Forest edge responses present a variety of patterns in southwestern France

Audrey Alignier, Marc Deconchat

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UMR 1201 Dynafor INRA/INPT-ENSAT – Toulouse - FRANCE

Forest Edges in Landscape: a critical role for Vegetation Biodiversity

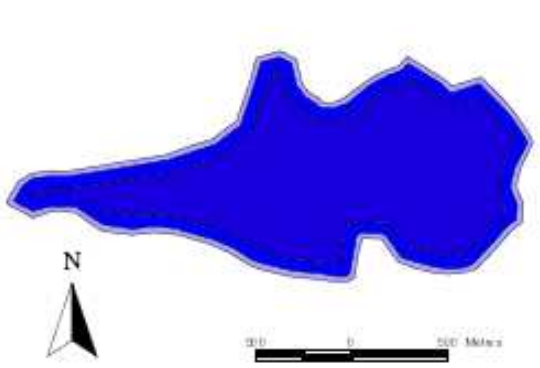
- Spatial dynamics of landscape modified by human activities:

  Fragmentation/ Defragmentation

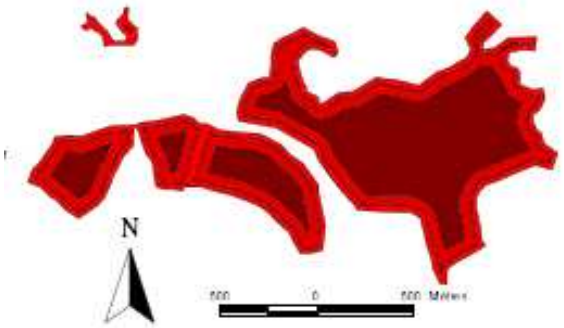
  - Loss of habitat (e.g. by forest cutting)
  - Isolation of patches

➡ **Increase of discontinuity proportion in landscape**

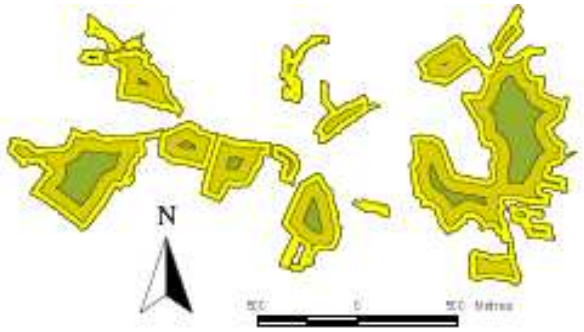
Ex. Progressive fragmentation of a woodlot since 1750, in southwestern France (Arrignon, 2003)



1750



1860

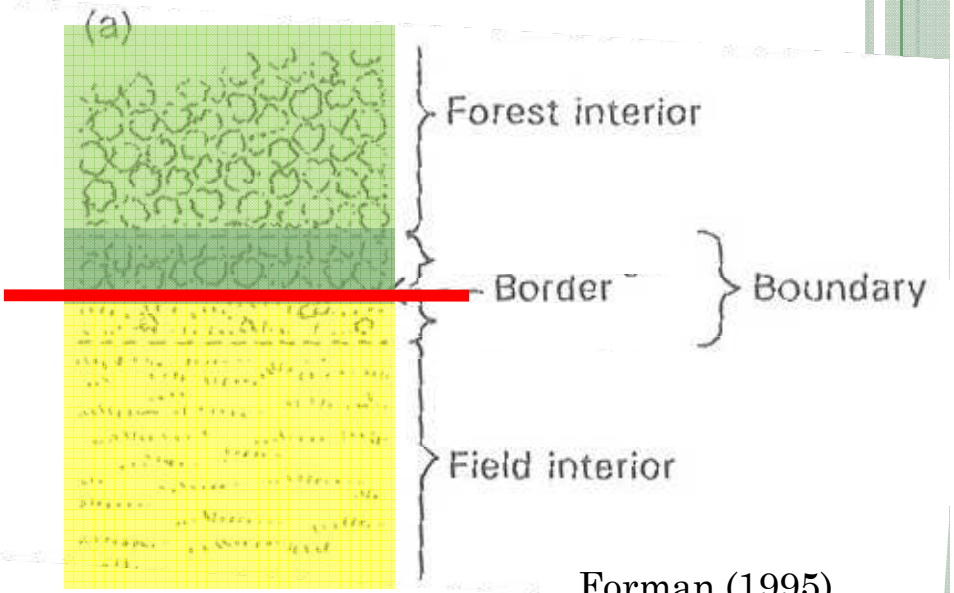


Actual woodlot

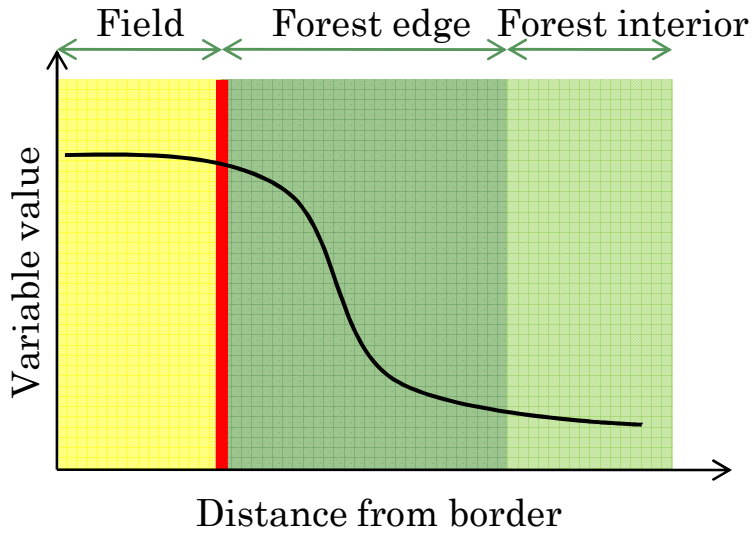
Forest Edges in Landscape: a critical role for Vegetation Biodiversity

- Edge = zone, in the forest, under discontinuity influence (Murcia, 1995)

Discontinuities influence environmental conditions to which vegetation respond (richness, abundance, composition).



Forman (1995)



Theoretical pattern of response to discontinuity, widely accepted.

Our Questions

- How do forest vegetation (richness, abundance and composition) and abiotic variables respond to edge effect ?

Method

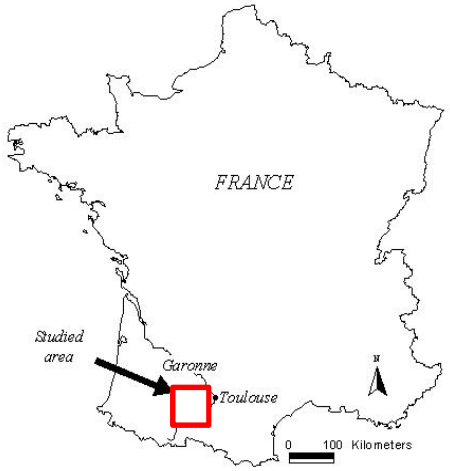
Comparing vegetation response curves to forest edges between several transects

- Can we characterize a common pattern of response to edges ?

