Les traits de vie comme indicateurs de réponses multi-taxa à la fragmentation des paysages forestiers

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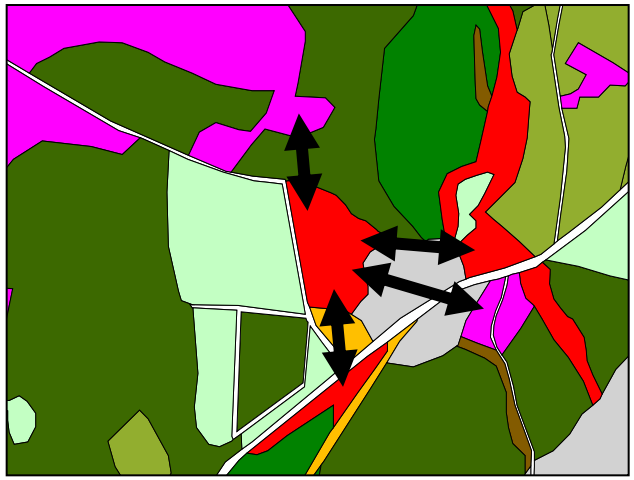


Atelier multitaxa – GIP Ecofor Bordeaux, 26 juin 2013

Introduction

- **Le changement global conduit à une homogénéisation biotique**
  (Mc Kinney and Lockwood 1999)

PERSPECTIVES

Biotic homogenization: a few winners replacing many losers in the next mass extinction

Michael L. McKinney
Julie L. Lockwood

- **Perte de biodiversité avec un déclin généralisé des espèces spécialistes**
  (Warren et al. 2001)

Rapid responses of British butterflies to opposing forces of climate and habitat change

M. S. Warren*, J. K. Hill†‡, J. A. Thomas§, J. Asher*, R. Fox*, B. Huntley‡, D. B. Roy‖, M. G. Telfer‖, S. Jeffcoate*, P. Harding‖, G. Jeffcoate*, S. G. Willis‡, J. N. Greatorex-Davies‖, D. Moss‖ & C. D. Thomas¶

- **Les espèces spécialistes partagent des traits d'histoire de vie particuliers**
  (Julliard et al. 2004)

Common birds facing global changes: what makes a species at risk?

ROMAIN JULLIARD, FRÉDÉRIC JIGUET and DENIS COUVET
Centre de Recherches sur la Biologie des Populations d'Oiseaux, Muséum National d'Histoire Naturelle, 55, Rue Buffon, F-75005 Paris, France

Introduction

- **Traits de vie caractérisant les espèces sensibles à la fragmentation**

  (Henle et al. 2004)

Predictors of species sensitivity to fragmentation

KLAUS HENLE[1,*], KENDI F. DAVIES[2,6], MICHAEL KLEYER[3], CHRIS MARGULES[4] and JOSEF SETTELE[5]

- ❖ **Rareté et biogéographie**
- ❖ **Guilde trophique**
- ❖ **Taille ou masse**
- ❖ **Mobilité et dispersion**
- ❖ **Potentiel reproductif**
- ❖ **Phénologie**

Oedippe

Pipit rousseline

Introduction

- **Relation entre fragmentation du paysage et diversité fonctionnelle (traits de vie)**

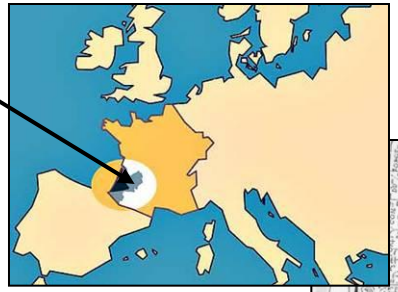
- **Contexte particulier des forêts de plantation**

- **Trois taxa animaux avec différentes histoires de vie: oiseaux nicheurs, carabiques et papillons de jour**

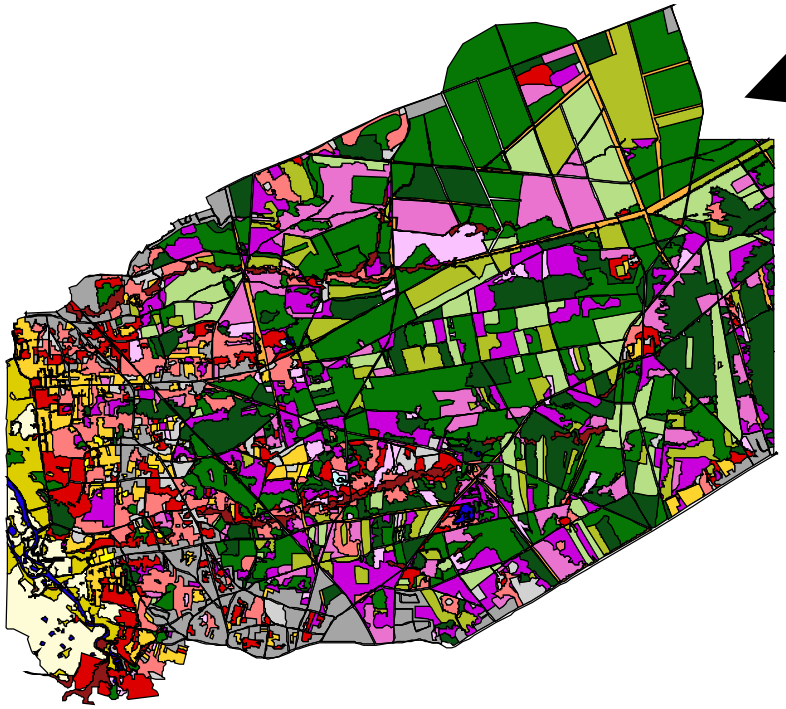
- **Question: comment relier directement les traits de vie aux métriques de paysage (structure et composition)?**

