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Modeling the dynamics of microhabitats

Benoît Courbaud, Laurent Larrieu, Anthony Letort, Francois Rouault de Coligny

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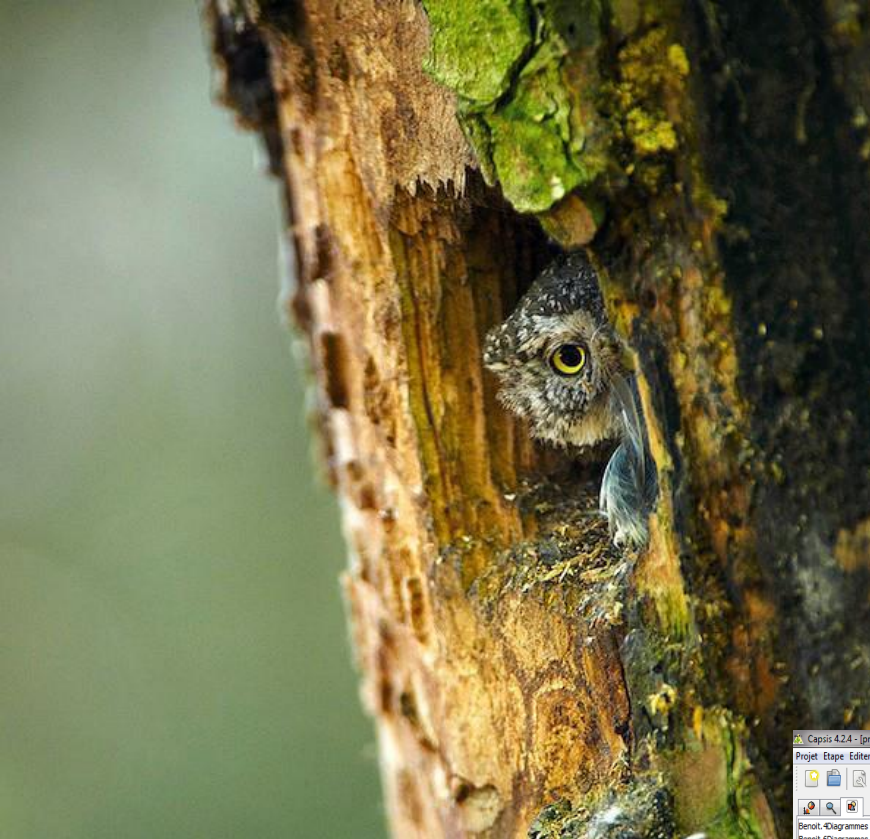
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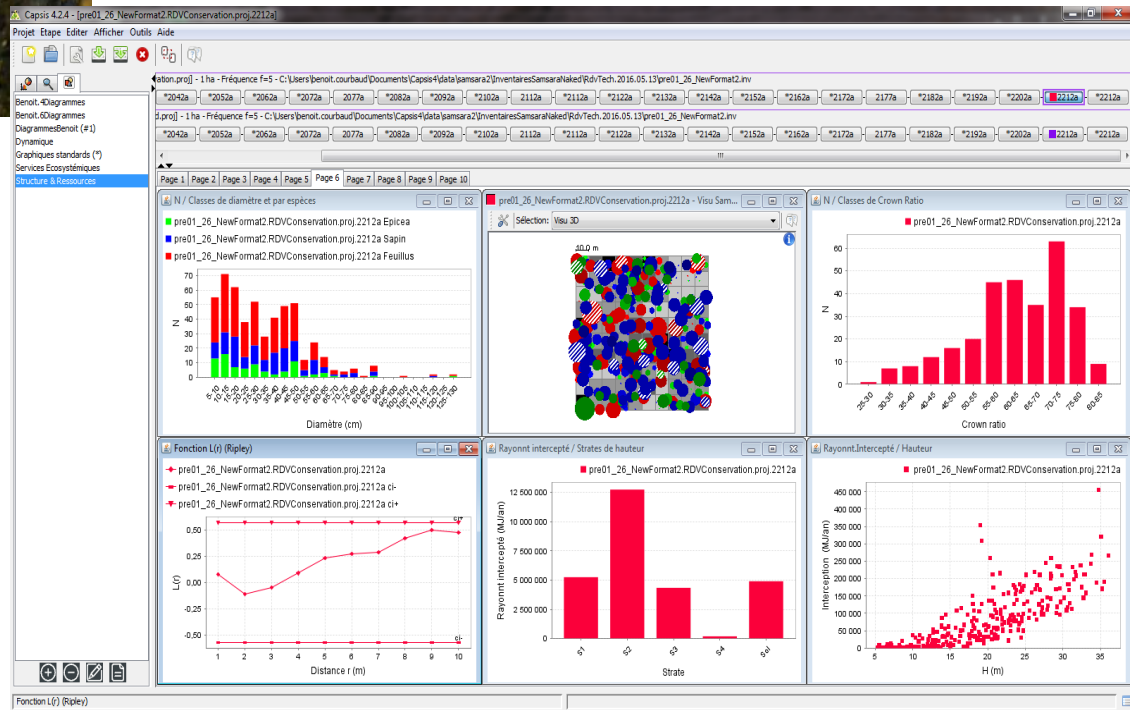
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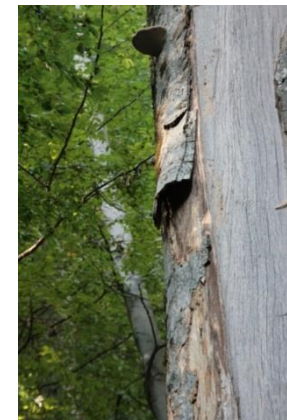
Modeling the dynamics of microhabitats

