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How do trees structure pollinator communities in agricultural landscapes ?

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Trees in french rural landscapes

A diversity of types:



Forests
Small groves
Edges
Hedgerows
Scattered trees ...
= rural forests



Trees in french rural landscapes



Rural forest owners and managers are mainly farmers in SW France (included in farms, traditional self-reliance and autonomie principles).

They are part of cultural landscapes, source of ES including production (less today than before).

Trees in french rural landscapes



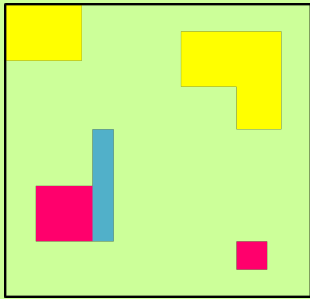
Rural forests = Resources for many pollinators :

- feeding: pollen and nectar, host plants
- nesting sites: above-ground (cavities: plant stems or holes) / below ground (burrows)
- overwintering

Trees are part of heterogeneity of rural landscapes

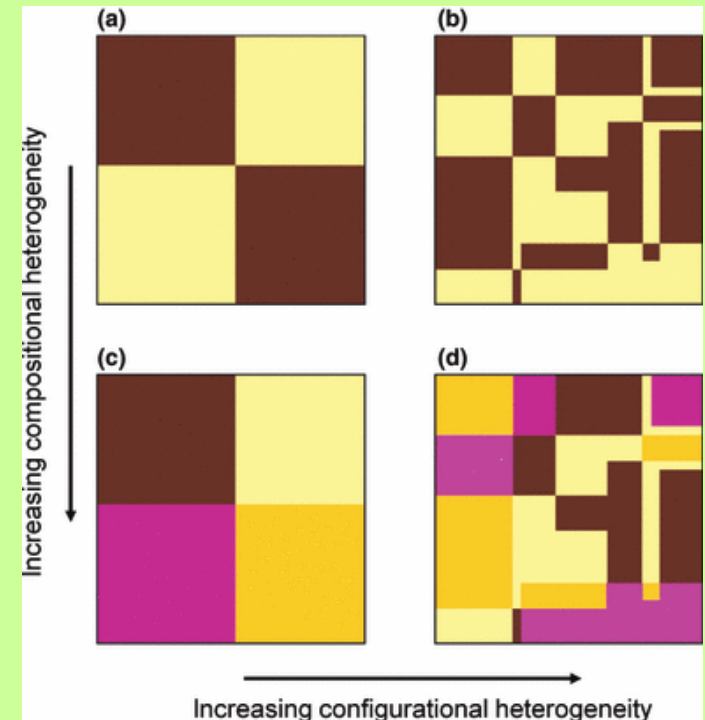
Mosaic of semi-natural habitats:

patches with different characteristics: permanent grasslands and other herbaceous habitats, all components of rural forests



Characterised by its

- composition (the number and proportions of different habitat types)
- configuration = the spatial arrangement of different habitat types

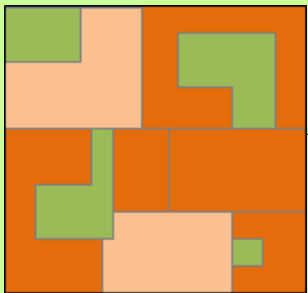
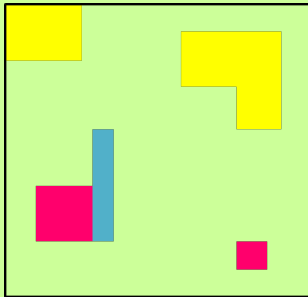


