



Région Centre



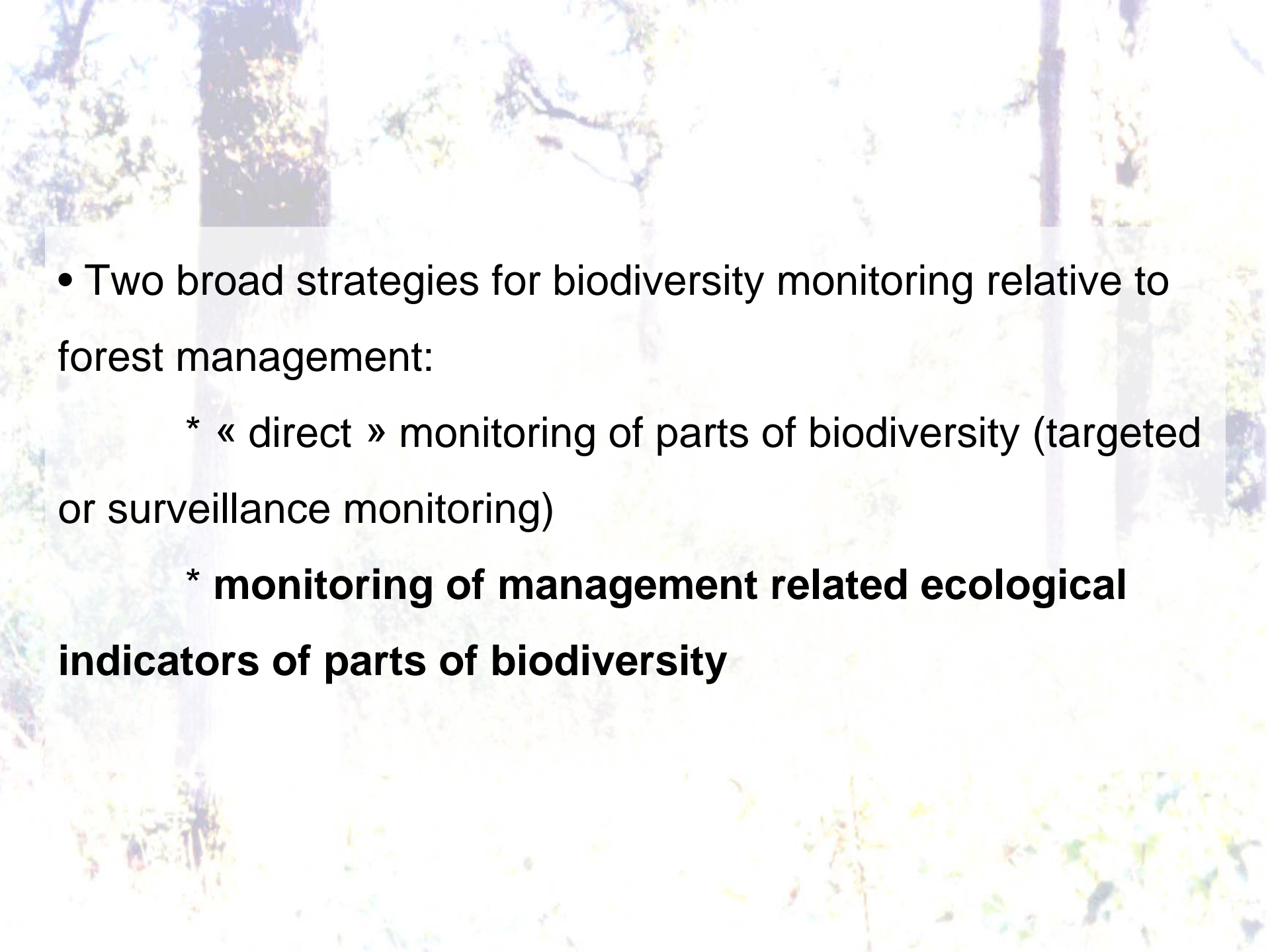
# **Are tree species diversity and dominance good indicators of understory diversity?**

*A case study in French lowland oak forests*

*Frédéric Gosselin, Stéphane Barbier, Richard Chevalier, Laurent Bergès & Philippe Balandier*

*Cemagref*

**Nogent-sur-Vernisson (France)**

- 
- Two broad strategies for biodiversity monitoring relative to forest management:
    - \* « direct » monitoring of parts of biodiversity (targeted or surveillance monitoring)
    - \* **monitoring of management related ecological indicators of parts of biodiversity**

