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Butterflies and landscape connectivity: Do effects depend on species traits and conservation value?

Anne Villemey, Inge van Halder, Annie Ouin, Luc Barbaro, Julie Chenot, Pauline Tessier, François Calatayud, Hilaire Martin, Philipp Roche, Frédéric Archaux

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Butterflies and landscape connectivity

Do effects depend on species traits and conservation value?

Anne Villemey

I. van Halder, A. Ouin, L. Barbaro, J. Chenot,
P. Tessier, F. Calatayud, H. Martin, P. Roche, F. Archaux

ICCB, ECCB

Montpellier, August, 2015





Context

BUTTERFLIES IN A CHANGING WORLD

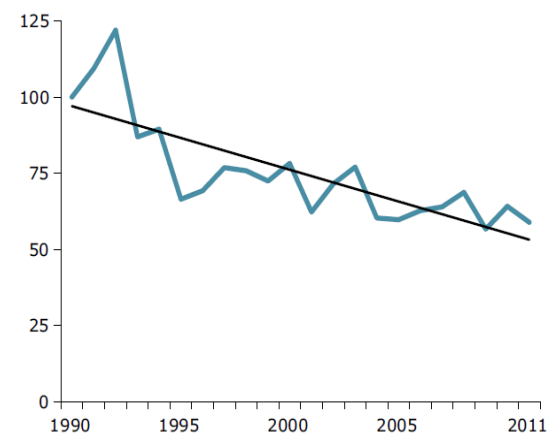
Declining, especially in farmland

The European Grassland Butterfly Indicator: 1990–2011

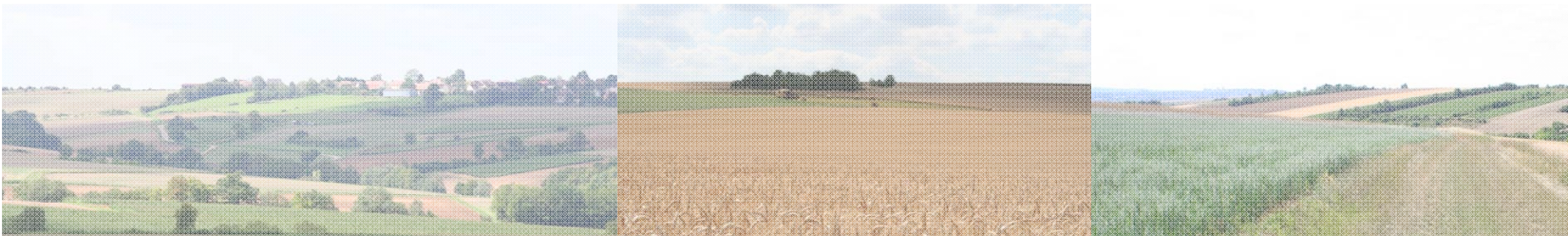
EEA Technical report | No 11/2013

ISSN 1725-2237

Butterfly Conservation Europe/Statistics Netherlands



ICCB-ECCB
AUGUST, 2015





Context

BUTTERFLIES IN A CHANGING WORLD

Declining, especially in farmland

Sensitive to habitat loss



ICCB-ECCB
AUGUST, 2015



Context

BUTTERFLIES IN A CHANGING WORLD

Declining, especially in farmland

Sensitive to habitat loss

None or trait-dependent negative effect of habitat connectivity

Journal of Biogeography, 30, 889–900



How does landscape context contribute to effects of habitat fragmentation on diversity and population density of butterflies?

Jochen Krauss*, Ingolf Steffan-Dewenter and Teja Tscharntke. *Agriculture, University of Göttingen, Waldweg 26, Göttingen, Germany*

