectivity among localities. These ingredients contribute to coexistence across spatial scales via species sorting, patch dynamics, mass effects and neutral dynamics. These mechanisms however seldom act in isolation and the impact of landscape configuration on their relative importance remains poorly understood. **We present a new model of metacommunity dynamics** that simultaneously considers these four possible mechanisms over spatially explicit landscapes and propose a statistical approach to partition their contribution to species distribution. We find that landscape configuration can induce

(Fournier, 2016)

## simecol (Petzoldt, 2007)

Structure générique

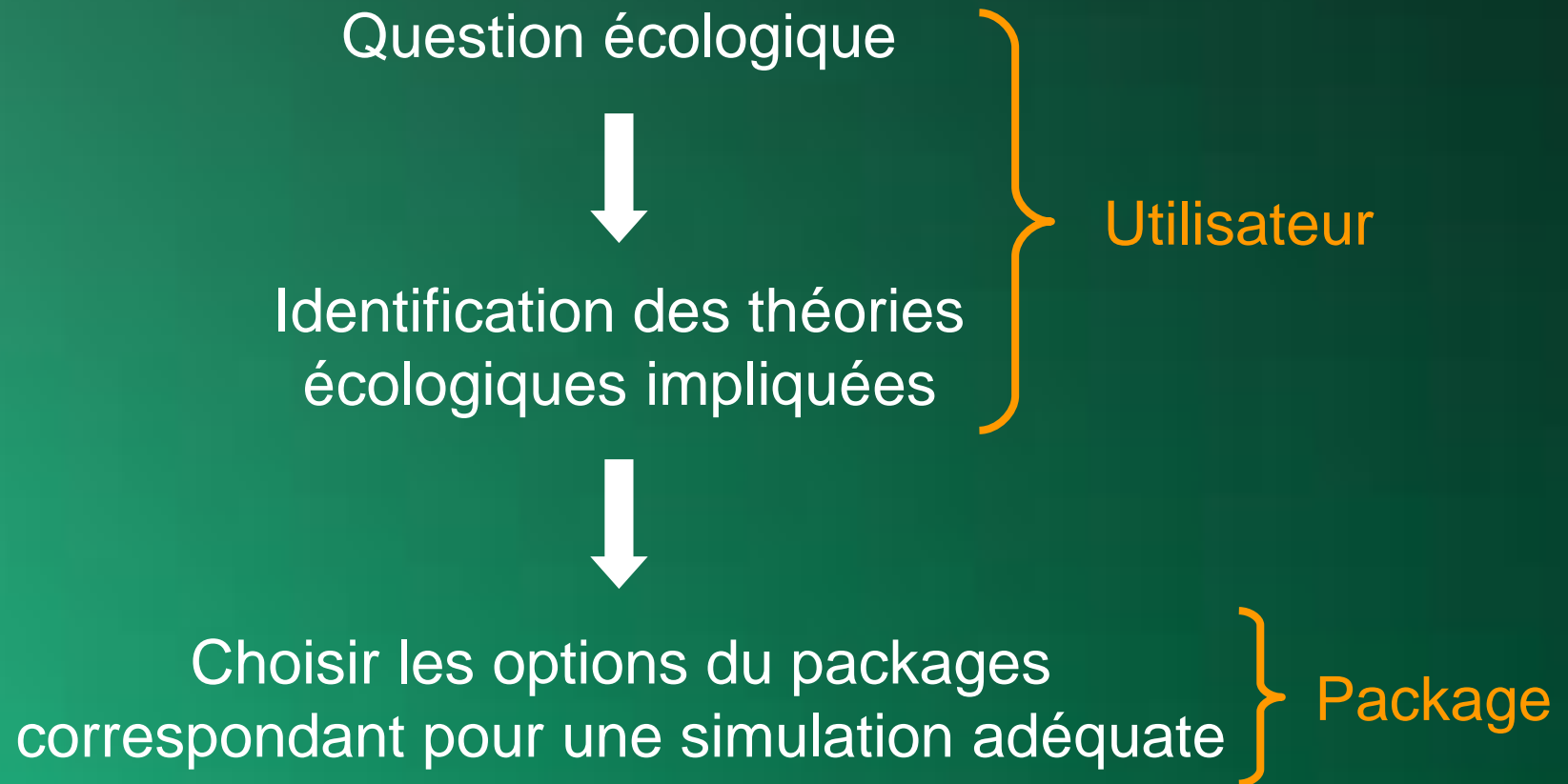
Compréhensibilité des modèles

Réutilisation des modèles

Package sœur : simecolModels

<b>simObj</b>	
main:	function
equations	list
times:	numeric
init:	ANY
parms:	ANY
inputs:	ANY
solver:	character
out:	ANY
initfunc:	function

Projet de package commun pour les simulations en écologie des communautés et métacommunautés





# Merci de votre attention