- Lacking for most ecological indicators of biodiversity: their **indicator identity/quality card**:
  - the parts of biodiversity they indicate
  - the shape, direction and magnitude of the correlation
  - the ecological conditions of validity of the relation
- We also need to test **alternative indicators** that might be more relevant for some parts of biodiversity

# Scope of this presentation

We propose that **biodiversity indicators be subject to a quality control, esp. be tested relative to real data by:**

- defining and comparing alternative ecological models in a specific field

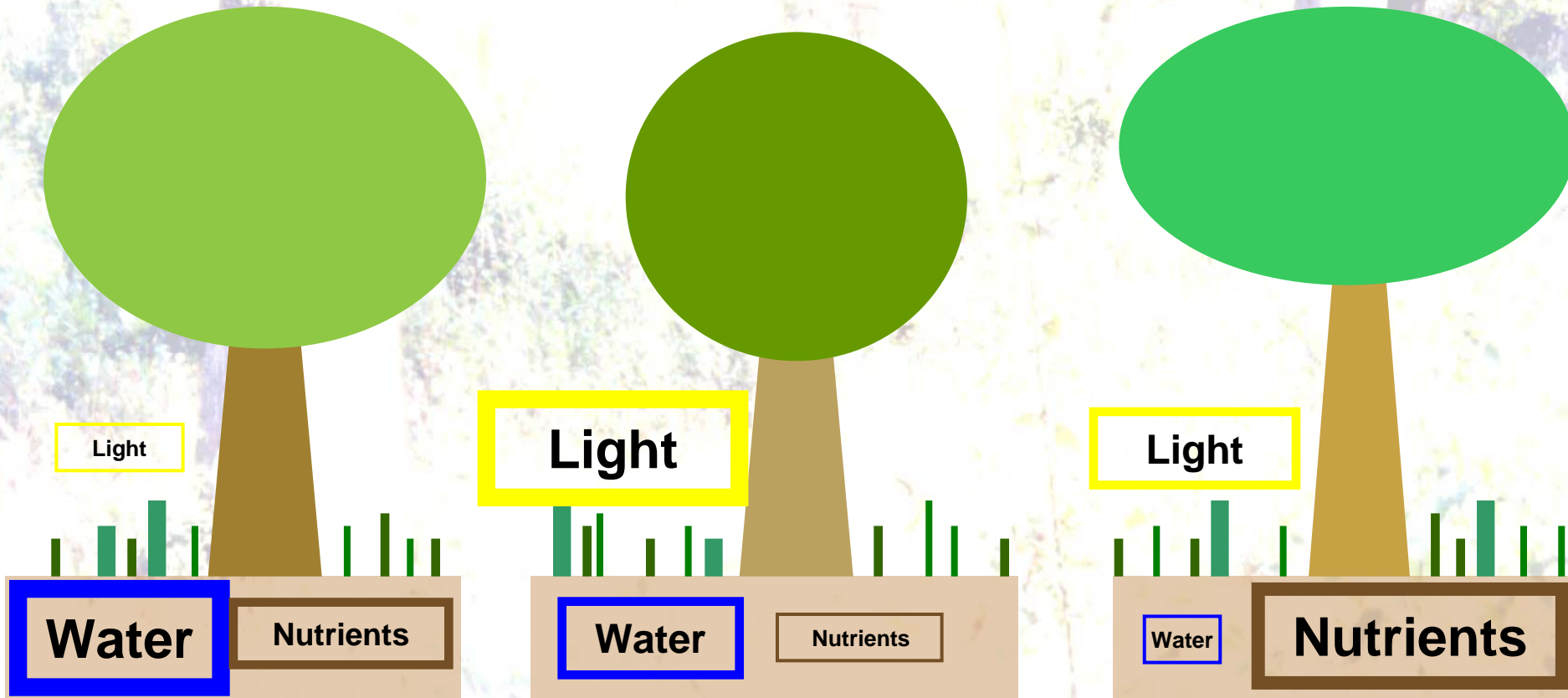
- **analyzing data at biodiversity relevant levels** (species, ecological groups)

- reporting the results in a quantitative manner (**direction and magnitude, confidence interval**)

*Illustrated by a case study on the relation between tree species composition and floristic diversity*