Landscape Ecol (2013) 28:1283–1292
DOI 10.1007/s10980-013-9864-2

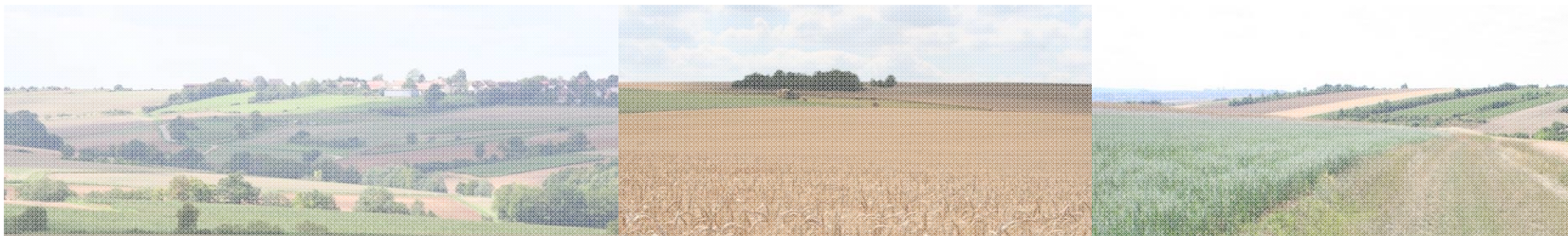
RESEARCH ARTICLE

Trait-dependent responses of flower-visiting insects to distance to semi-natural grasslands and landscape heterogeneity

Johan Ekroos · Maj Rundlöf · Henrik G. Smith



ICCB-ECCB
AUGUST, 2015





Context

HABITAT CONNECTIVITY

Lot of metrics

No consensus on the “best metric”

Depends on population functioning

REVIEWS REVIEWS REVIEWS Front Ecol Environ 2004; 2(10): 529-536

A comparison-shopper’s guide to connectivity metrics

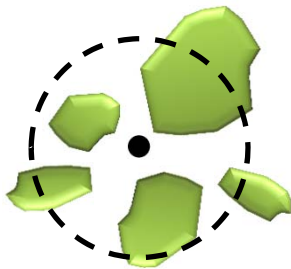
Justin M Calabrese and William F Fagan

Landscape Ecol (2008) 23:879–890
DOI 10.1007/s10980-008-9245-4

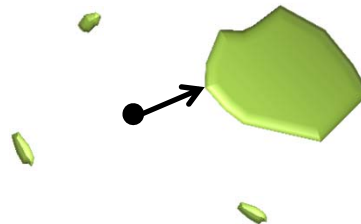
Connectivity measures: a review

Pavel Kindlmann · Francoise Burel

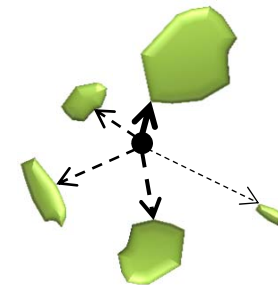
Proportion in a radius



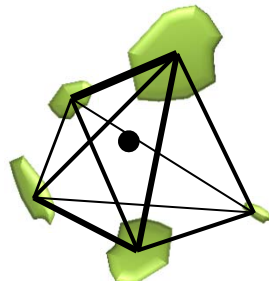
Distance to the nearest patch



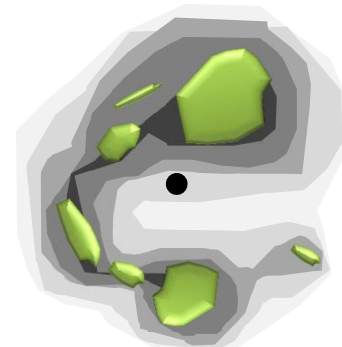
Hanski’s index



Graph theory



Circuit theory



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AUGUST, 2015



Context

HABITATS IN AGRICULTURAL CONTEXT

Grassland patches

- main habitat

Linear elements

- alike grasslands
- non-negligible amount



Woodlands

- complementary / supplementary resources?