Method

Attributing a statistical model to responses of vegetation and abiotic variables

STUDY SITE



Nord

1km

Site LTER « Vallées et coteaux de Gascogne »

Subatlantic climate with mediterranean influence
(average annual T°C = 11°C; average annual rainfall = 800mm)

Woodlots managed by private owners ; coppice with standards

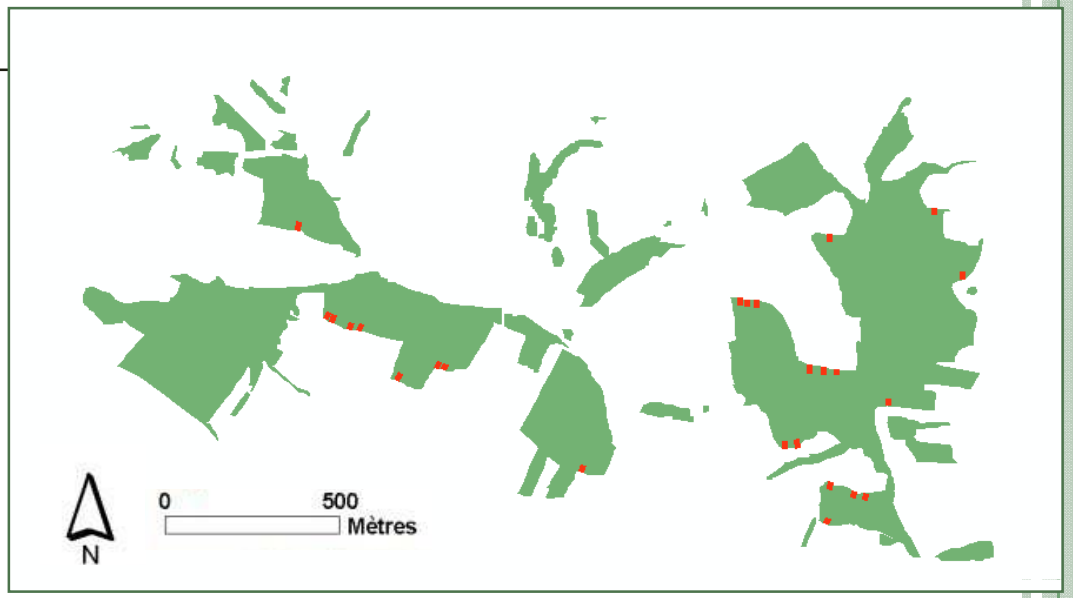
Dominant species: oaks (*Quercus robur, Q.pubescens, Q.petreae*), hornbeam (*Carpinus betulus*), wild cherry (*Prunus avium*)

Sampling Design

- 28 transects, extended from the border to 40m into the forest interior

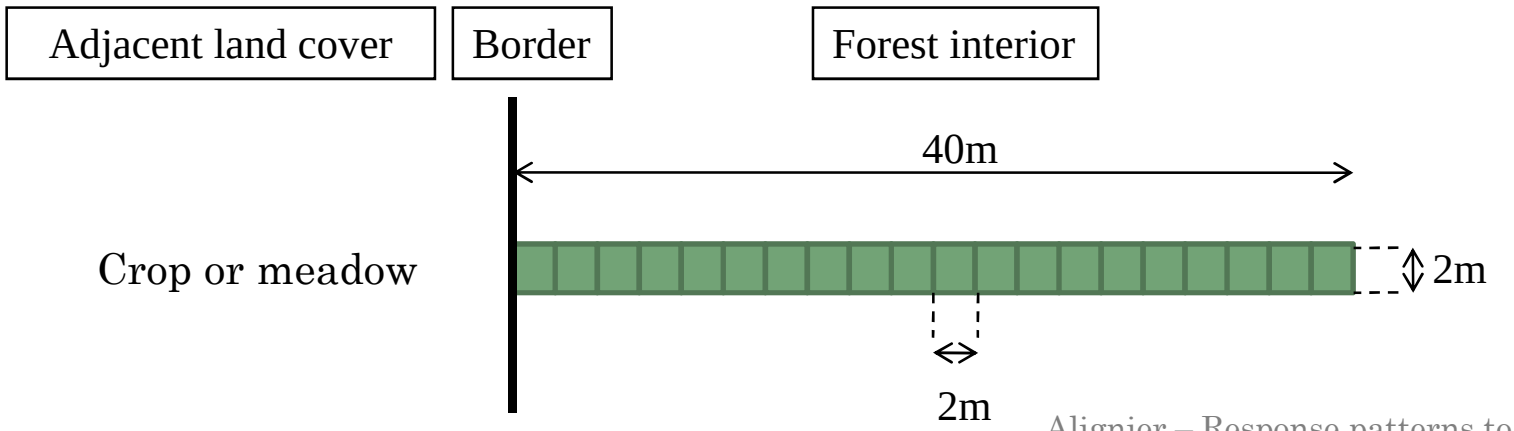
Border =line formed by the first tree trunks (Murcia,1995)

- 40m away from clearcut or other discontinuities



Localisation map of 28 transects studied (in red)

One transect:



Data Analysis: Model Application per Transect

Vegetation data:

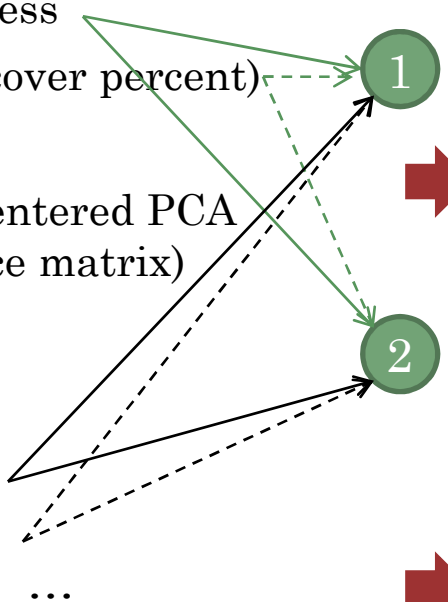
- Total species richness
- Total abundance (cover percent)
- Composition

(Scores on Axis 1 of centered PCA on presence/absence matrix)

Environmental data:

- Soil temperature
- Soil moisture (RH)
- Soil pH
- Soil penetrability
- Canopy openess (%)

…



In relation to distance from border

➡ Response curves

Models adjustment and best model selection (Ewers & Didham, 2006)