# Resource available for flora vary according to tree species identity and tree species abundance

*Barbier et al. (2008) FEM 254 (1-15)*



**This leads to different models of relation between tree species composition and floristic diversity**

**Tree species  
diversity (TSR  
and -TSDOM)**



**diversity of  
resource  
availability**

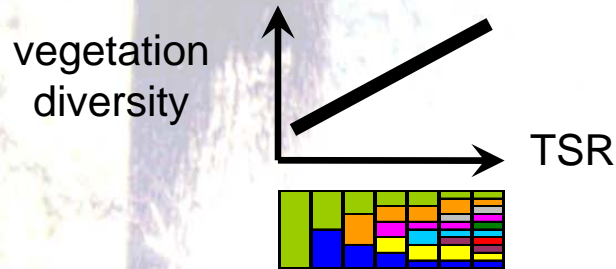


**increase in  
floristic  
diversity**

*Barbier et al. (2008) FEM 254 (1-15)*

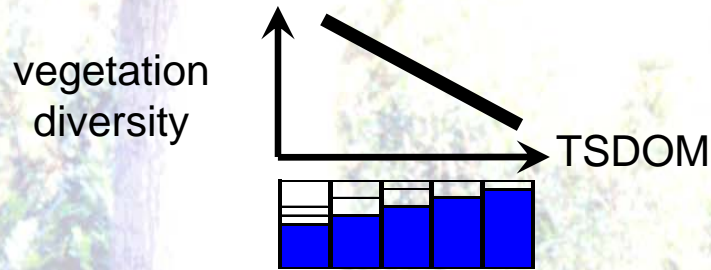
*Mölder et al. (2008) FEM 256 (272-281)*


# Summary of the literature



YES: 

NO: 



*For deciduous trees only:*  
NO: 

*Reverse trend actually observed*

*Overall: mixed results*

***Barbier et al. (2008) FEM 254 (1-15)***

***Mölder et al. (2008) FEM 256 (272-281)***

# Summary of the literature

*Proposal to also analyze tree species composition effect through tree species abundance (TSA)*

***Betts et al. (2005) The Forestry Chronicle 81 (265-269)***

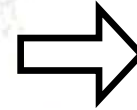
***Barbier et al. (2008) FEM 254 (1-15)***

# This leads to different models of relation between tree species composition and floristic diversity

**Tree species diversity (TSR and -TSDOM)**



**diversity of resource availability**



**increase in floristic diversity**

**Tree species identity (TSI)**



**resource availability**



**floristic diversity**

**Tree species abundance (TSA)**



**resource availability**



**floristic diversity**

*Barbier et al. (2008) FEM 254 (1-15)*

*Mölder et al. (2008) FEM 256 (272-281)*

- Yet, foresters often apprehend biodiversity through tree species diversity

↳ Tree diversity (TSR & TSDOM) is among the most frequent indicators of sustainable forest management relative to biodiversity, not TSI and TSA (MCPFE, French indicators).

***Is this choice relevant?***

# Models being compared

<b>TSI+TA</b>	cf. following
<b>TSI+TSDOM</b> (Dominance)	TSDOM: percent basal area in the dominant tree species group
<b>TSR</b> (Richness)	Tree species/genus richness as measured in the dendrometric relevé
<b>TSI</b> (Identity Dominant)	Identity of the most BA abundant tree group, among "Pioneer", "Oaks", "Shade Tolerant" <i>Pioneers: Betula sp., Populus sp...; Shade tolerant: Carpinus betulus, Tilia sp.,...</i>
<b>TSA</b> (Abundance)	Basal area of each of the tree groups: "Pioneer", "Oaks", "Shade Tolerant" <i>Pioneers: Betula sp., Populus sp...; Shade tolerant: Carpinus betulus, Tilia sp.,...</i>
<b>TA</b> (Total Abundance)	Total basal area
<b>Humus</b>	Mean humus score
<b>Null model</b>	Covariates (in all models): date & scale of relevé; identity of observer; mean depth of apparition of clay

Models corresponding to current European/French indicators

Baseline models to interpret results

Proposed new models of tree species composition/abundance

## Material and methods

- \* 49 *adult* stands sampled with a diversity of deciduous tree species compositions
- \* Vegetation sampled on 4\*100 and 4\*4 m<sup>2</sup> quadrats
- \* Analysis of **species richness of various ecological groups: here: life history \* successional status:**