Integrate+ Conference 2016

Benoit Courbaud
 Laurent Larrieu
 Anthony Letort
 François de Coligny



Sustainable forest biodiversity conservation requires
the maintenance of a permanent flux of TreMs
-> We need a balance
between TreM formation and TreM disappearance rates



Available TreM data today are cross sectional :

Observations of TreMs on different trees at a single time
The rate of TreM formation is not measured directly



Can we estimate the probability of TreM formation on a tree ?

Can we integrate a TreM submodel
in a forest dynamics simulator ?



Indirect estimation methods are required:

We hypothesize a model for the probability of TreM formation

We calculate the probability of observing the data given the process model and estimate the parameters of the model

A harmonized data base of expert data in Europe:

~ 30 000 trees / 12 tree species / 106 sites / 8 types of TreMs

Presence/Absence of TreMs on trees

covariables: tree DBH / tree species / site



Survival analysis : indirect method to estimate the time of a discrete event

Transposition to our case:

D : random variable corresponding to the DBH at which the first TreM forms

F(d): Cumulated Distribution Function (CDF) of the random variable D.

Corresponds to the probability of presence of at least one TreM on a tree

$$F(d) = P(D \leq d)$$

h(d): Hazard rate function of the random variable D

Probability of formation of the first TreM on a tree that has no TreM yet

$$h(d)\partial d = P(D \in [d, d + \partial d[\mid D \geq d)$$

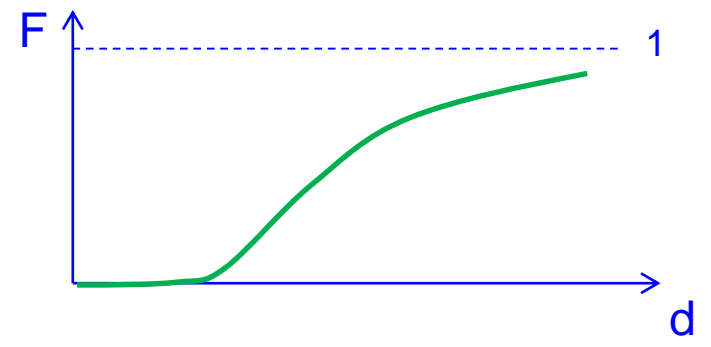
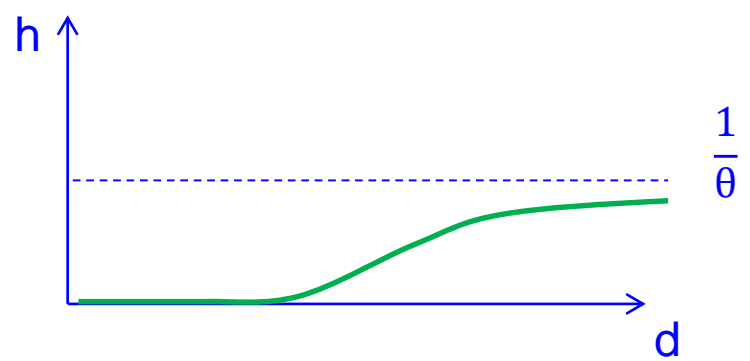
(Courbaud et al. Submitted)