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Most studies focused on

- Extremely fragmented landscapes
- High-conservation-value habitats

They did not consider

- Linear elements
- Woodlands



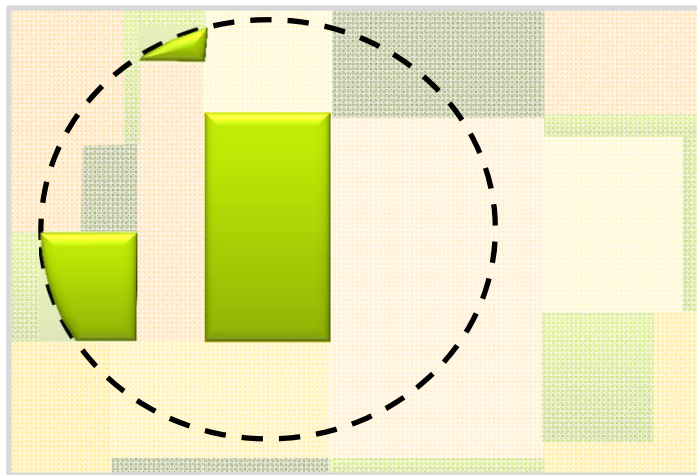
Context

HYPOTHESES

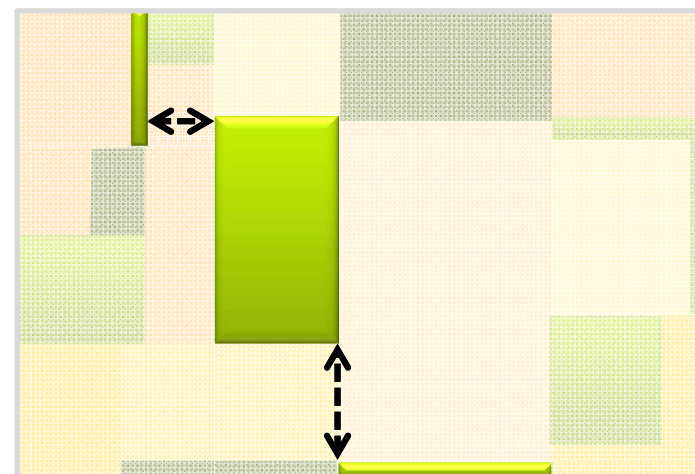


7

The best connectivity index in grassland patches is the **amount** of surrounding semi-natural grasslands



In linear elements, connectivity metrics including **distance** to grasslands better fit butterfly patterns



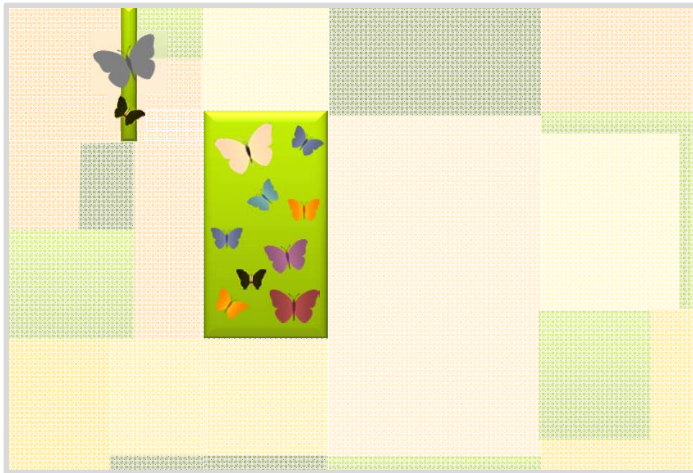


Context

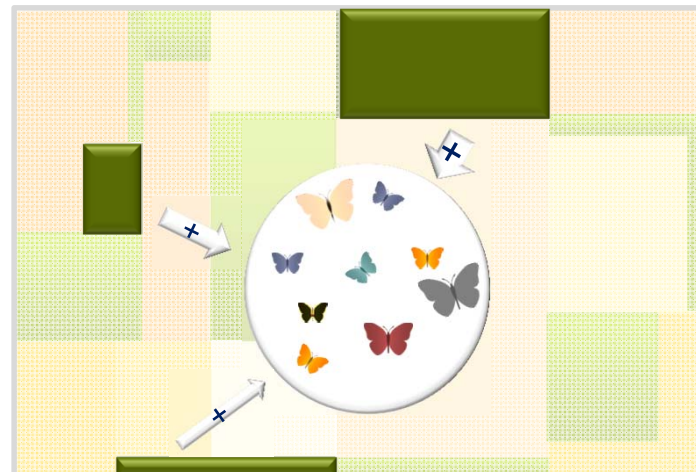
HYPOTHESES



Communities are of lower conservation value in linear elements compared to grassland patches