Fahrig et al 2011

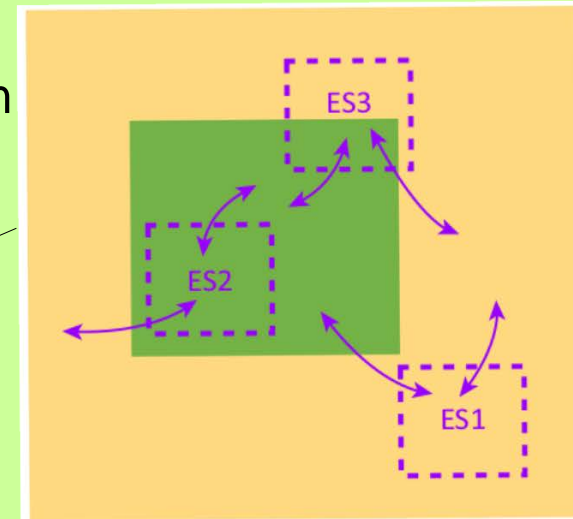
Trees are part of heterogeneity of rural landscapes

But trees are not alone ! They are embeded in the agricultural matrix





Semi-natural habitat mosaic



And ecotones / interaction between the two mosaics



Key:

-  Natural land cover: e.g., forest, grassland
-  Human-dominated land cover: e.g., crops, urban area
-  Area of ES supply
-  ES flow

Agricultural mosaic:

- different crops, temporary grasslands
- various farming practices (N input, herbicide/insecticides application, ploughing frequency, mowing)

Trends in Ecology & Evolution

Figure 1. Ecosystem Services (ESs) are Provided Both by Human-Dominated Land Covers (ES1) and Natural Land Covers (ES2). Flows can occur between natural and human-dominated land covers but also between distinct natural land covers and between distinct human-dominated land covers. ES3 corresponds to ESs supplied by organisms dependent on landscape heterogeneity (i.e., in the case of landscape complementation).

Trees are part of heterogeneity of rural landscapes

Since WW2 wide changes in European rural landscapes: intensification agricultural practices.

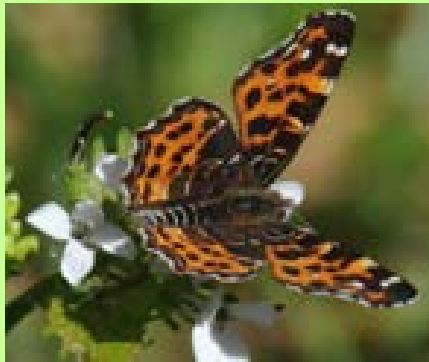
→ Landscape features such rural forests and natural grasslands were destroyed to develop larger, intensively managed agricultural fields, or converted to non-native commercial coniferous woodlands.

How do these landscape changes affect pollinator communities ?

A)



B)



C)



Spatial and temporal habitat complementarity

Hoverflies (Syrphidae) are **beneficial insects**

→ Adults are **pollinators**
(pollen and nectar)



→ larvae of some species are **biological control agents** (predation of aphids)



Ex : *Episyrphus balteatus*: pollinator and natural enemy

In winter migration in the south

fertilized females are resident (overwinter)