$\Delta$ DIC PMP	Bryophytes forest	non-forest	Herbaceous peri-forest	forest	Woody peri-forest	forest
TSI+TA						
TSI+TSDOM (Dominance)						
TSR (Richness)						
TSI (Identity Dominant)						
TSA (Abundance)						
TA (Total Abundance)						
Humus						
Null model						

### *Mixed bayesian models*

*compared with DIC (Spiegelhalter et al., 2002) & Posterior Model Probability (PMP) (Congdon 2005)*

# Results

## Model comparisons for successional groups

$\Delta$ DIC <i>PMP</i>	Bryophytes	Herbaceous			Woody		Mean
	forest	non-forest	peri-forest	forest	peri-forest	forest	
<b>TSI+TA</b>	<b>-9</b>	<b>-44</b>	<b>-35</b>	<b>-16</b>	<b>-21</b>	<b>-7</b>	<b>-22</b>
	0,15	0,22	0,28	0,17	0,18	0,13	0,19
<b>TSI+TSDOM</b>	<b>-17</b>	<b>-12</b>	<b>-11</b>	<b>-15</b>	<b>-3</b>	<b>-2</b>	<b>-10</b>
<i>(Dominance)</i>	0,15	0,02	0,05	0,14	0,04	0,09	0,08
<b>TSR</b>	<b>-1</b>	<b>2</b>	<b>-1</b>	<b>-2</b>	<b>1</b>	<b>-2</b>	<b>-1</b>
<i>(Richness)</i>	0,06	0,01	0,02	0,05	0,03	0,08	0,04
<b>TSI</b>	<b>-15</b>	<b>-12</b>	<b>-10</b>	<b>-16</b>	<b>-2</b>	<b>-3</b>	<b>-10</b>
<i>(Identity Dominant)</i>	0,13	0,02	0,04	0,15	0,04	0,10	0,08
<b>TSA</b>	<b>-15</b>	<b>-67</b>	<b>-41</b>	<b>-20</b>	<b>-34</b>	<b>-13</b>	<b>-32</b>
<i>(Abundance)</i>	0,14	0,56	0,37	0,22	0,40	0,18	0,31
<b>TA</b>	<b>-10</b>	<b>-37</b>	<b>-28</b>	<b>-7</b>	<b>-21</b>	<b>-10</b>	<b>-19</b>
<i>(Total Abundance)</i>	0,08	0,15	0,18	0,09	0,17	0,14	0,13
<b>Humus</b>	<b>-11</b>	<b>-2</b>	<b>-1</b>	<b>-1</b>	<b>2</b>	<b>0</b>	<b>-2</b>
	0,10	0,01	0,02	0,05	0,03	0,06	0,04
<b>Null model</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
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	0,10	0,01	0,02	0,05	0,03	0,06	0,04
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	0,06	0,01	0,02	0,05	0,03	0,06	0,04

↪ *TSA is the best overall model,*

*with bigger discrepancies for non-forest and peri-forest species*

# Results

## Direction and magnitude of the effects : TSA

*Predicted multiplier of species richness [and its 95% interval] when the basal area of tree species groups increases by 10m<sup>2</sup>/ha for...*

	Bryophytes	Herbaceous			Woody	
	forest	non-forest	peri-forest	forest	peri-forest	forest
<b>Pioneer</b>	<b>1.08</b>	<b>0.62</b>	<b>0.59</b>	<b>1.30</b>	<b>1.01</b>	<b>0.90</b>
	<i>[0.87; 1.33]</i>	<i>[0.18; 1.93]</i>	<i>[0.2; 1.59]</i>	<i>[0.78; 2.20]</i>	<i>[0.80; 1.30]</i>	<i>[0.70; 1.14]</i>
<b>Oak</b>	<b>0.99</b>	<b>0.34</b>	<b>0.45</b>	<b>0.91</b>	<b>0.79</b>	<b>0.96</b>
	<i>[0.82; 1.21]</i>	<i>[0.11; 0.91]</i>	<i>[0.18; 1.06]</i>	<i>[0.56; 1.46]</i>	<i>[0.63; 0.99]</i>	<i>[0.76; 1.19]</i>
<b>Shade</b>	<b>1.12</b>	<b>0.06</b>	<b>0.18</b>	<b>0.58</b>	<b>0.69</b>	<b>0.83</b>
	<i>[0.99; 1.27]</i>	<i>[0.02; 0.14]</i>	<i>[0.09; 0.33]</i>	<i>[0.42; 0.78]</i>	<i>[0.60; 0.79]</i>	<i>[0.72; 0.95]</i>