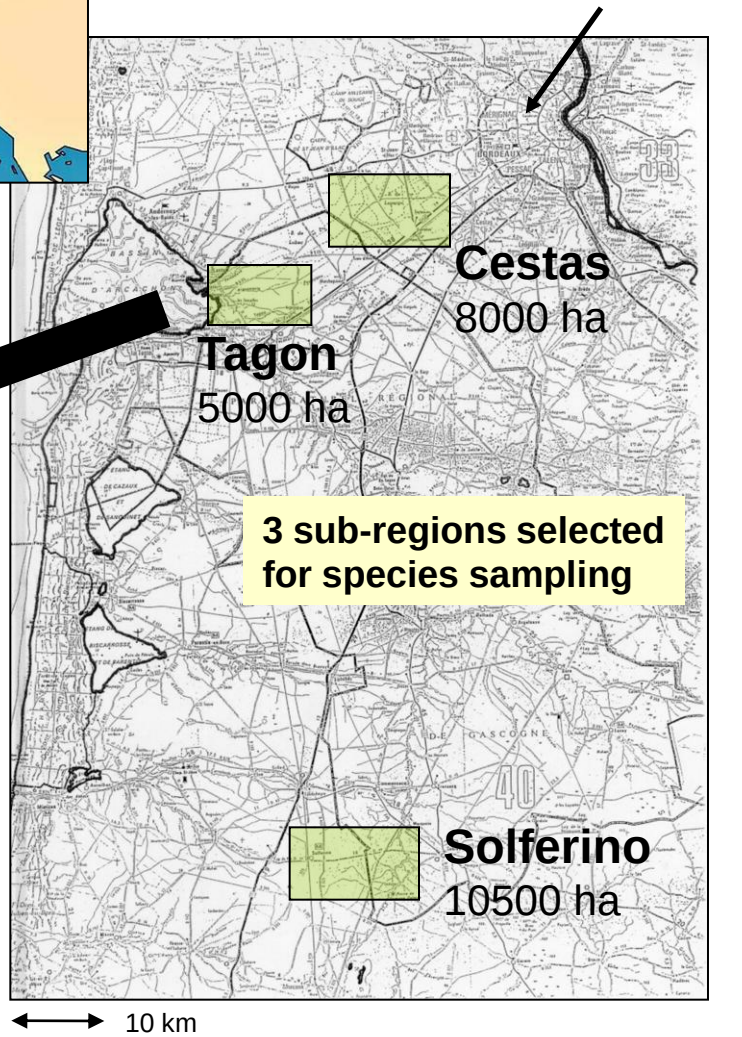
Study area

Landes de Gascogne forest, south-west France:



1 million ha of landscapes dominated by native maritime pine *Pinus pinaster* plantations with clear-cutting every 40-50 yrs





Sampling methods

Stratified sampling based on the 7 main habitat types:

- 4 stages of the pine plantations rotation cycle

- 3 semi-natural habitat types

herbaceous clearcuts

shrubby clearcuts

young pines (< 7m)

mature pines (>7m)

hay meadows

herbaceous firebreaks

deciduous woods and hedges

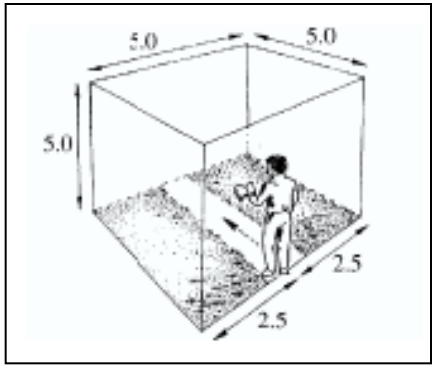
Sampling methods

- 287 point counts for breeding birds

2 x 20min visits - early and late breeding seasons

- 244 pitfall traps for carabid beetles

continuous trapping - spring-autumn

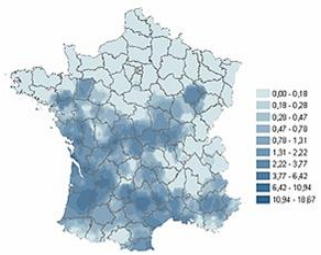


- 162 line transects for butterflies

400m-long and 5m-wide with 4 visits - spring-autumn

Selection of life-history traits

- Rarity and biogeography



- National or European trend (increasing, stable, declining)

- National rarity (% range)

- Regional rarity (% range)

- Biogeographical position (northern, widespread, southern)