→ Interesting in **biological control**: early control of aphid populations

Spatial and temporal complementarity

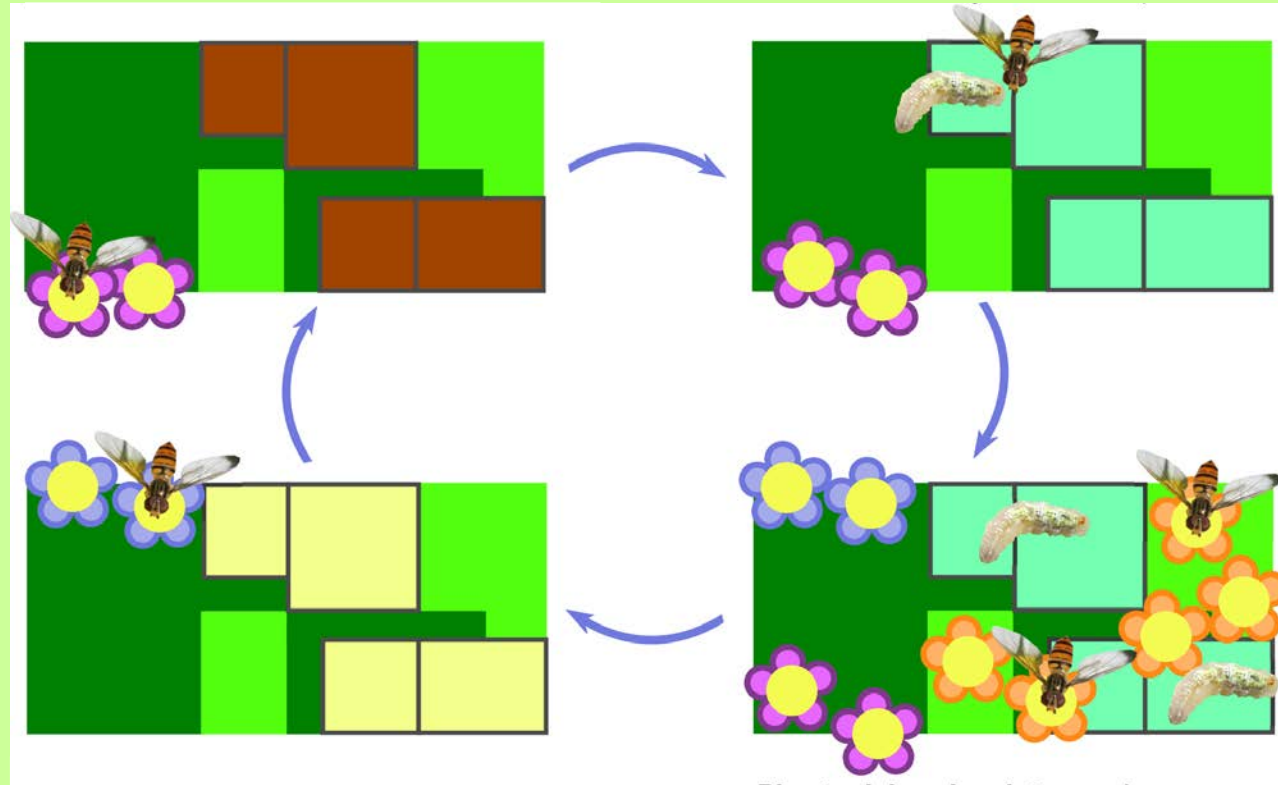
Sarthou et al 2005,
Alignier et al 2014



Winter: fertilized females overwintering in **forests** feed on late flowering species occurring in **south-facing edges**.

Early spring: females lay up eggs in **crops surrounding forests**, their aphidophagous larvae cause an early control of aphids.

- rural forests
- grasslands
- crop cycle:
 - bare ground
 - vegetation
 - ripening