➡ Characterization of edge reponses by adjusted models

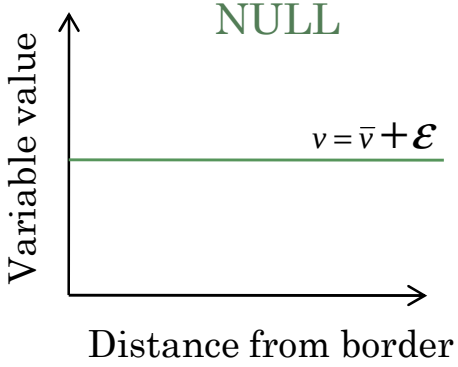
Comparison of models

* 28 transects

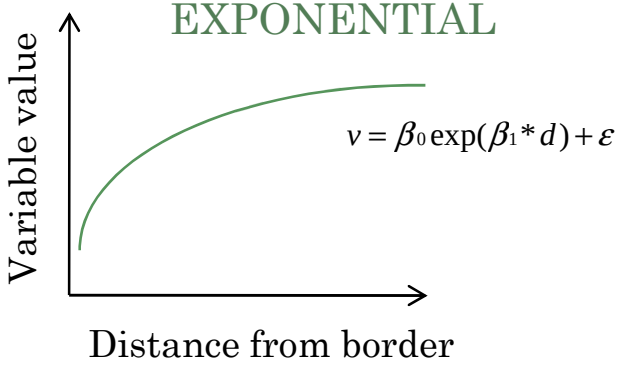
Data Analysis : Best model Selection

v = tested variable
d = distance from border
β_x = constant

NULL

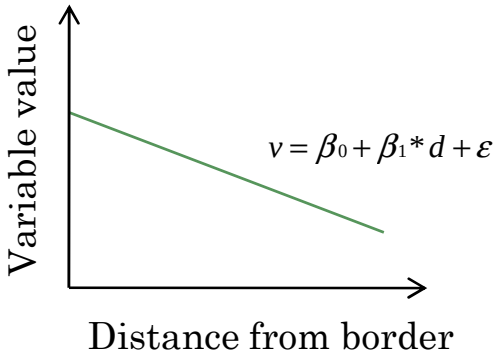


EXPONENTIAL



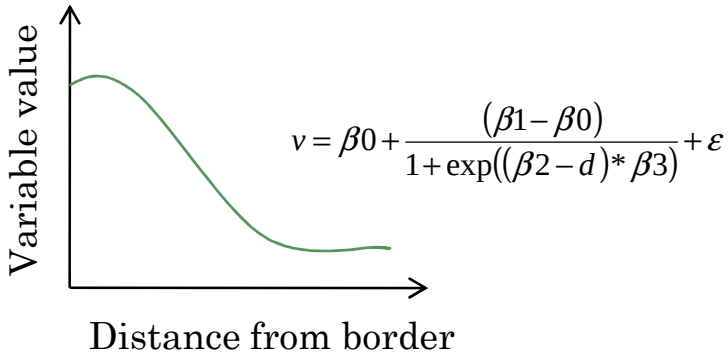
Selection on AIC criterion

LINEAR



« Simple » models

LOGISTIC

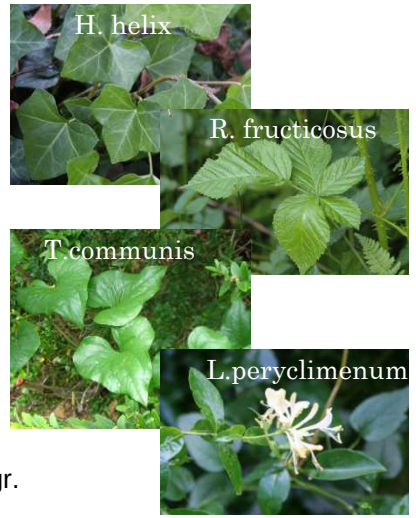


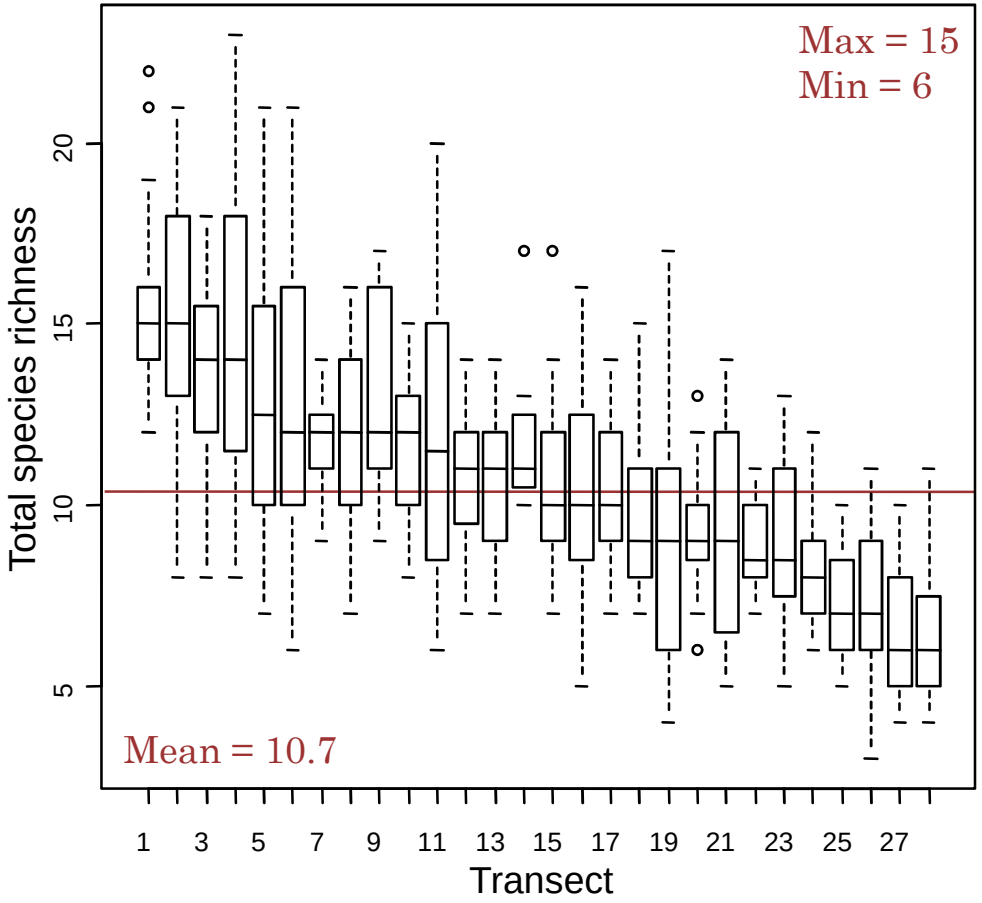
Widely accepted theoretical model

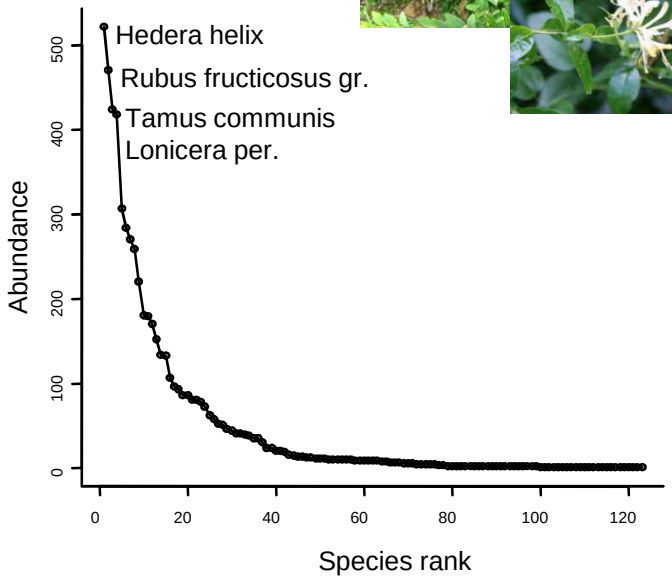
\- Complexity +

RESULTS: VEGETATION

123 species from 42 families ; 75 herbaceous perennials, 42 woody species and 6 annual species







80% of species have an occurrence frequency <10%.