- Trophic guild

- Birds = Foraging guild and Diet

- Carabids = Diet

- Butterflies = Polyphagy level and Host-plant type

- Body size

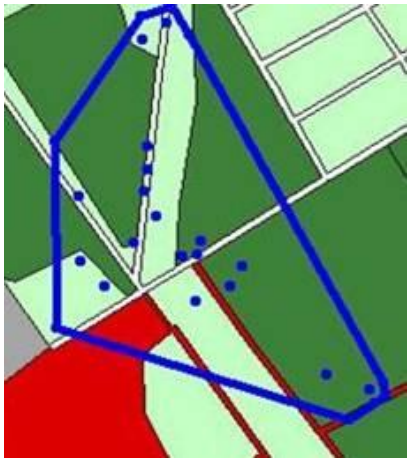
- Birds = Body mass

- Carabids = Body length

- Butterflies = Wing length

Selection of life-history traits

- Mobility and dispersal
  - **- Birds = Home-range size and Migration status**
  - **- Carabids = Wing development**
  - **- Butterflies = Population density and Mobility**



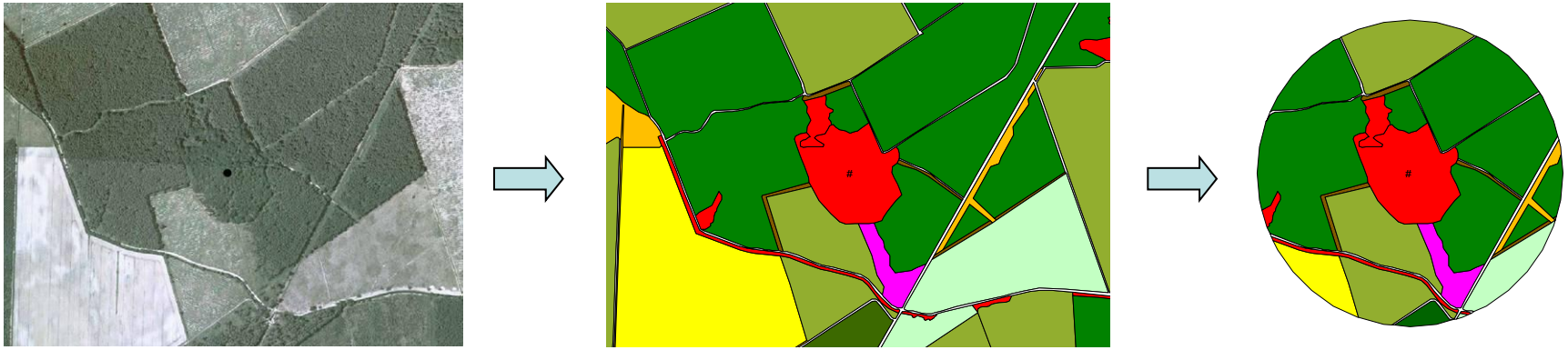
- Breeding parameters
  - **- Birds = Nest location and Clutch size**
  - **- Carabids = Breeding season**
  - **- Butterflies = Egg number**

- Phenology
  - **- Birds = Laying date**
  - **- Carabids = Overwintering and Activity period**
  - **- Butterflies = Overwintering and Flying period**