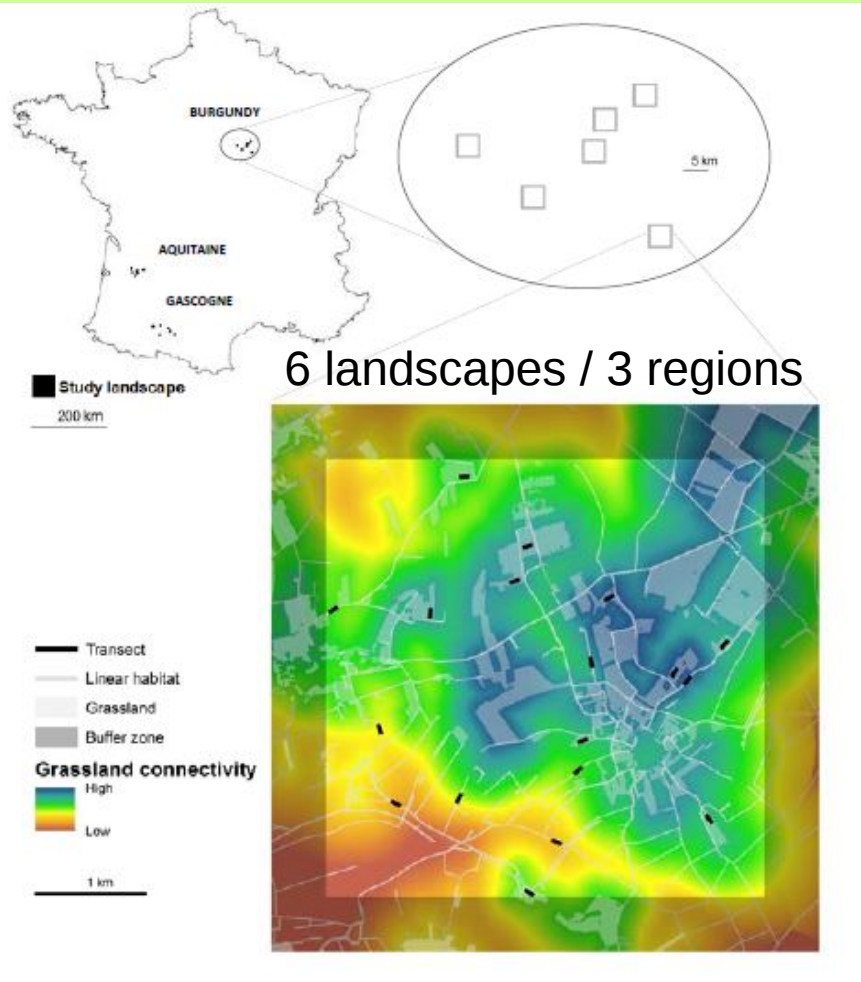


Summer: flowering resources are scarcer, adult hoverflies feed on flowers in **north-facing edges**.

Late spring: flowers are available in **semi-natural habitats** and in some crops, adults scatter in the landscape and lay up eggs not only in the close proximity of forests.