Woodlands have a additional positive effect



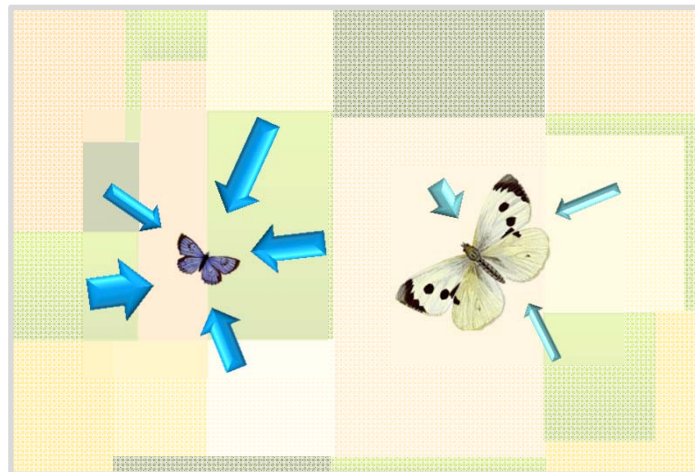


Context

HYPOTHESES



Grassland specialist and sedentary species are more strongly affected by landscape than generalist and mobile ones





Methods

SAMPLING DESIGN

3 regions



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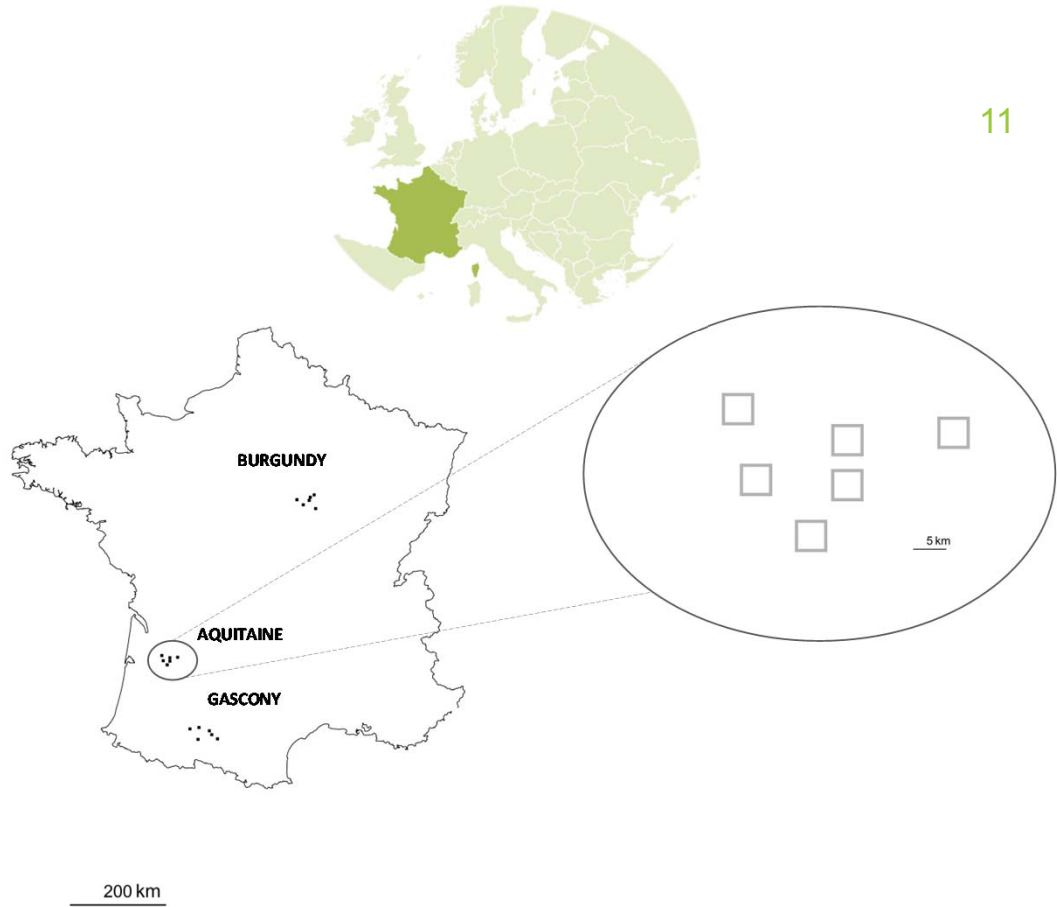