Landscape metrics

GIS mapping of 9 land-use types based on aerial photos

Extraction of circular buffers of 50ha (400m-radius) around sampling points

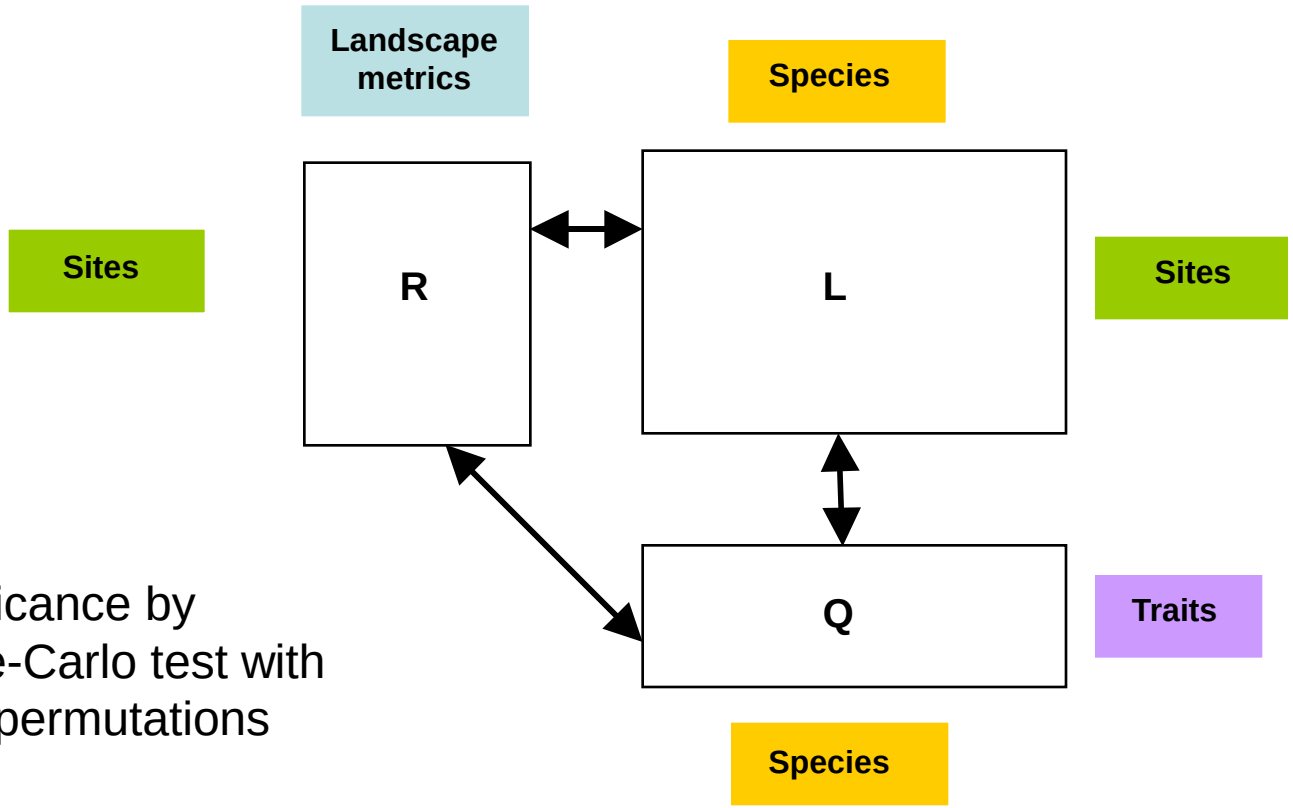


Calculation of 12 landscape metrics with Fragstats software (McGarigal et al. 2002)

- composition: % cover of 8 main habitats (7 sampled types + crops)
- 3 variables for landscape configuration: Mean patch area, Edge density and Shannon index of habitat diversity

Data analysis

- **RLQ analysis**: three-table ordination method based on co-inertia analysis in R-package ade4 (Doledec et al 1996, Dray and Dufour 2007)



Significance by Monte-Carlo test with 1000 permutations

RLQ analyses

RLQ analyses were significant at *P* < 0.001 for all taxa

Landscape metrics correlations

	F1-Bird	F2-Bird	F1-Beet	F2-Beet	F1-Butt	F2-Butt
Edge density	**0.41**	0.01	**0.45**	-0.13	**0.46**	-0.07
Mean patch area	**-0.43**	0.15	**-0.43**	0.18	**-0.35**	0.11
Meadows	0.28	**0.38**	0.25	**0.46**	0.06	-0.20
Shrublands	0.11	-0.25	-0.08	-0.04	**0.48**	**0.42**
Mature pines	-0.07	**-0.69**	-0.08	**-0.61**	-0.33	0.13
Deciduous woods	**0.42**	0.09	**0.35**	0.21	0.27	**-0.59**

First axis = gradient of landscape fragmentation similar for all taxa

Second axis = gradient of landscape composition differing among taxa

- **meadows vs mature pines for birds and carabids**
- **deciduous woods vs shrublands for butterflies**

Bird traits

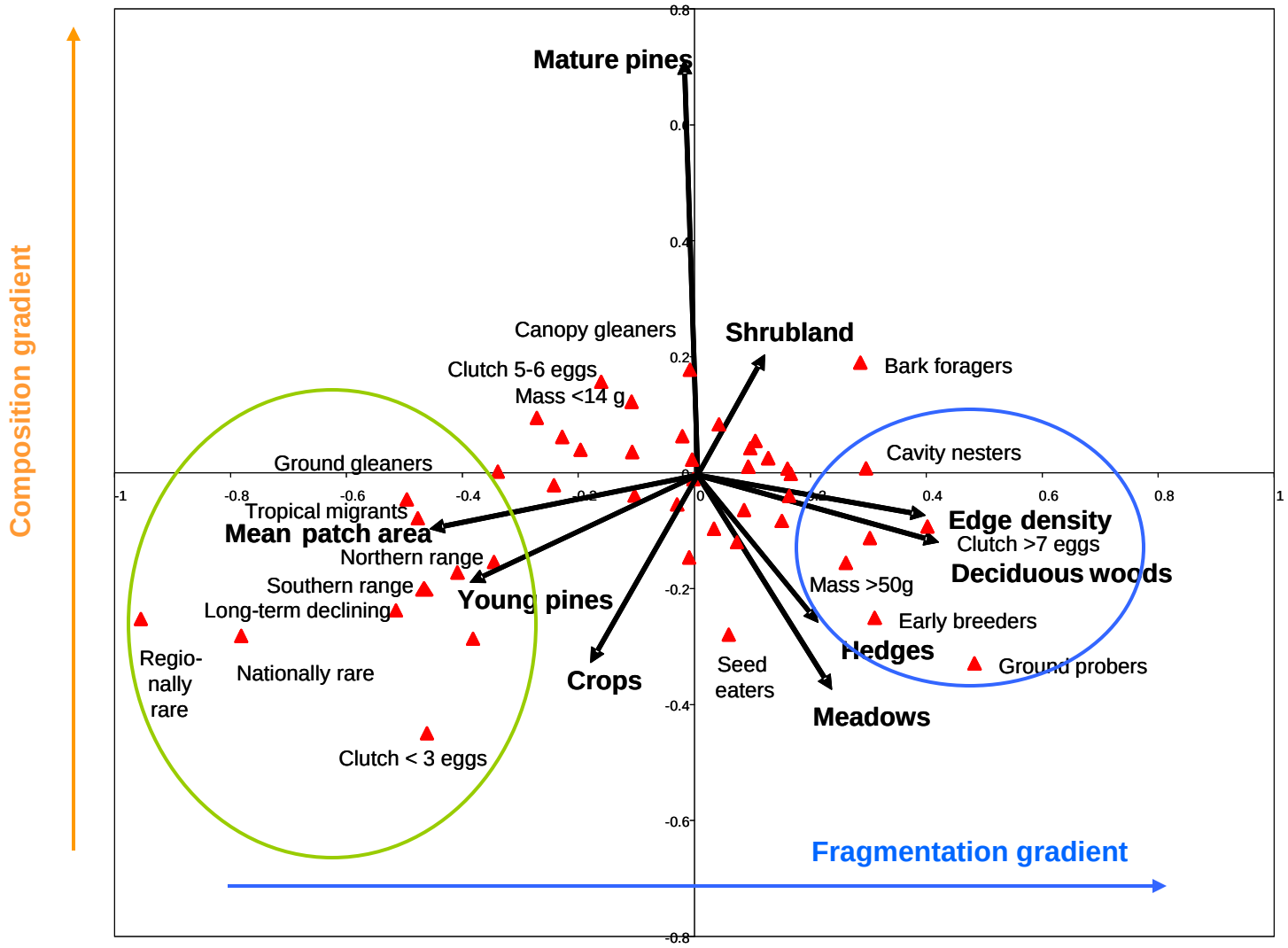
Bird life traits	F1	F2
National trend	0.10	0.04
National rarity	0.12	0.03
Regional rarity	0.12	0.02
Biogeography	0.09	0.06
Foraging guild	0.20	0.23
Diet	0.04	0.05
Nest location	0.12	0.06
Home range	0.01	0.04
Clutch size	0.09	0.19
Body mass	0.06	0.12
Migration status	0.12	0.04
Laying date	0.06	0.11