# Results

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<b>Pioneer</b>	<b>1.08</b> [0.87; 1.33]	<b>0.62</b> [0.18; 1.93]	<b>0.59</b> [0.2; 1.59]	<b>1.30</b> [0.78; 2.20]	<b>1.01</b> [0.80; 1.30]	<b>0.90</b> [0.70; 1.14]
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↳ *the strongly significant results relate to the negative effect of the basal area of shade-tolerant trees...*

*... recalling the results by Kwiatkowska (1994) Vegetatio.*

# Discussion

## \* Limits of the present results:

– not a lot of quadrats => some noisy estimators: 

*Predicted multiplier of species richness [and its 95% interval] when the basal area of tree species groups increases by 10m<sup>2</sup>/ha for...*

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<b>Pioneer</b>	<b>1.08</b> [0.87; 1.33]	✓ <b>0.62</b> [0.18; 1.93]	✓ <b>0.59</b> [0.2; 1.59]	✓ <b>1.30</b> [0.78; 2.20]	<b>1.01</b> [0.80; 1.30]	<b>0.90</b> [0.70; 1.14]
<b>Oak</b>	<b>0.99</b> [0.82; 1.21]	✓ <b>0.34</b> [0.11; 0.91]	✓ <b>0.45</b> [0.18; 1.06]	<b>0.91</b> [0.56; 1.46]	<b>0.79</b> [0.63; 0.99]	<b>0.96</b> [0.76; 1.19]
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## Discussion

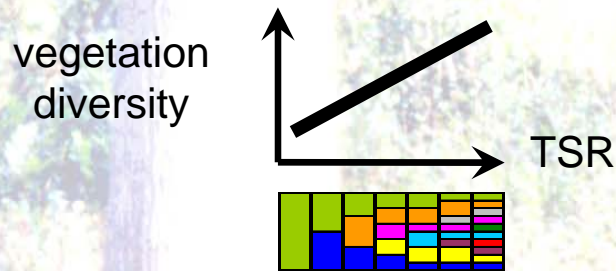
### \* Limits of the present results:

- not a lot of quadrats => some noisy estimators: ✓
- some **ecological gradients are short**; and the region studied is small
- **only one broad taxonomic group analyzed**


# Conclusion

**Are tree species diversity and dominance  
good indicators of understorey diversity?**

In this case study: NO for tree species richness (TSR)  
rather NO for tree species dominance



**YES:** 

**NO:** 

## Conclusion

**Are tree species diversity and dominance  
good indicators of understorey diversity?**

- \* A case for an alternative candidate: **indicators based on  
tree species abundance (TSA)**

## Recap

We propose that **biodiversity indicators be subject to a quality control, esp. be tested relative to real data by:**

- defining and comparing alternative models
- **analyzing data at biodiversity relevant levels**

(species, ecological groups)

- reporting the results in a **quantitative** manner
- *defining context of validity*
- *devising tools to communicate the results in case of multivariate models*

**Discussion: ways to reconcile the inconciliable?**

**How to decide/evaluate/communicate with complex, multivariate models as indicators?**

Why not using the **statistical models as predictive tools** to test the impact of the **new values of the indicators** on different statistics of biodiversity?

## **Discussion: reconcile the conciliable**

**We need both surveillance monitoring (SM) and indirect ecological indicators (EI):**

- EI does not address properly cumulative effects
- SM might be the only good data provider for EI evaluation
- EI is one of the possible interfaces/interpreters between SM and forest management

## Many thanks...

- \* To the people involved in the project, in the field and in the lab: Philippe Loussot, Marc Roussel, Yann Dumas.
- \* The Office National des Forêts and private owners who enabled us to work on their forests.