Methods

SAMPLING DESIGN

3 regions
6 replications / region



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Methods

SAMPLING DESIGN

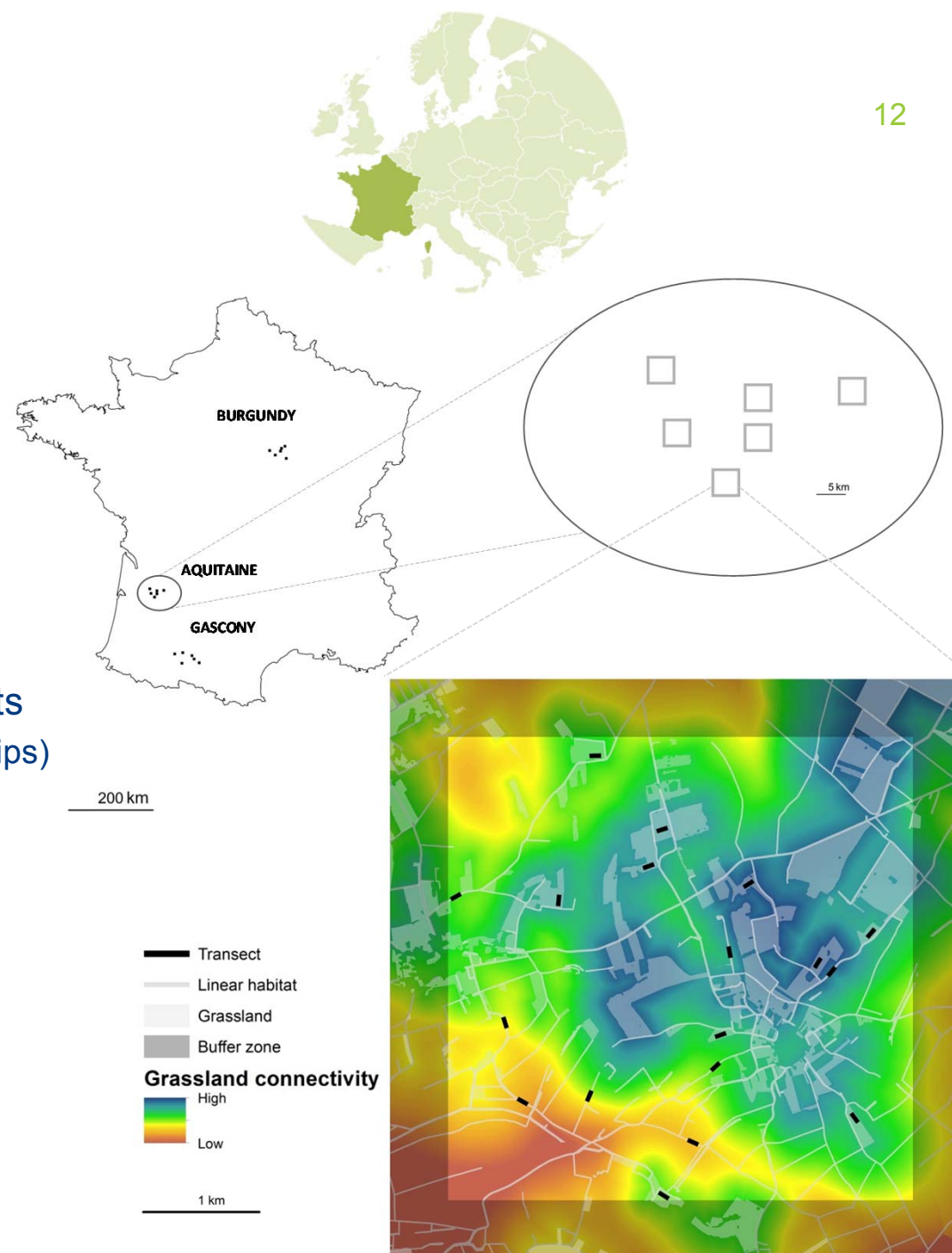
3 regions

6 replications / region

In each landscape:

- 8 grasslands
- 8 grassy linear elements
(half road verges, half grass strips)
along a grassland
connectivity gradient

→ **286** sampled sites





Methods

FIELD WORK

Transect 5 x 100 m
Butterflies recorded 3 times
(6624 ind. 78 sp.)
Local quality




Methods

FIELD WORK

Transect 5 x 100 m
 Butterflies recorded 3 times
 (6624 ind. 78 sp.)
 Local quality