High variation in species richness between transects (similar results for abundance).

RESULTS: ABIOTIC VARIABLES

High variation of soil temperature **between transects**:
variation between transect (up to 4°C) > variation within a transect (max 1.3°C)

pH was **stable** with distance from border except for 7 transects with a slight decrease in forest interior as in Marchand & Houle (2006).

Soil moisture was **stable** with distance from border, except for 6 transects which present an increase of soil moisture in forest interior.

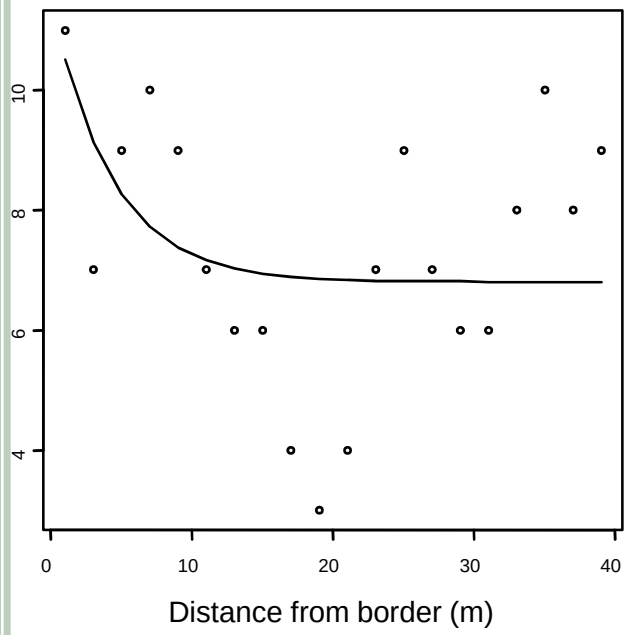
General **decrease of % canopy openess** with distance from border.

➡ High variation of abiotic variables between transects, often > variation within transect.
Results consistent with previous studies.

Results: Vegetation Response Models

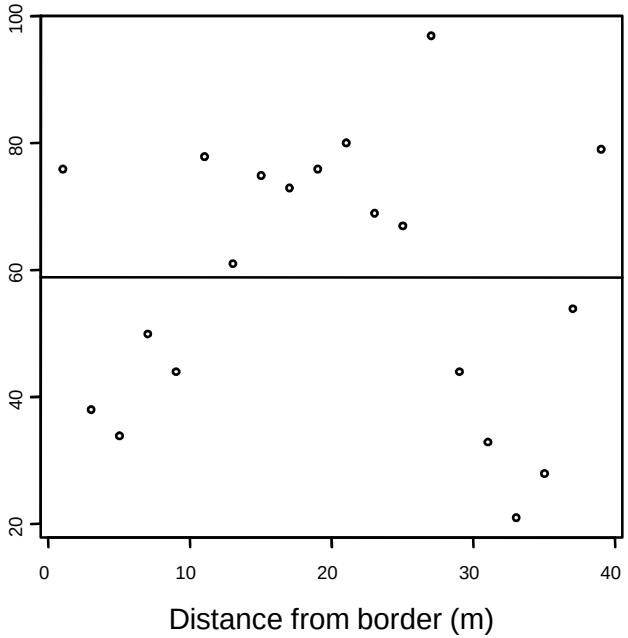
Example for transect n°19:

Species richness



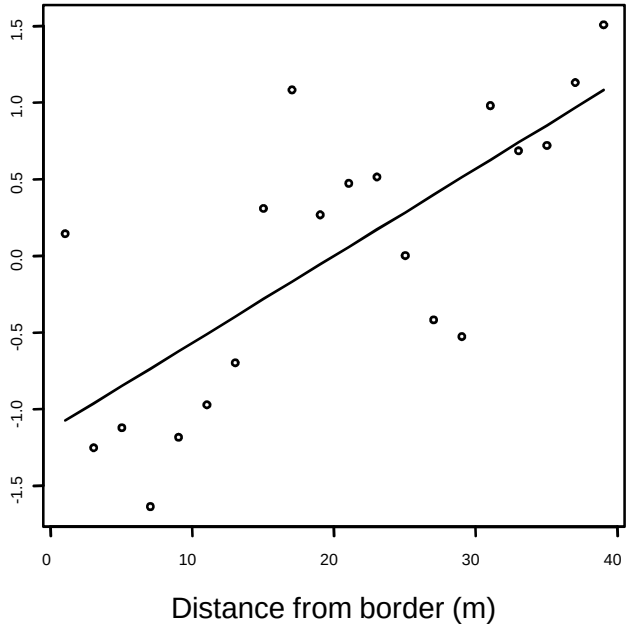
EXPONENTIAL

Percent cover



NULL

Composition



LINEAR

➡ Different models between vegetation descriptors

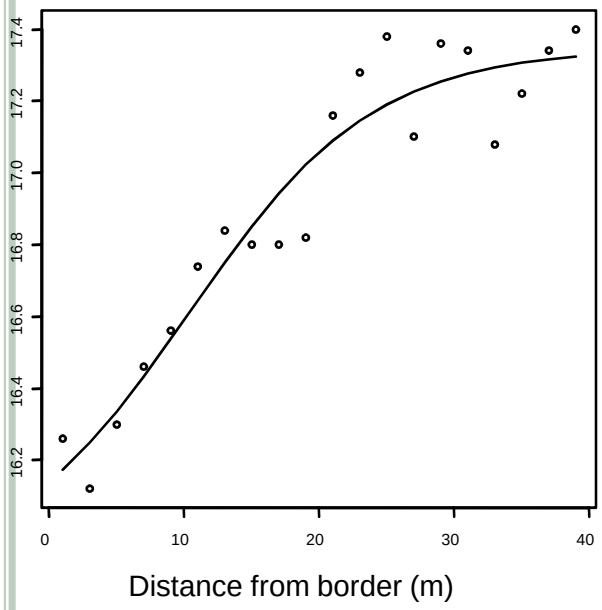
Results: Abiotic Response Models

Example for transect n°19:

(Penetrability)

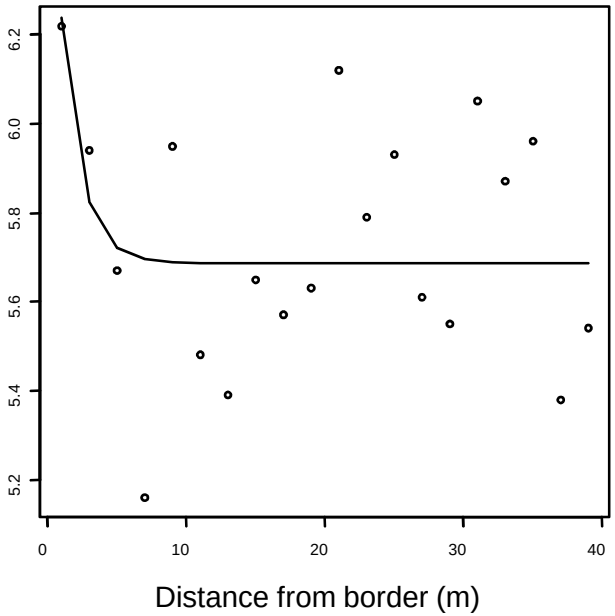
(Canopy openess)

Soil temperature



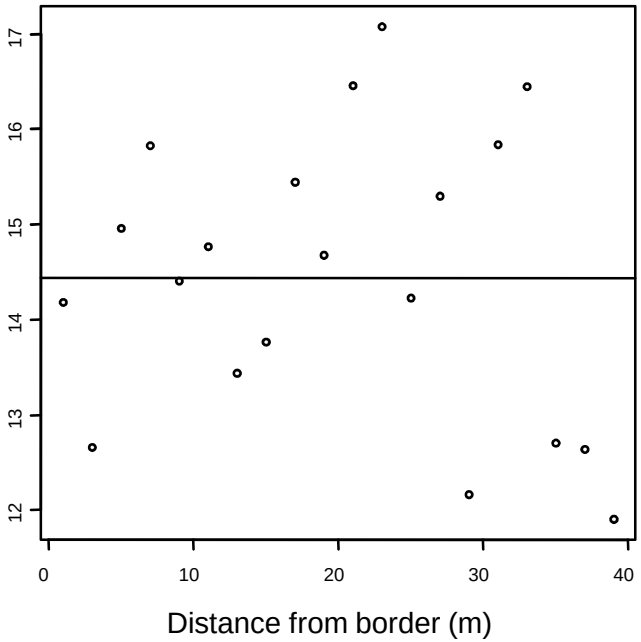
LOGISTIC

pH



EXPONENTIAL

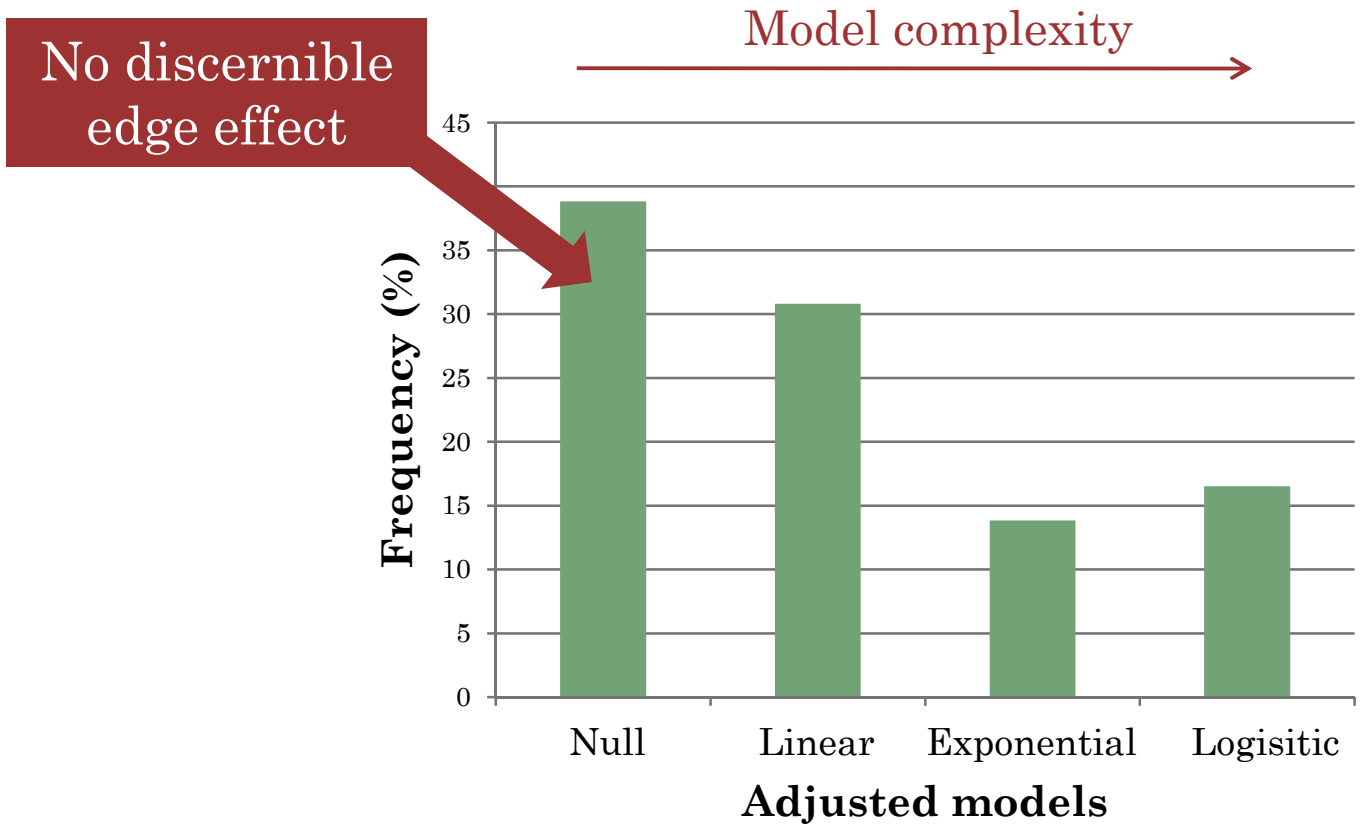
Soil moisture



NULL

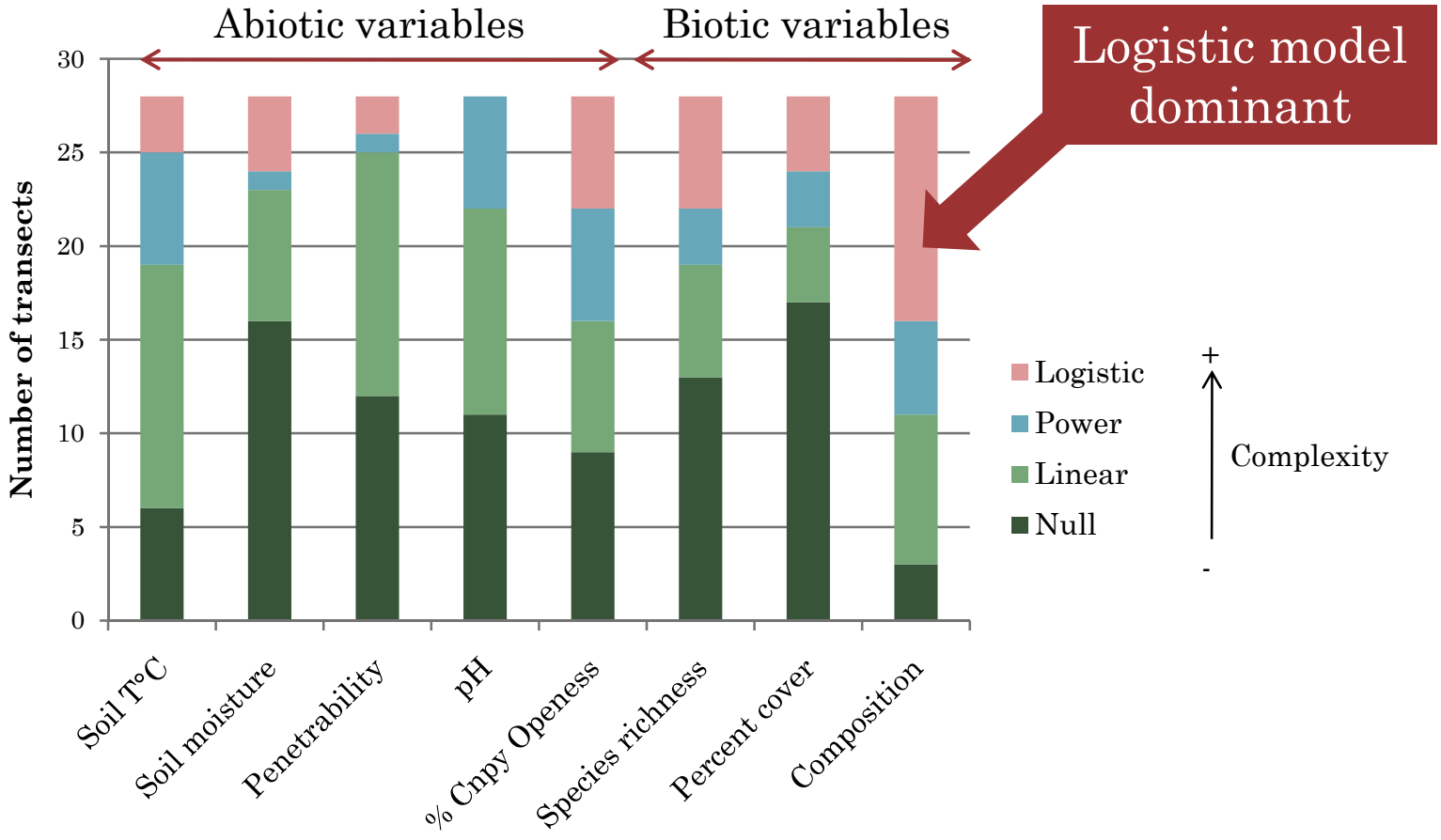
➡ Different models between abiotic descriptors

Results: Frequency of Models for ALL tested variables