Habitat complementarity between grasslands and rural forests

Butterfly surveys in grassland patches and grassy linear elements



Villemey et al BioCons 2015

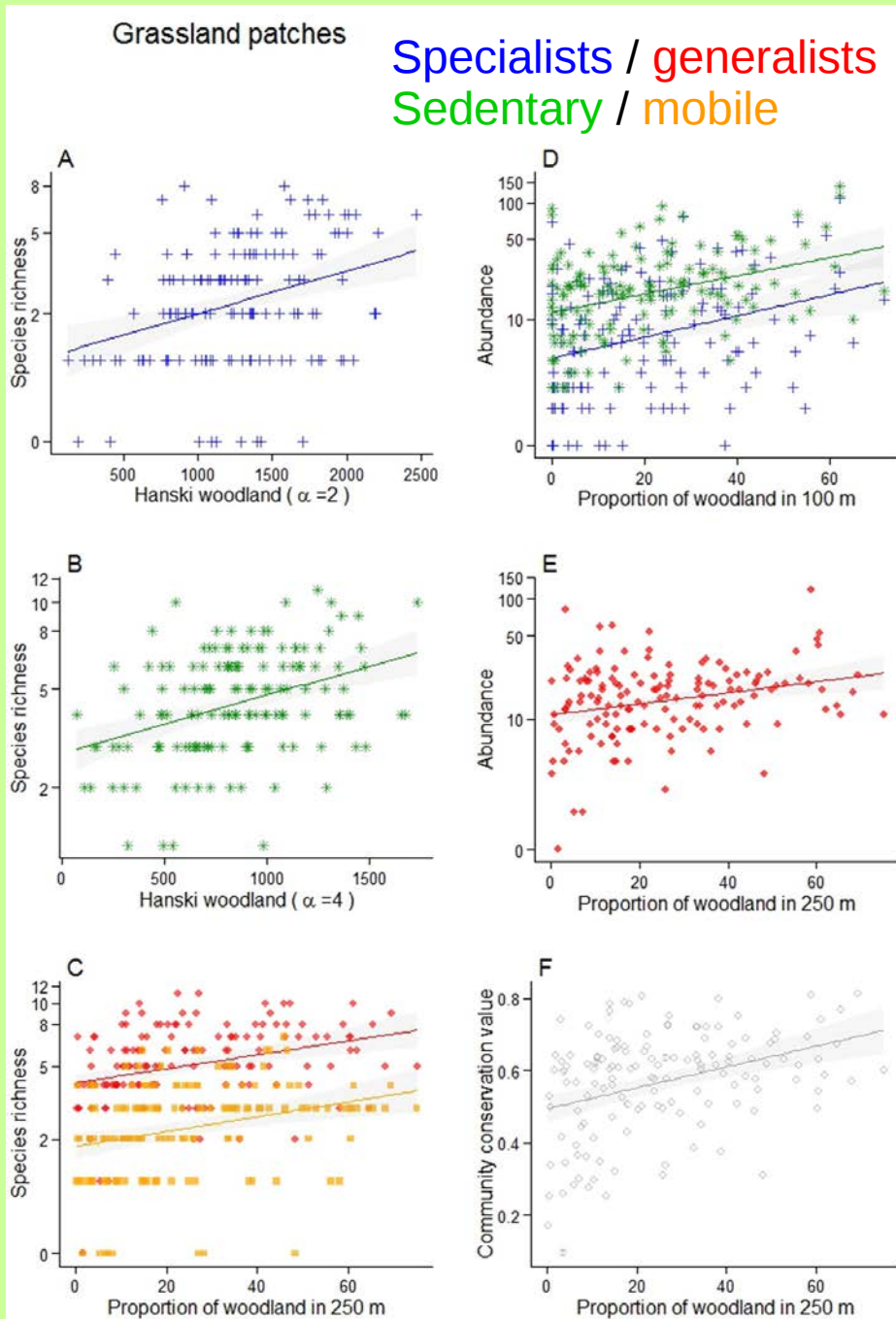
- herbaceous habitat connectivity
- rural forest connectivity
- habitat quality (flower cover ...)



Abundance, diversity and conservation value of butterflies in grasslands

- all species
- grassland specialists / generalists
- sedentary / mobile species

Habitat complementarity between grasslands and rural forests



- Low/no effect of herbaceous habitat connectivity (Hanski) on diversity and abundance
- Positive effect of rural forest % or connectivity on butterfly communities within grassland patches, even for grassland specialists

Rural forests =

Ressources

- Supplementation and complementation
- Critical resources after mowing

Shelter

- climatic (wind, buffer extreme temperatures)
- during disturbances in agricultural matrix
- buffer zone against pesticide spray