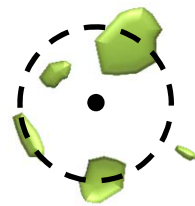


CONNECTIVITY METRICS

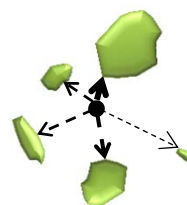
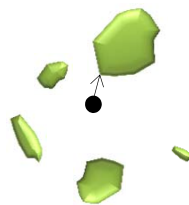
Grassy linear elements


Grassland patches, woodlands

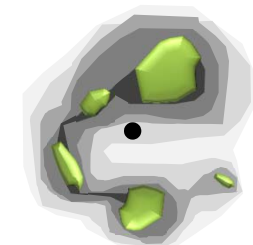
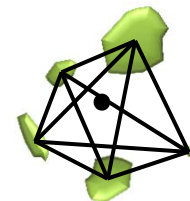

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Radius = 100,
 250, 500 m



$\alpha = 2, 4, 10$





METHODS

STATISTICS



Linear mixed models

Datasets

Grasslands and linear elements separately



Response variables

Community conservation value
Species richness by group

- grassland specialization (2 grps)
- dispersal capacity (2 grps)

$$Y = XB + ZU + E$$

Random effects

Landscapes nested in regions

Explanatory variables

Connectivity metrics

- grasslands
- woodlands
- linear elements

Habitat quality

- nectar resources
- host plant diversity
- vegetation height
- nutrient level



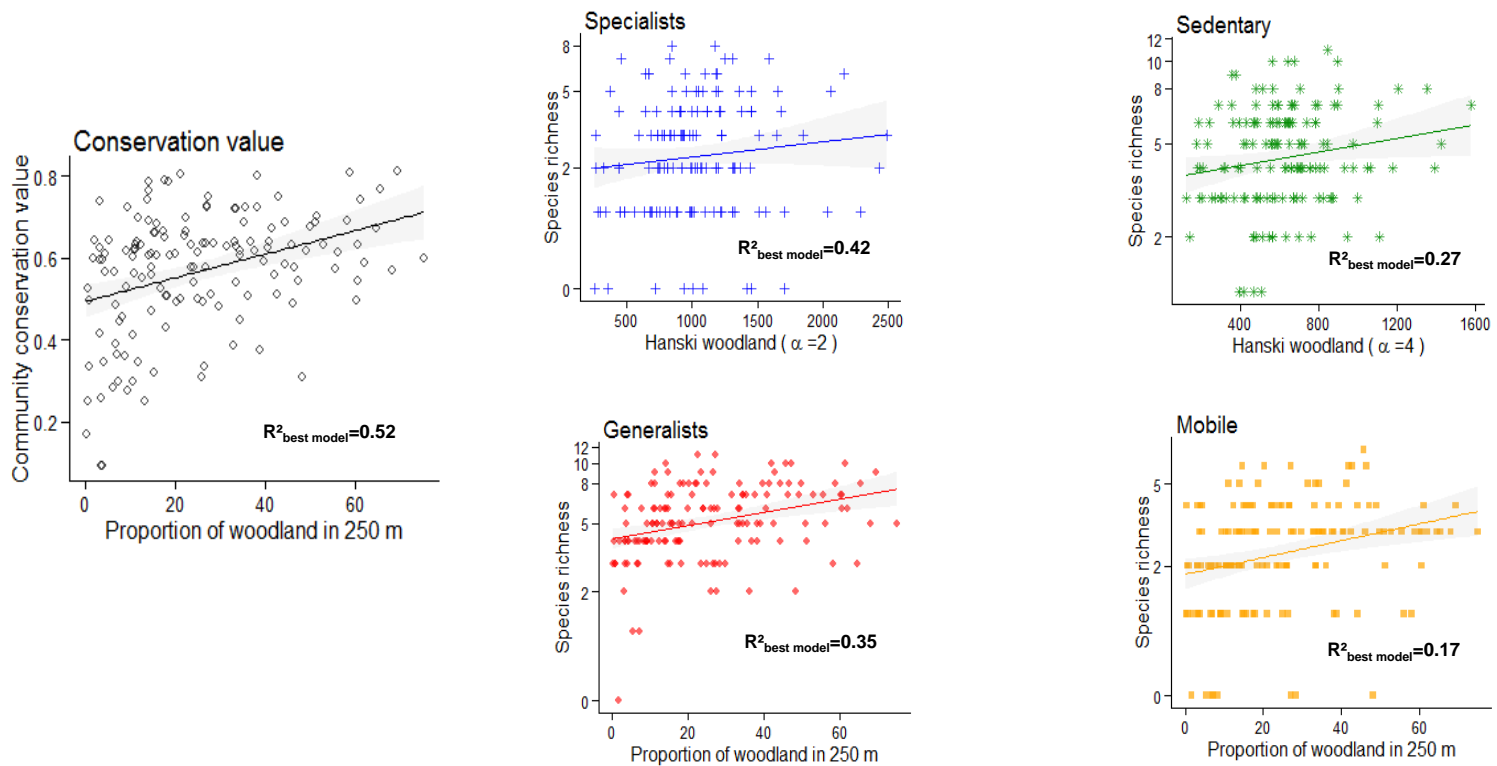
Results

GRASSLANDS



No effect of grassland connectivity

Positive effect of woodland in vicinity (% 250 m or Hanski)





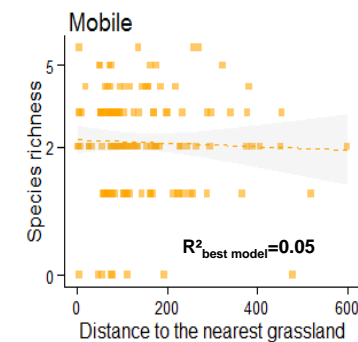
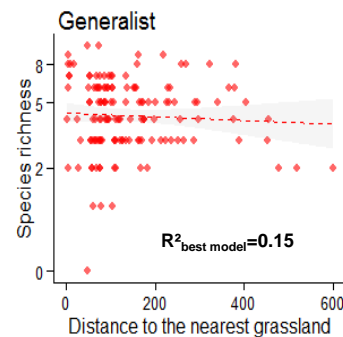
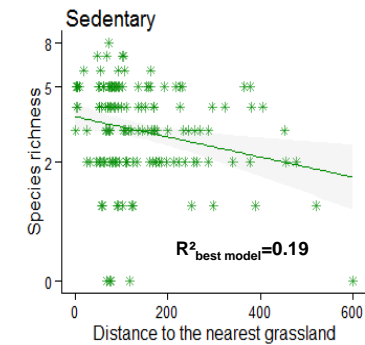
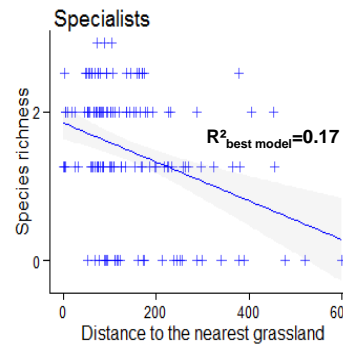
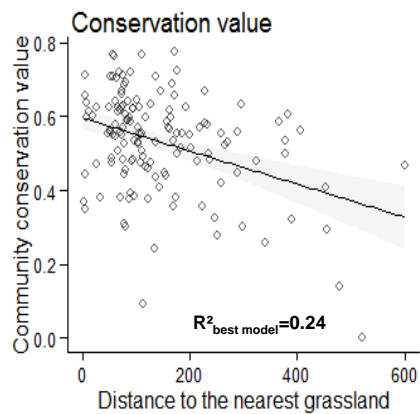
Results

LINEAR ELEMENTS



Conservation value and species richness of specialist and sedentary decrease with distance to the nearest grassland patch