Dartford warbler

Cirl bunting

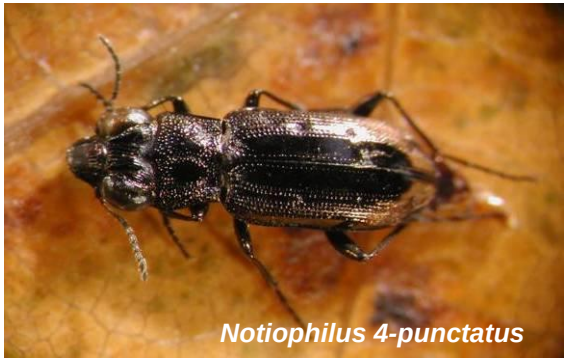
Linnet

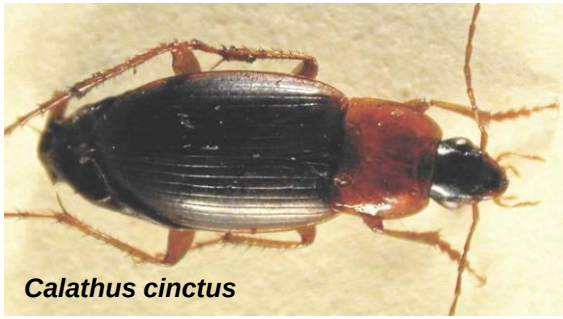
Bird traits


Composition gradient
Fragmentation gradient
Mature pines
Shrubland
Young pines
Crops
Meadows
Hedges
Deciduous woods
Edge density
Mean patch area
Canopy gleaners
Clutch 5-6 eggs
Mass <14 g
Bark foragers
Cavity nesters
Clutch >7 eggs
Mass >50g
Early breeders
Ground probers
Seed eaters
Ground gleaners
Tropical migrants
Northern range
Southern range
Long-term declining
Regio-nally rare
Nationally rare
Clutch < 3 eggs
0.8
0.6
0.4
0.2
-0.2
-0.4
-0.6
-0.8
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1