Estimating the probability of TreM formation on a tree

Gamma model : θ regulates the maximum hazard rate
 k regulates how the hazard rate changes with DBH

the process
proba of TreM formation
during a growth step

the result
proba of TreM presence
today



$$\theta_{i,j,s} = e^{\alpha_j + \beta_s + \varepsilon_i}$$

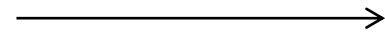
α_j : effect of tree species j

β_s : effect of site s

ε_i : random effect of tree i

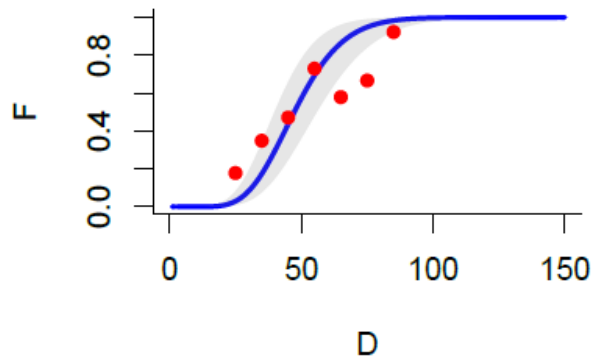
First results

We calibrate
The function F
on presence data

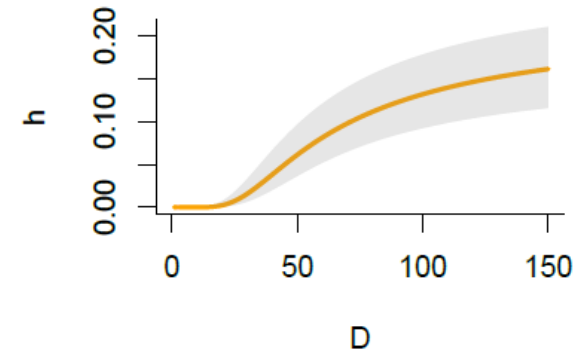


We deduce
The function h
describing the process

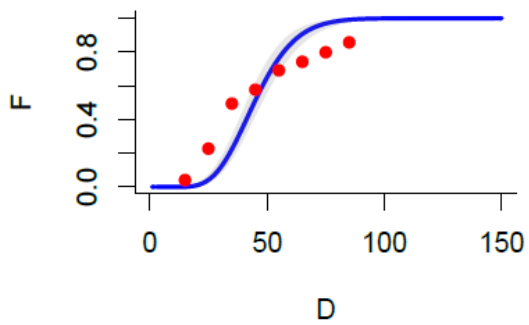
Tours - *Picea abies* (IRSTEALP)



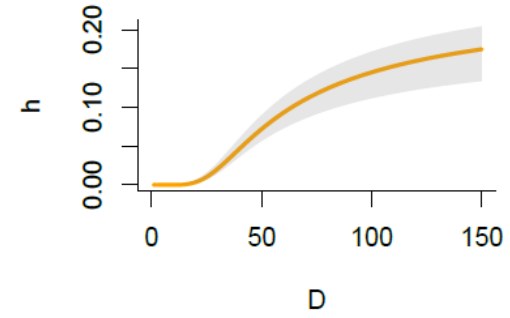
Tours - *Picea abies* (IRSTEALP)



Uholka haP - *Fagus sylvatica* (UH-haP)