Model « null » dominant **BUT**
Edge effects in the majority of cases
(model « linear » + model « exponential » + model « logistic »)

Results: Models Adjustment



Simple models are dominant for the majority of variables.

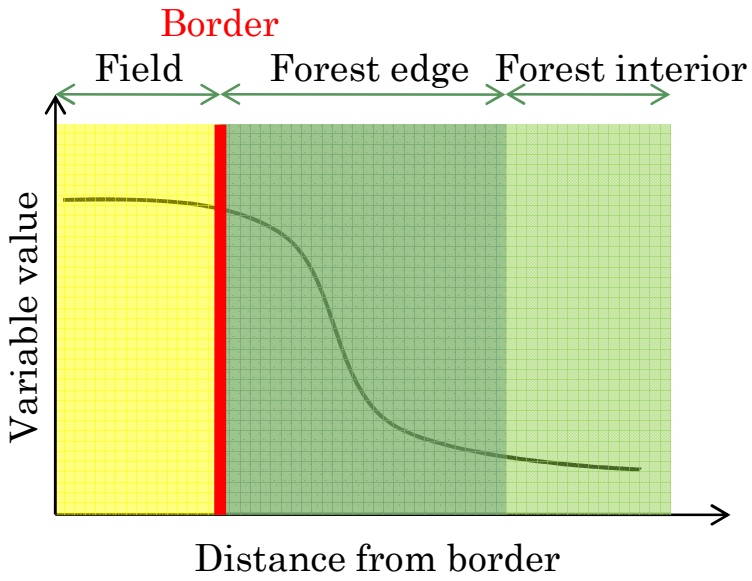
« Logisitic » model dominant for botanical composition