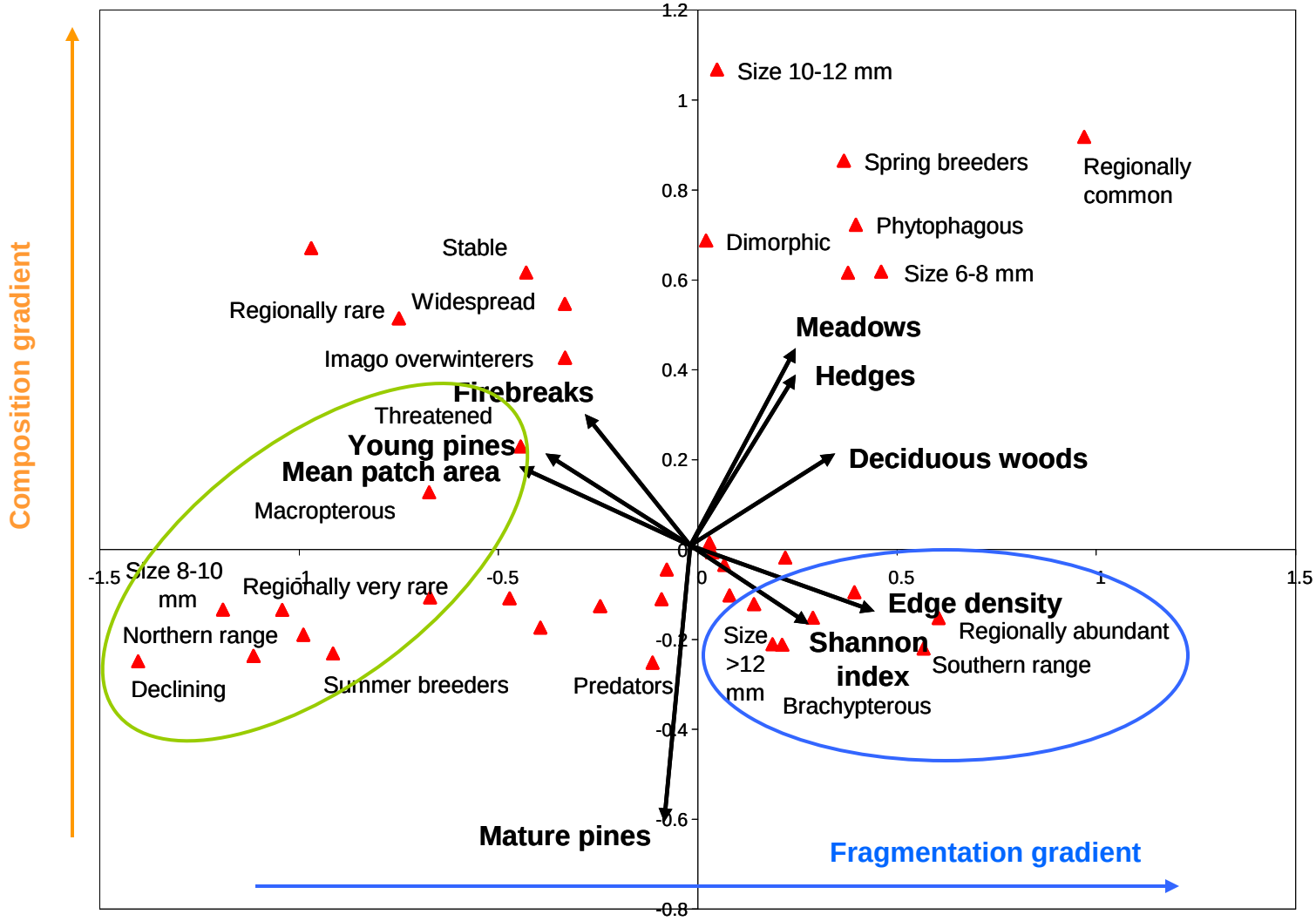
Carabid beetle traits

Beetle life traits	F1	F2
European trend	0.13	0.14
European rarity	0.01	0.01
Regional rarity	0.30	0.12
Biogeography	0.19	0.14
Daily activity	0.08	0.03
Diet	0.03	0.22
Overwintering	0.01	0.05
Body color	0.01	0.01
Breeding period	0.08	0.16
Body size	0.09	0.24
Wing develop.	0.06	0.13
Activity period	0.21	0.11





Carabid beetle traits



Butterfly traits

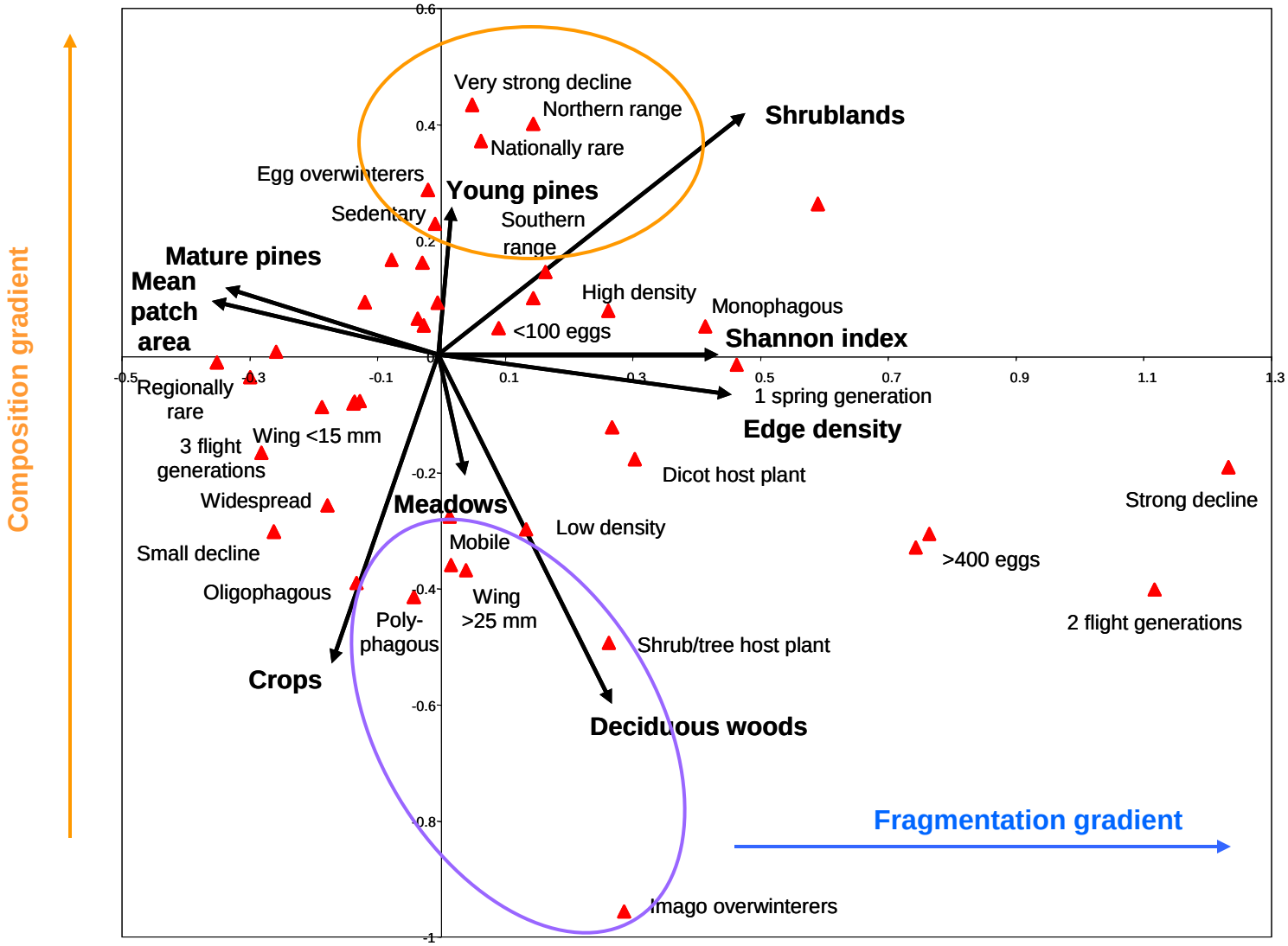
Butterfly life traits	F1	F2
National trend	0.27	0.18
National rarity	0.13	0.16
Regional rarity	0.20	0.07
Biogeography	0.06	0.24
Polyphagy level	0.04	0.09
Host plant type	0.07	0.09
Overwintering	0.02	0.33
Pop. density	0.15	0.04
Number of eggs	0.17	0.04
Wing length	0.06	0.11
Mobility	0.00	0.29
Flying period	0.19	0.09