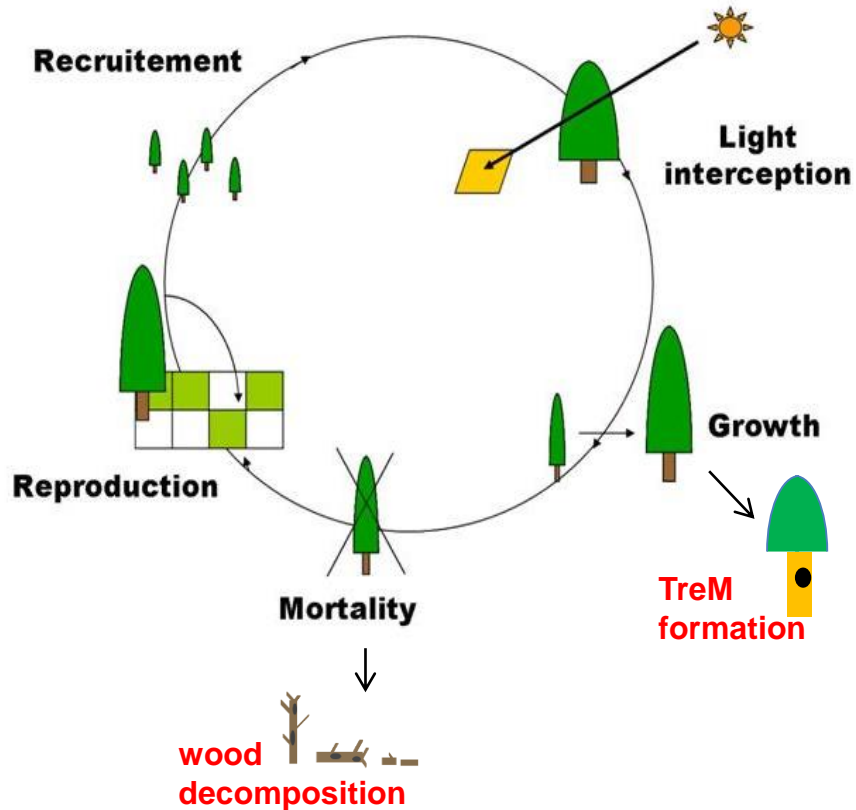


Uholka haP - *Fagus sylvatica* (UH-haP)