No effect of woodland connectivity

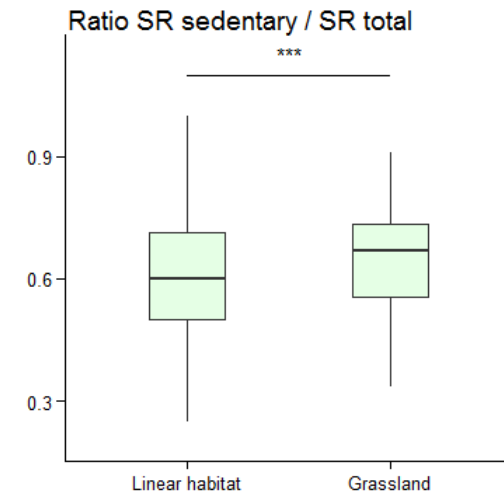
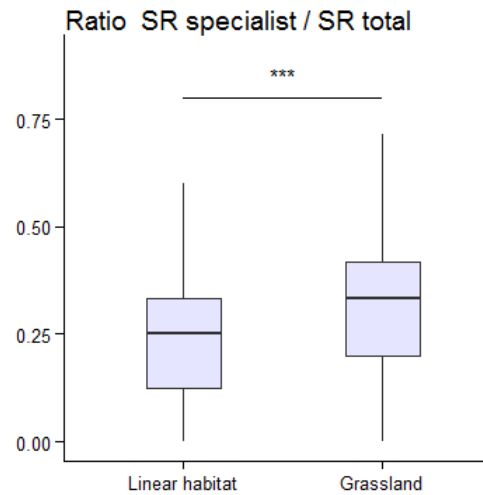
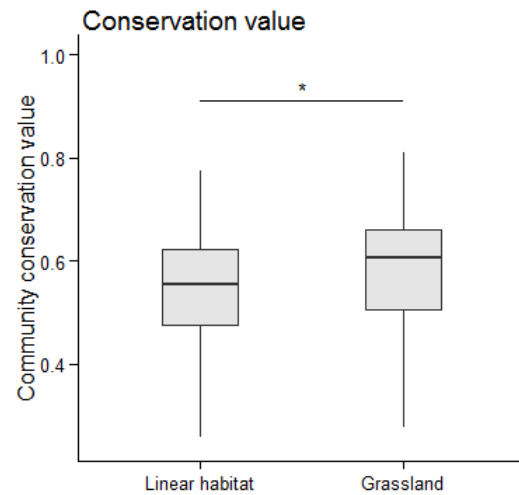


Results

GRASSLANDS VS LINEAR ELEMENTS



Linear habitats contains communities of **lower conservation value with fewer specialist and sedentary species** than in grasslands



Discussion

RESULTS

Communities impoverished in linear elements

Lower quality (resources, edge effect), carrying capacity

In grasslands

No effect of grassland connectivity

→ Contexts not enough fragmented (17% grassland)

% woodland positive

→ Complementation/supplementation, functional spillover?

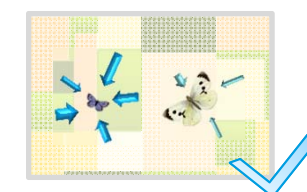
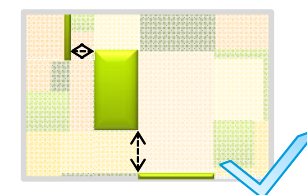
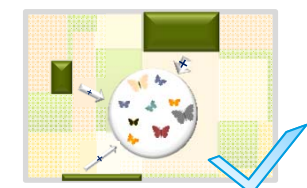
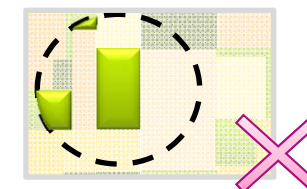
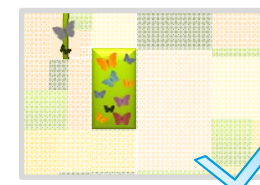
In linear habitats

Decreased diversity with distance to grassland

→ Source-sink or island-mainland?

Species traits

Specialists and sedentary species more impacted



Discussion

CONSERVATION IMPLICATIONS

Linear elements

Not sufficient to preserve butterfly communities

Woodlands

Positive effect even on grassland specialists

Species of conservation concern most impacted

Homogenization of communities

Connectivity metrics

Using multiple metrics help to understand population/community functioning



Discussion

CONSERVATION IMPLICATIONS

Linear elements

Not sufficient to preserve butterfly communities

Woodlands

Positive effect even on grassland specialists

Species of conservation concern most impacted

Homogenization of communities

Connectivity metrics

Using multiple metrics help to understand population/community functioning

→ Mosaic of grasslands and woodlands is more effective than habitat connectivity to conserve butterflies in French farmland



Thanks for your attention!



Questions?



Mosaic of grasslands and woodlands is more effective than habitat connectivity to conserve butterflies in French farmland



Anne Villemey^{a,*}, Inge van Halder^{b,c}, Annie Ouin^{d,e}, Luc Barbaro^{b,c}, Julie Chenot^{b,c}, Pauline Tessier^{d,e}, François Calatayud^{d,e}, Hilaire Martin^a, Philip Roche^f, Frédéric Archaux^a



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