Limenitis reducta

Hipparchia semele

Satyrium ilicis

Butterfly traits



Summary: fragmentation-sensitive traits

Which traits were good indicators of sensitivity to fragmentation?

- **Rarity and biogeography – yes for rare, declining and northern species**
- **Trophic guild – yes for bird foraging guild but beetle and butterfly diets were more linked to landscape composition**
- **Body size – yes for mid-sized species but no for large-sized species**
- **Mobility level – yes for long-distance dispersing birds and carabids but mobility in butterflies more linked to landscape composition**
- **Reproductive potential and phenology – yes for low-productive and late-breeding birds and carabids, and overwintering mode for butterflies**

- **Combination of life-history traits as a tool for conservation planning of threatened species ?**

Marsh fritillary

Red-backed shrike

Harpalus rufipalpis

- **Conservation of functional diversity at the landscape scale may improve ecosystem services**
  (Tscharntke et al. 2008)

  - **Seed dispersal**
  - **Pollination**
  - **Biological control**

LANDSCAPE CONSTRAINTS ON FUNCTIONAL DIVERSITY OF BIRDS AND INSECTS IN TROPICAL AGROECOSYSTEMS

TEJA TSCHARNTKE,[1,6] CAGAN H. SEKERCIOGLU,[2] THOMAS V. DIETSCH,[3] NAVJOT S. SODHI,[4] PATRICK HOEHN,[1] AND JASON M. TYLIANAKIS[5]

Functional richness and ecosystem services: bird predation on arthropods in tropical agroecosystems

STACY M. PHILPOTT,[1,6] OLIVER SOONG,[2] JACOB H. LOWENSTEIN,[3,4] ASTRID LUZ PULIDO,[5] DIEGO TOBAR LOPEZ,[5] DAN F. B. FLYNN,[3] AND FABRICE DECLERCK[5]

Perspectives : relier les métriques de diversité fonctionnelle à l'hétérogénéité du paysage (projet GIP Ecofor Bilisse)

4 composantes de la diversité fonctionnelle (traits multiples)

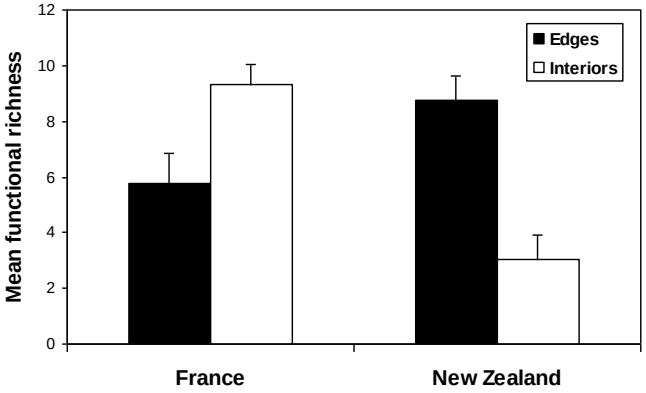
A distance-based framework for measuring functional diversity from multiple traits

ETIENNE LALIBERTÉ[1,3] AND PIERRE LEGENDRE[2]

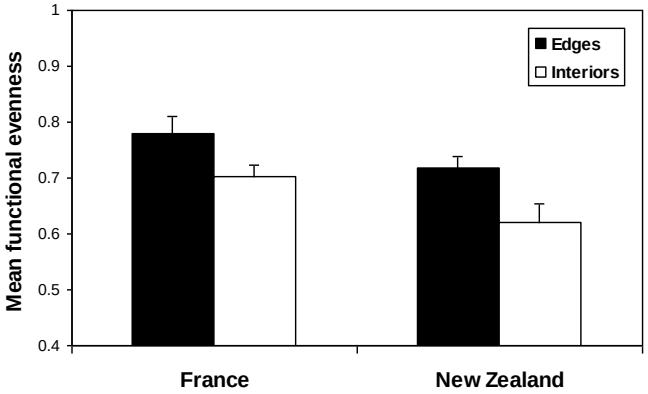
7 traits de vie compilés pour 21 espèces en NZ et 33 espèces d'oiseaux en France:
body mass, biogeography, mobility, foraging method, adult diet, nest location, clutch size