Amount and proximity of farm forests affect wild bees traits



Carrié et al 2017 Ecography

Amount and proximity of forest edges



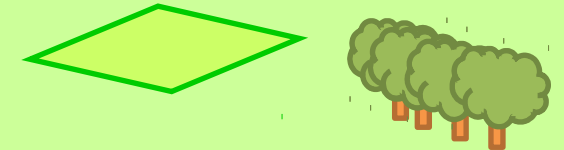
RLQ axe 2

Small-bodied
late foraging
Social
Polylectic
Below-ground nesting

Small-bodied
Solitary
below-ground nesting

RLQ axe 1

Grassland Hedgerow
amount and proximity



large-bodied
Social
above-ground nesting

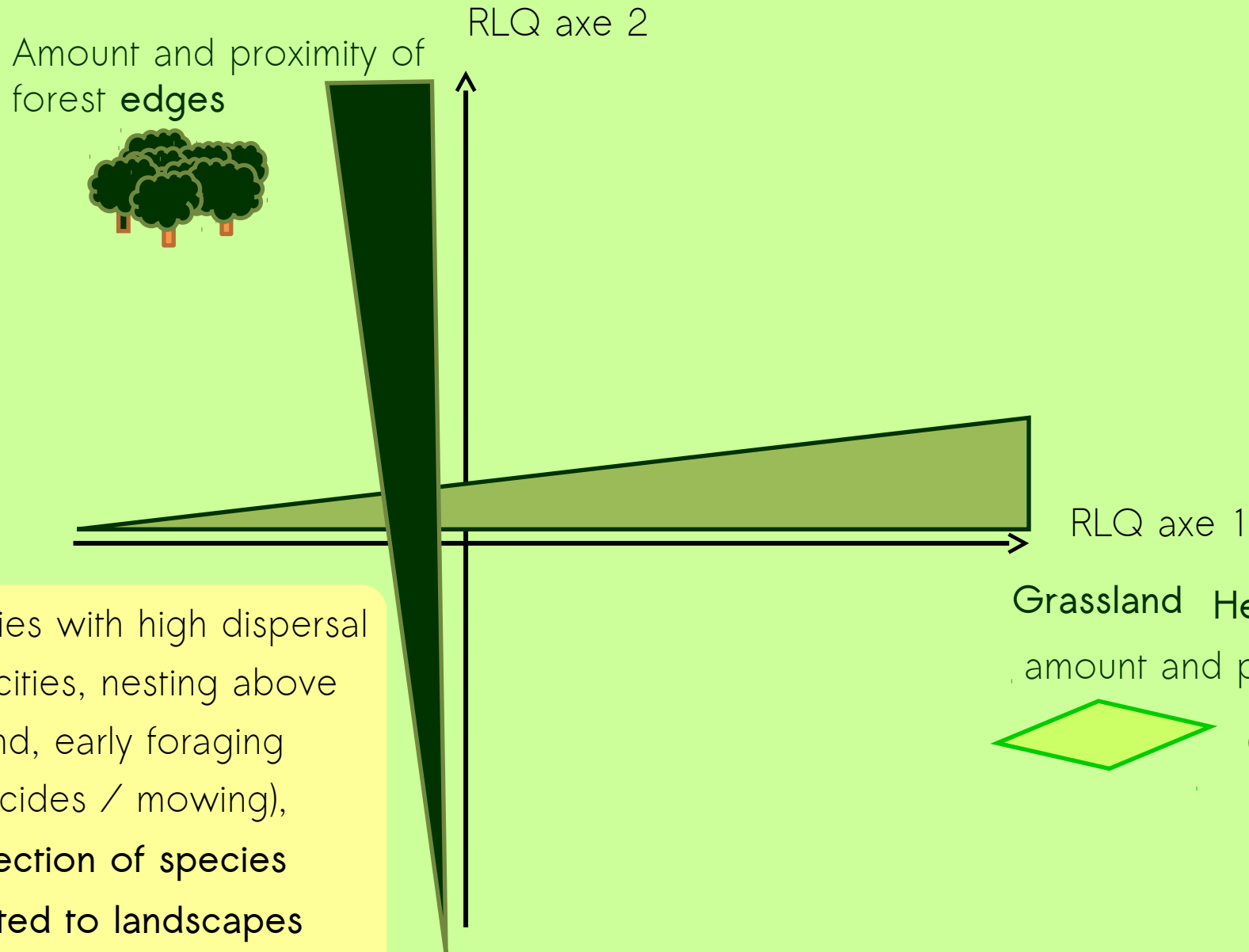
Large-bodied
early foragers
Solitary
Oligolectic
above-ground nesting

wild bees communities are different depending on landscape composition and configuration → diversity of landscapes