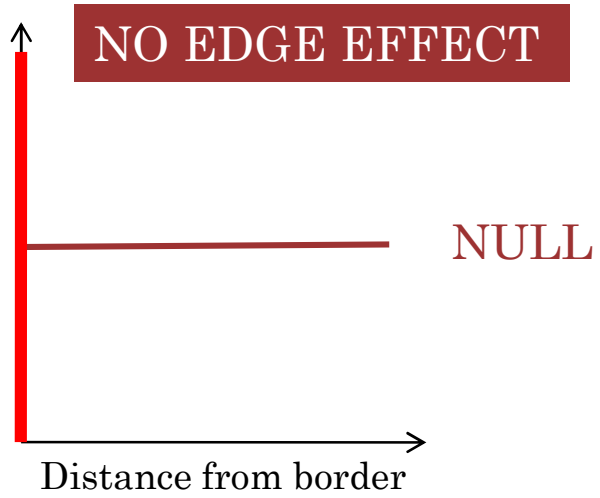
Discussion

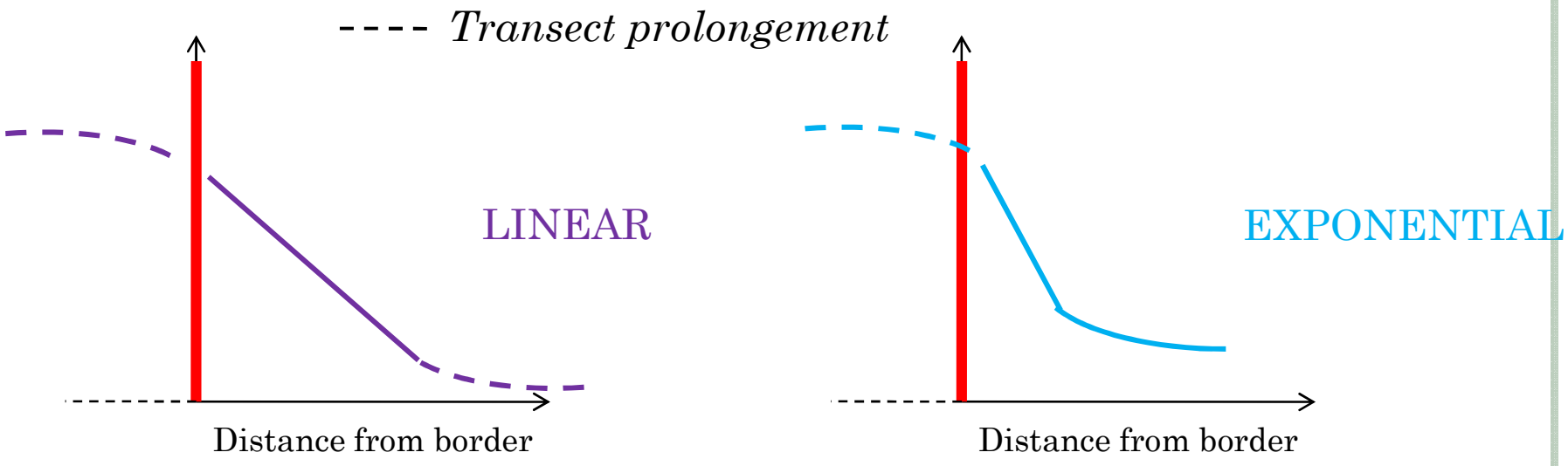
- How forest vegetation (richness, abundance and composition) respond to edge effect ? And abiotic variables ?

  No unique (general) model but different models between vegetation descriptors and abiotic variables.

DISCUSSION


Border
Field
Forest edge
Forest interior
Variable value
Distance from border


NO EDGE EFFECT
NULL
Distance from border


Transect prolongement
LINEAR
EXPONENTIAL
Distance from border
Distance from border

DISCUSSION

- How forest vegetation (richness, abundance and composition) respond to edge effect ? And abiotic variables ?

  No unique (general) model but different models between vegetation descriptors and abiotic variables.

- Can we characterize a common response pattern to edges ?

  High variability of edge responses between transects:

  - Different adjusted models according to tested variables
  - Null model predominant for overall transects ⇨ NO EDGE EFFECT
  - Selection among 4 models ⇨ not always the best adjustment to data

Discussion

How to explain the absence of edge effects ?

- Small woodlots (from <0.05 to 5ha)

- Human management

Frequent perturbation over years

Management by private owners

<u>Perspectives :</u>

To integrate forest management (cuttings) and forest continuity as explicative variables in data analysis

To develop monitoring (air temperature and humidity) in edges

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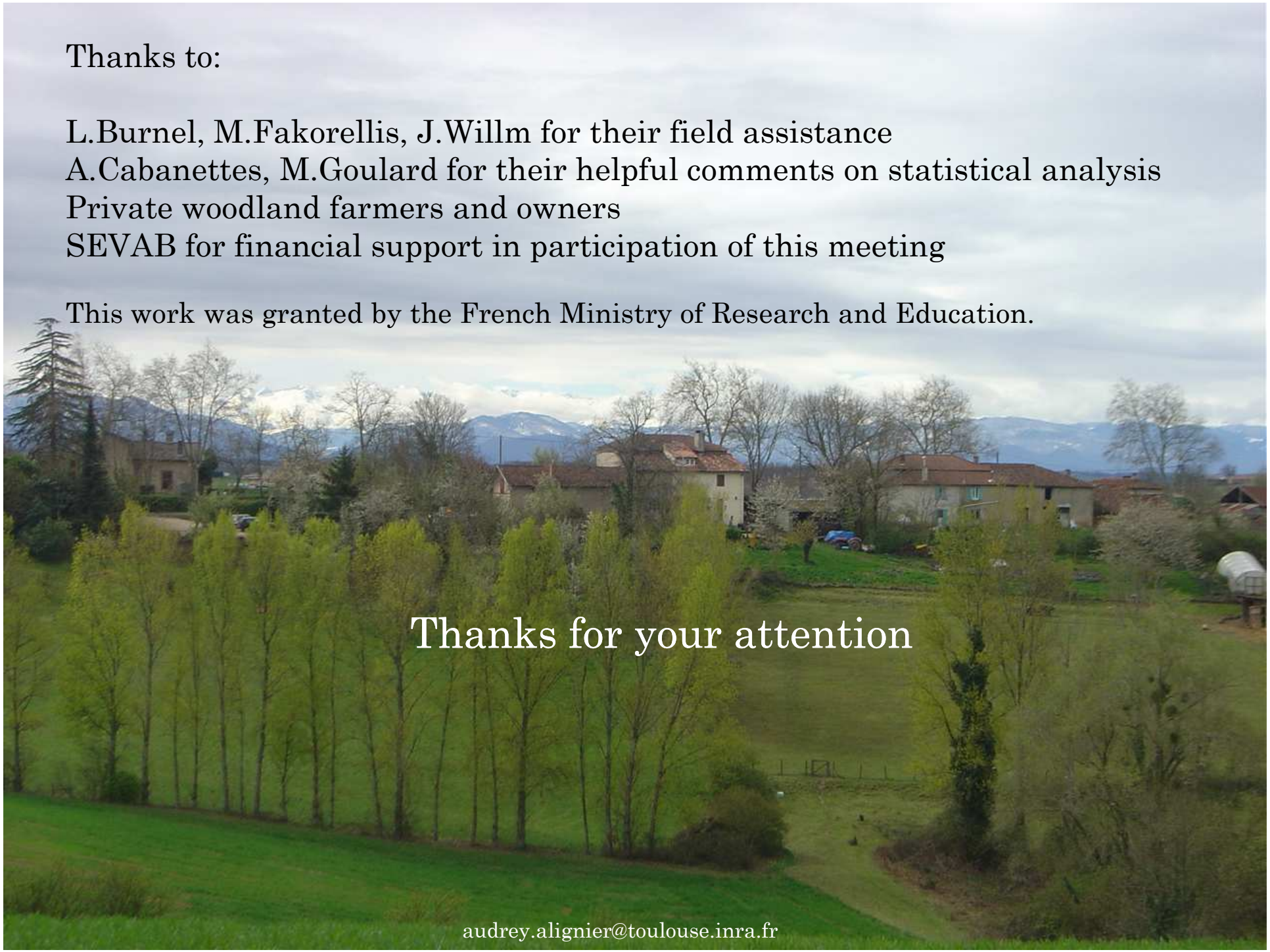
L.Burnel, M.Fakorellis, J.Willm for their field assistance
A.Cabanettes, M.Goulard for their helpful comments on statistical analysis
Private woodland farmers and owners
SEVAB for financial support in participation of this meeting

This work was granted by the French Ministry of Research and Education.