## **A piece of advertisement**

Job opportunity – Senior scientist – at Cemagref, Nogent sur Vernisson (France):

[http://www.cemagref.fr/Informations/MobiliteConcours/Concours/concours\\_externes/profils%20concours/profil\\_DR\\_2008-01\\_%E9cologie\\_international.htm](http://www.cemagref.fr/Informations/MobiliteConcours/Concours/concours_externes/profils%20concours/profil_DR_2008-01_%E9cologie_international.htm)

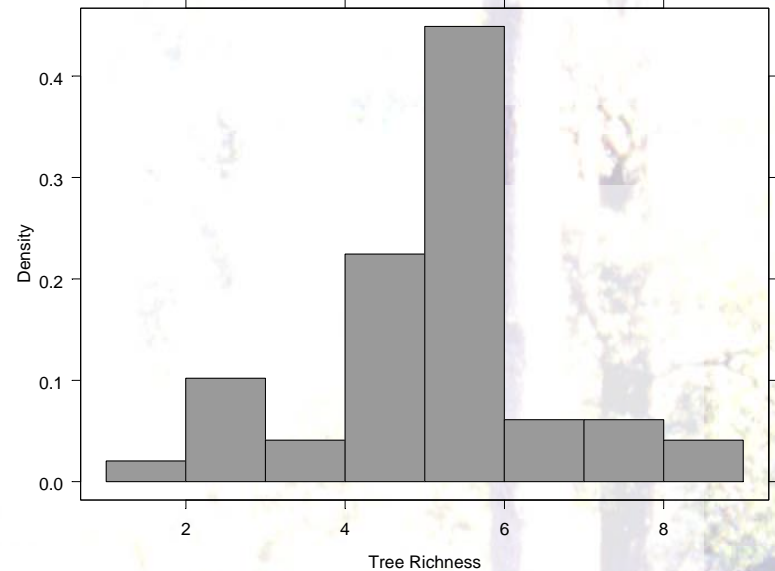
or Google search with kw: concours DR Cemagref Nogent



# **Supplementary material**

## Description of gradients

\* Tree richness not very variable :

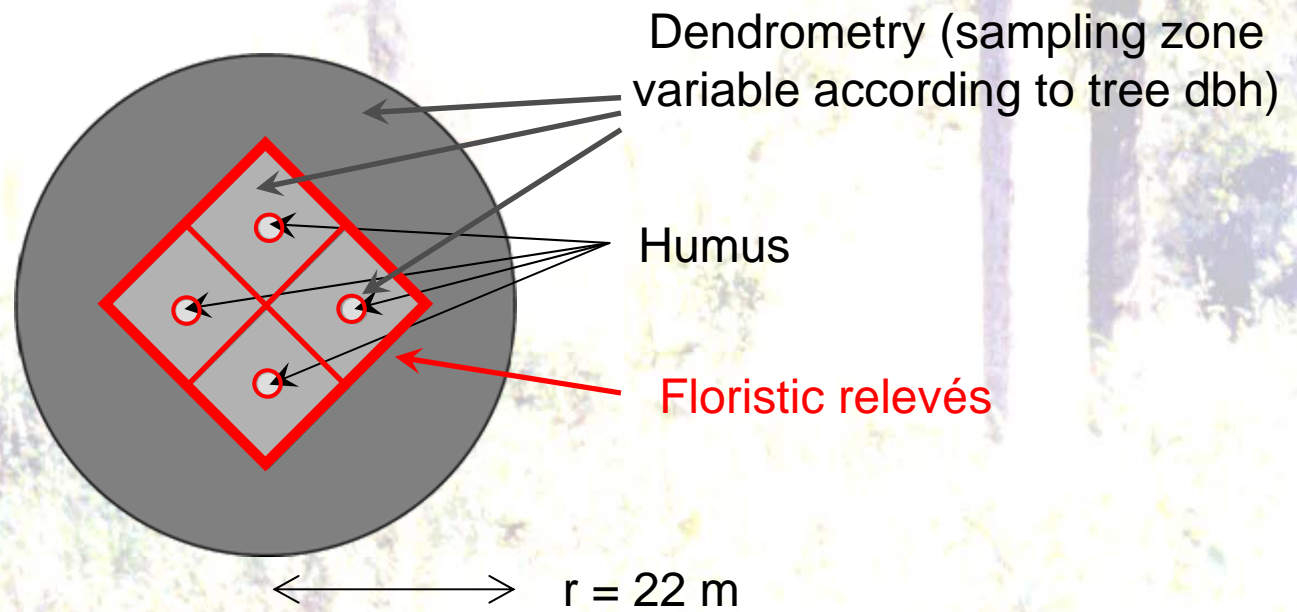


\* 28 stands dominated by oaks, 14 by shadow tree species and 7 by pioneer tree species.