Amount and proximity of farm forests affect wild bees traits



Carrié et al 2017. *Ecography*

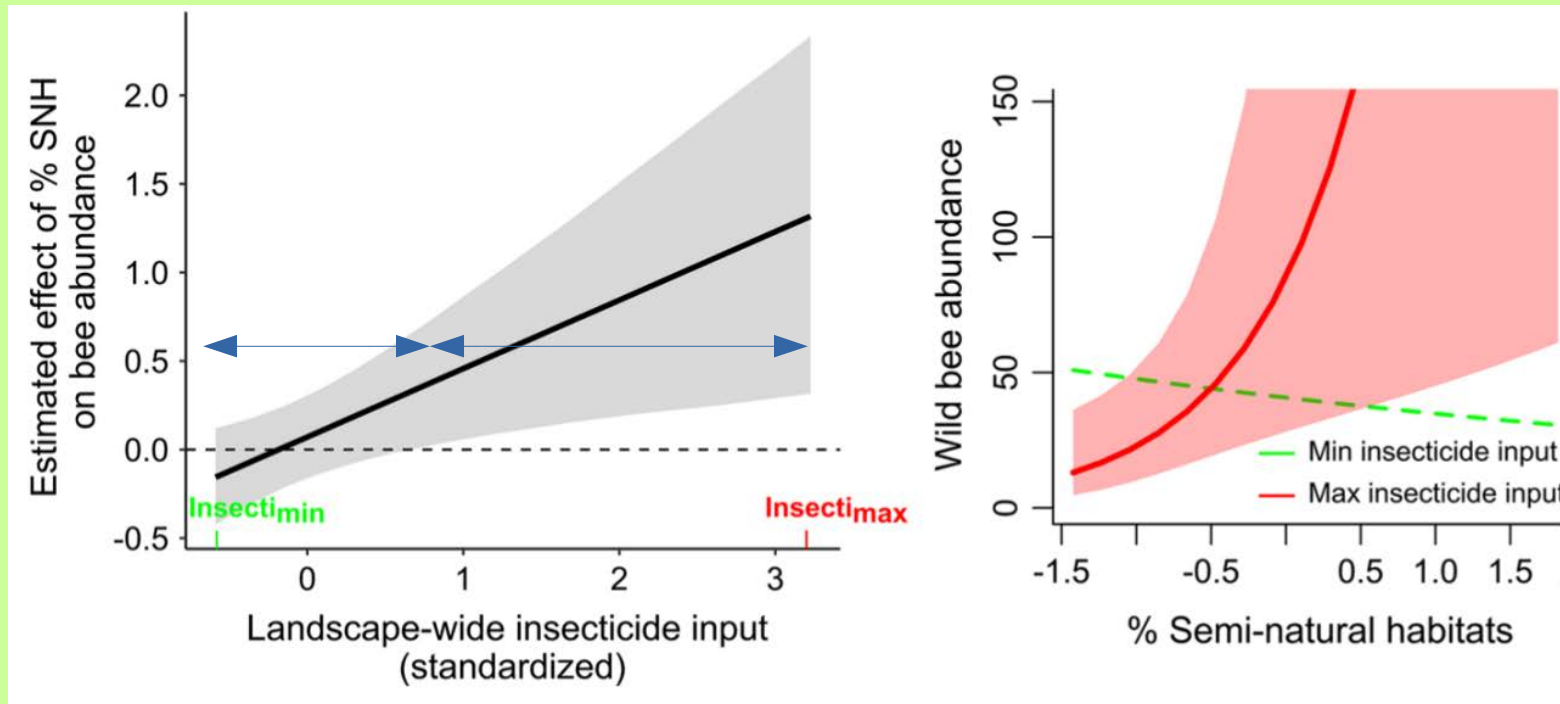


Species with high dispersal capacities, nesting above ground, early foraging (pesticides / mowing), = selection of species adapted to landscapes dominated by agriculture



Carrié et al 2017 Land. Ecol.