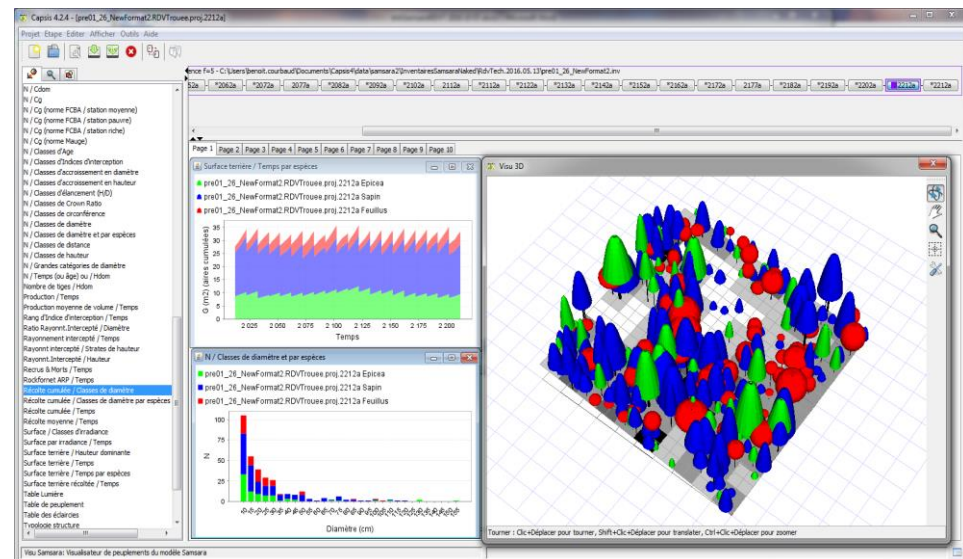


Samsara : an individual-based, spatially explicit simulation model

Courbaud et al., 2003
Courbaud et al. 2015

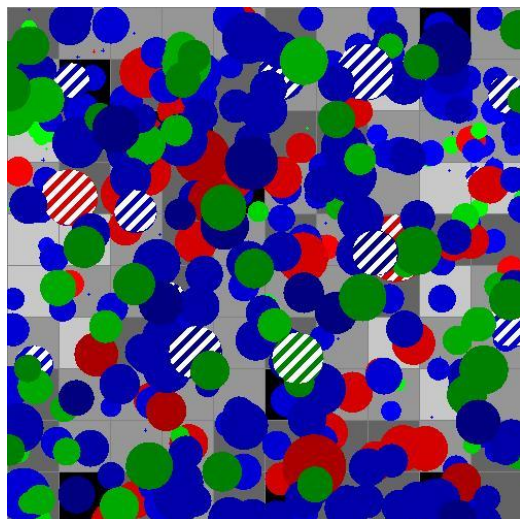


Development platform Capsis

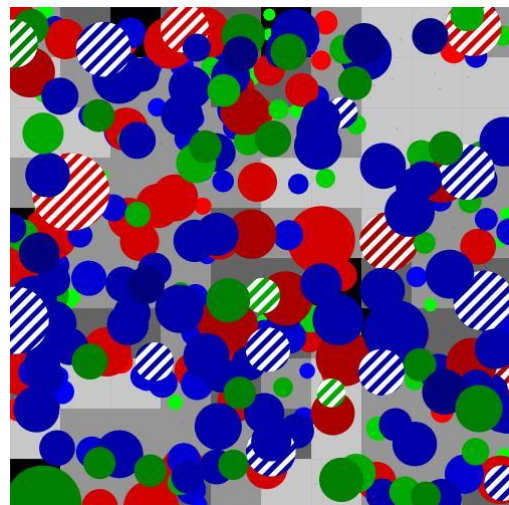


Coligny et al., 2003
Dufour-Kowalski et al. 2012

Long term projection with Samsara

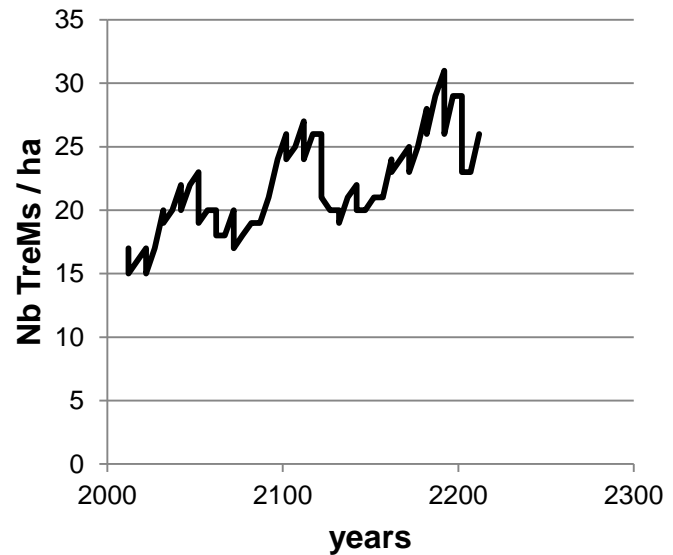


→
200 years

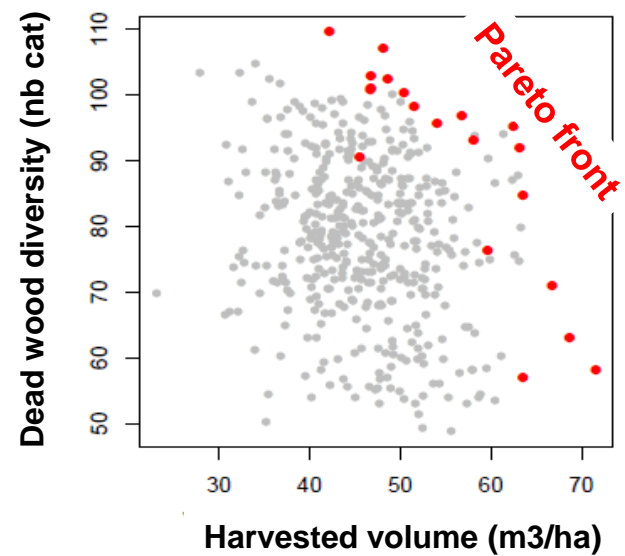


- Spruce
- Fir
- Beech
- Habitat tree
- Light level under canopy

Evolution of TreM density



Production-biodiversity trade-offs




Collaborative approaches are key to

Powerfull data sets

Complex simulation tools

A range of relevant case studies and silviculture scenarios





Thank you for your attention

Collaborations:

Daniel Kraus, Thibault Lachat, Brigitte Commarmot, Yoan Paillet, Nicolas Debaive