\* Basal area of oaks well balanced between 0 and 25 m<sup>2</sup>/ha; less so for pioneer and shadow trees.

Negative correlation (between  $-0.5$  and  $-0.8$ ) between basal area of oak and that of pioneer and shadow trees.

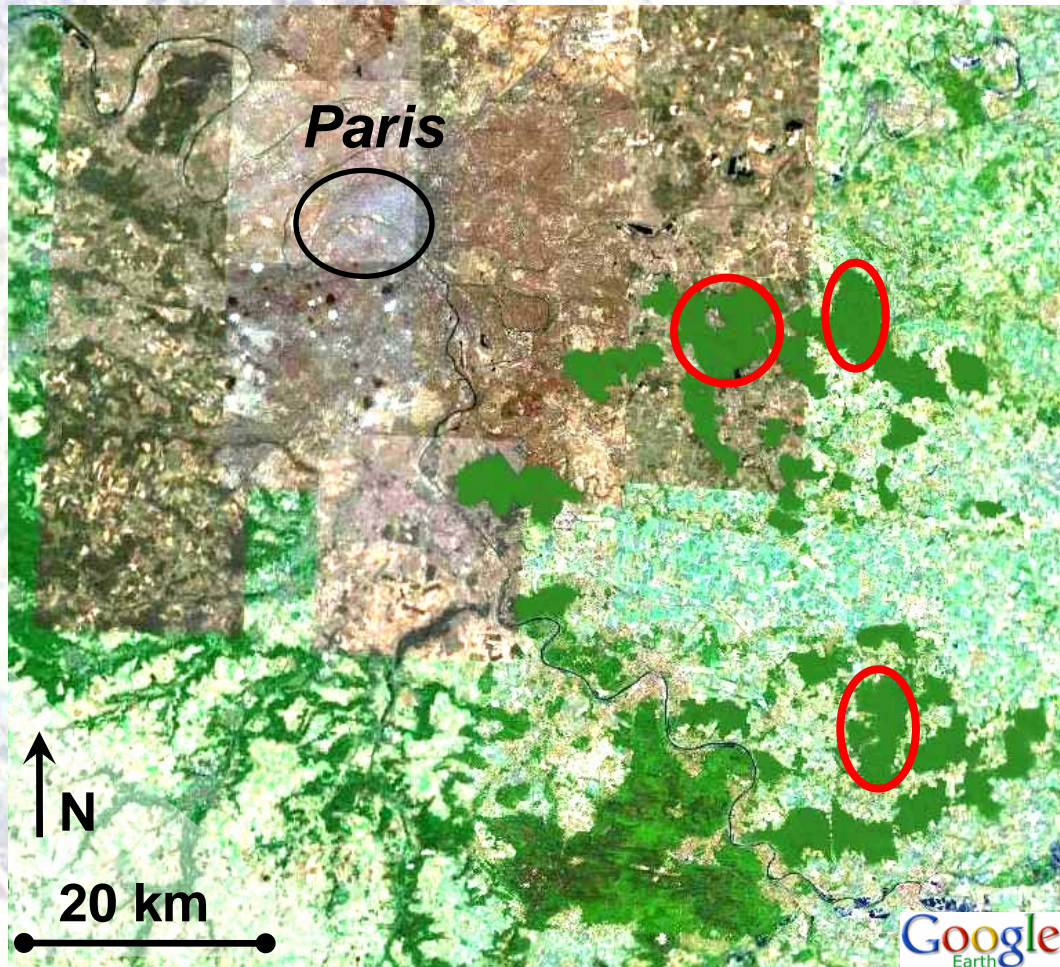
# Scheme of the sampling zones



## Discussion

- \* The **process would be strengthened**, if we were able to:
  - state a priori hypotheses based on our state of the knowledge;
  - engage **long-term experiments**, test for causal relationships, analyze discrepancies in results among regions/ecological gradients;
  - periodically check for permanence of the validity of the statistical models;
  - **link those analyses to the analysis of direct indicators (i.e. trends in biodiversity).**

## Sampling and site description



- 8,000 ha of deciduous oak forests studied in three zones near Paris: ○
- **Site type controlled** (silt over clay soils, moderately hydromorphic, mildly acidic)
- Mainly old coppice with standards
- $P=650\text{mm/yr}$ ,  $T=10.6^{\circ}\text{C}$

49 *adult* stands sampled that represent a diversity of deciduous tree species composition