Effets des lisières sur la diversité fonctionnelle des oiseaux

	FRic	FEve	FDiv	FDis
France				
Edges	5.76	**0.78**	**0.70**	**1.99**
Interiors	**9.31**	0.70	0.63	1.96
Total	**7.53**	**0.74**	0.66	1.97
New Zealand				
Edges	**8.35**	**0.72**	**0.75**	**2.16**
Interiors	3.46	0.62	0.70	1.91
Total	5.91	0.67	**0.73**	**2.04**
Total edges	**7.05**	**0.75**	**0.72**	**2.07**
Total interiors	6.38	0.66	0.67	1.94

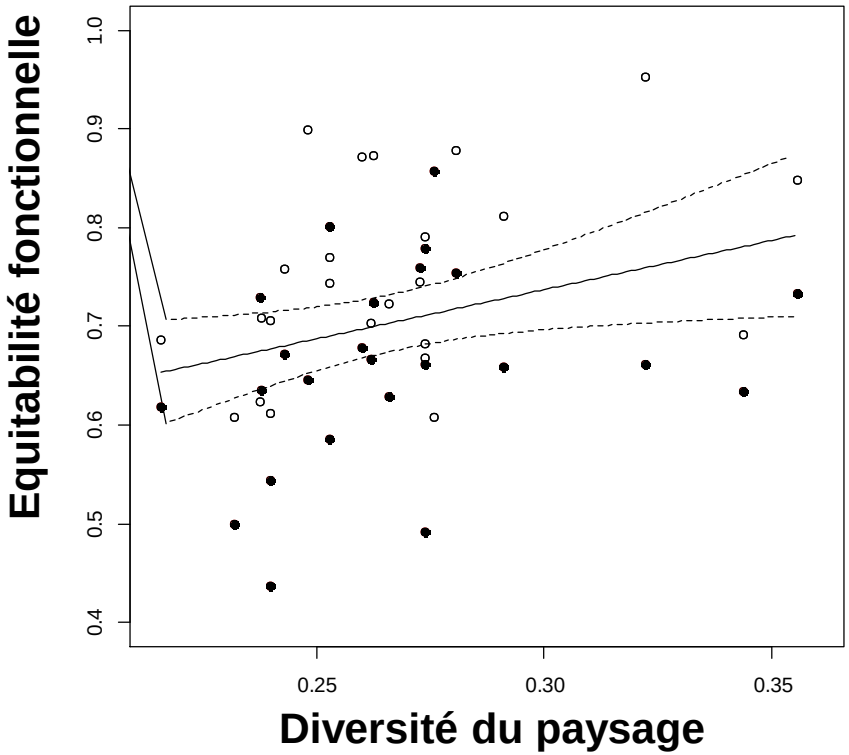


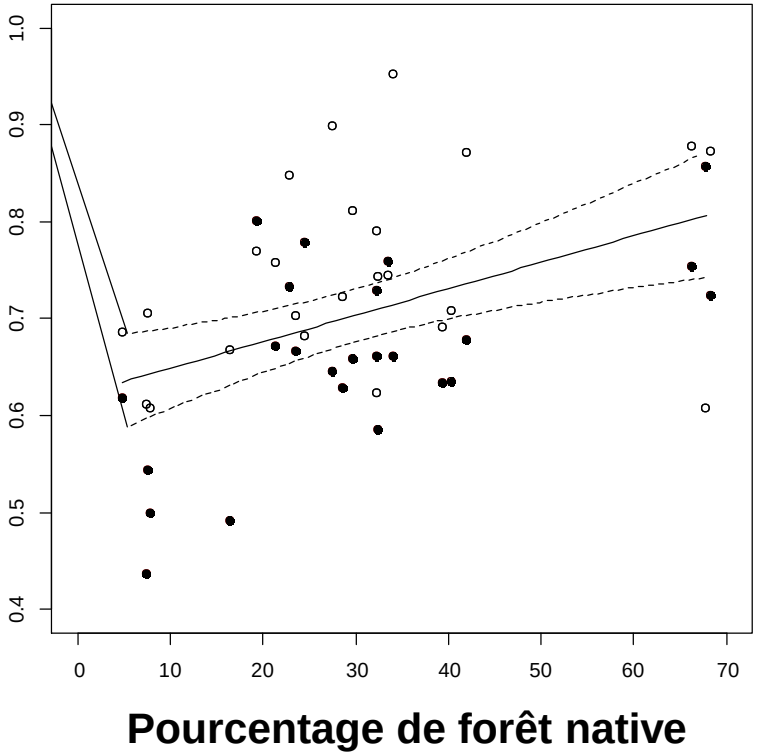
Richesse fonctionnelle



Equitabilité fonctionnelle

Effets du paysage sur la diversité fonctionnelle des oiseaux





Merci aux collègues impliqués dans ce travail

Et aux financeurs et gestionnaires forestiers