Positive effects of semi-natural habitats on wild bees depend on intensity of farmland management in the landscape



On both abundance and species richness

The more the landscapes are intensively managed, the more increasing %SNH has a strong positive effect

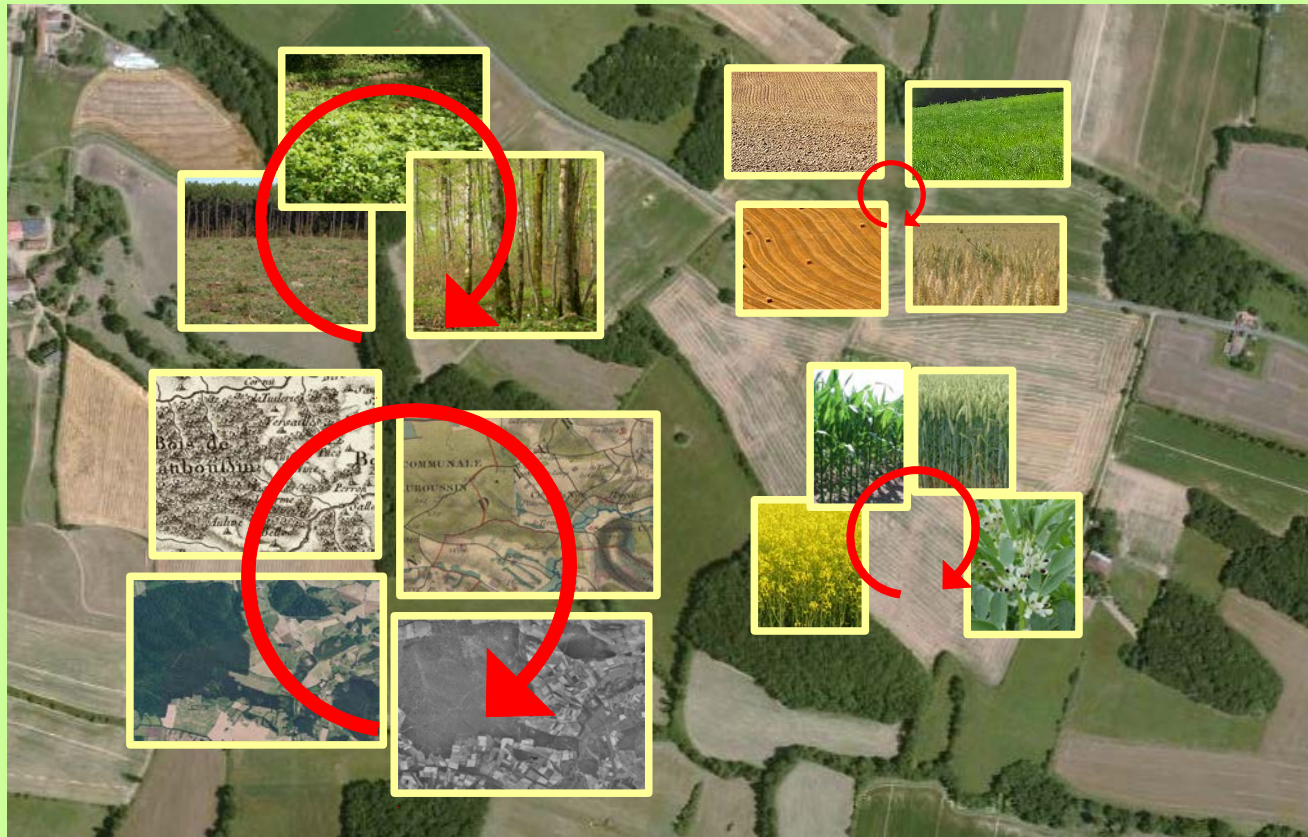
- in crops of extensively managed landscapes : additional ressources
- in intensively managed landscapes, ressources are only in semi-natural habitats

Pollinators and farm forests

Landscape heterogeneity and amount of semi-natural habitats are the key :

- **composition** : various types of tree elements (forests, hedgerows...)
- **configuration** : ecotones (edges) and spatial proximity
- **complementarity** between wooded and herbaceous habitats
- effects depend on **farm management intensity at the landscape level**

quantity and diversity of resources, permanent habitats for overwintering and nesting



Agricultural mosaic:
instability (intra-annual and
interannual changes)

Semi-natural mosaic:
stability (changes at the
decade or century scale)

Thank you !