Thanks for your attention

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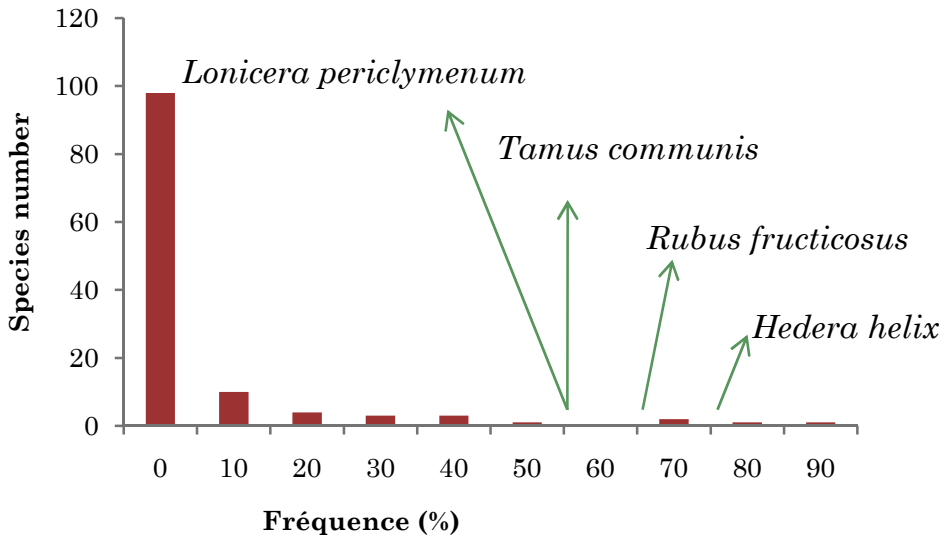
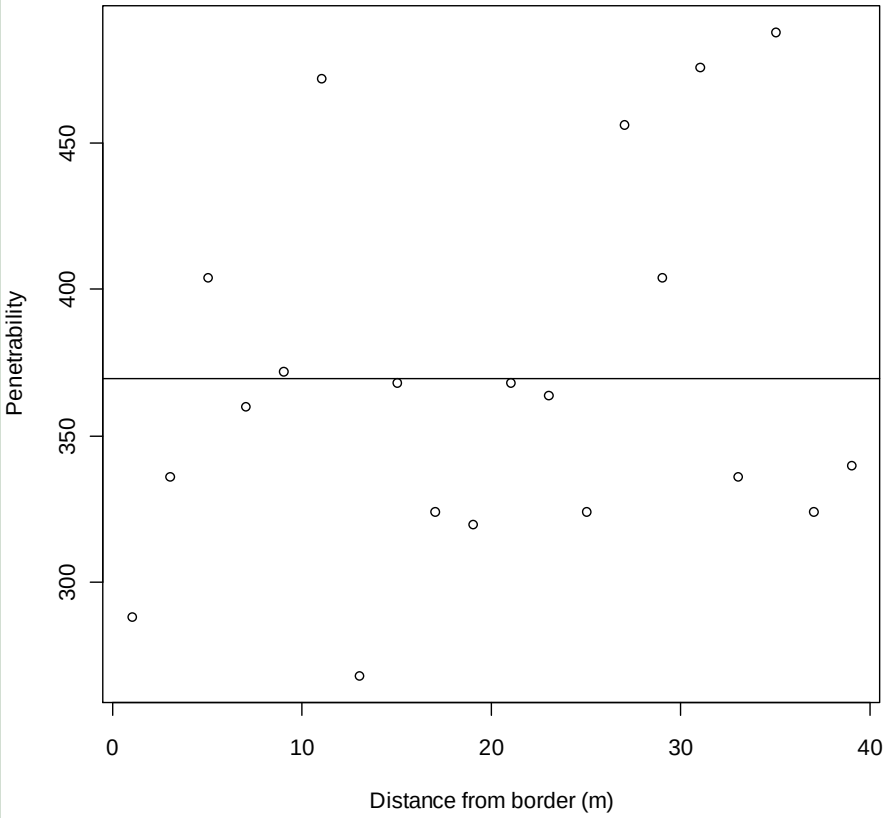
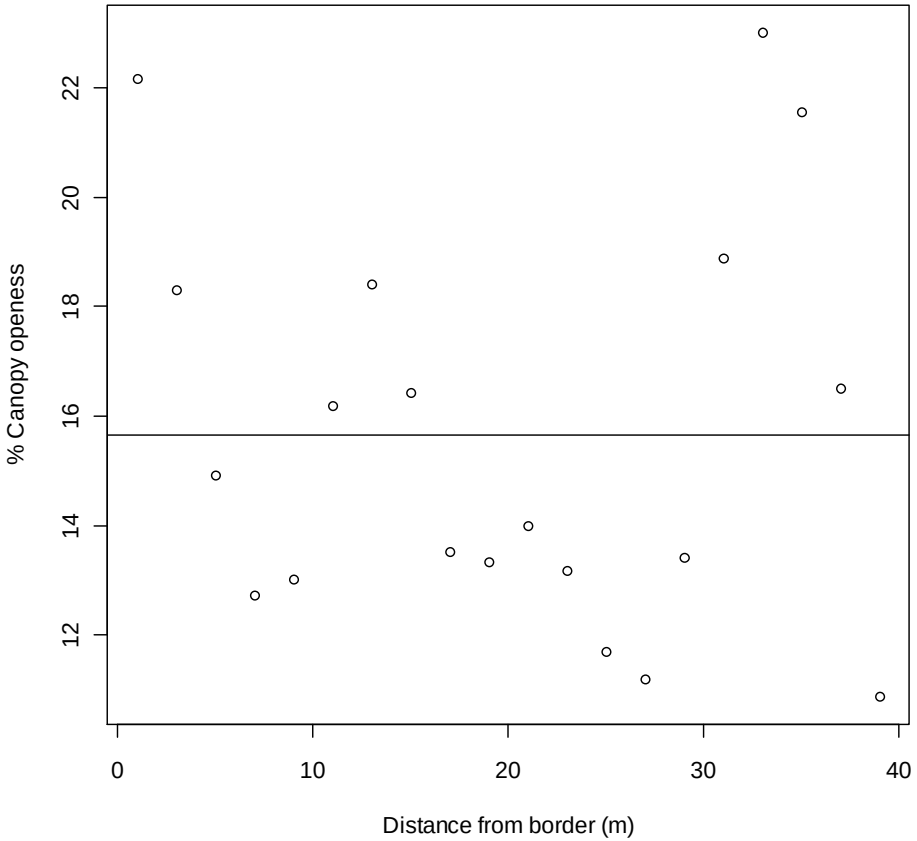
Hemispherical photography




Penetrability
300
350
400
450
0
10
20
30
40
Distance from border (m)


% Canopy openess
12
14
16
18
20
22
0
10
20
30
40
Distance from border (m)

Results: Models Adjustment

For all transects: