WOODNET: Connectivity patterns and processes along a gradient of European landscapes with woody vegetation and spatial heterogeneity. WP 2: Landscape legacies and species distribution

Audrey Alignier, Déborah Closset-Kopp, Guillaume Decocq, Aude Ernoult, Cendrine Mony

Louvain meeting
November, 6-8, 2019

France Spain Belgium

WOODNET: Connectivity patterns and processes along a gradient of European landscapes with woody vegetation and spatial heterogeneity

woodnetweb.wordpress.com/project-fr/

WP2:

Landscape legacies and species distribution

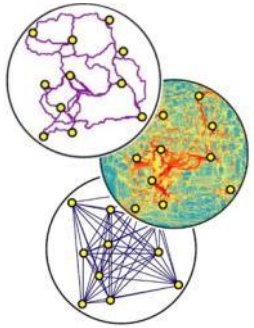
A. Alignier, D. Closset-Kopp, G. Decocq, A. Ernoult, C. Mony

WP2 sub-tasks

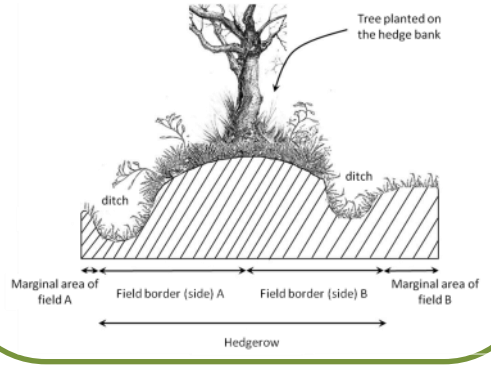
- Task 2.1: Drivers of actual local species assemblages in hedgerows
- Task 2.2: Disentangling dispersal from recruitment limitation in hedgerow corridors
- Task 2.3: Measuring landscape connectivity: a landscape genetic approach

Objective: Quantify the respective role of habitat quality and connectivity (using past and present landscape composition and configuration as proxies) in explainig local biodiversity in hedgerows

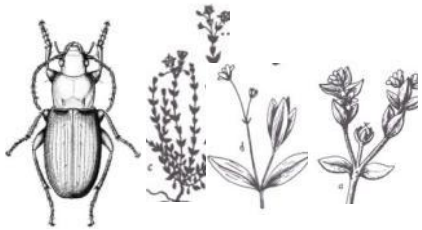
Connectivity measures over time



Local variables of hedgerow quality



Plant and carabid assemblages in woodlands



Specific structure

Functional structure

Task 2.1. Understanding the main drivers of connectivity dynamics

Objective: Quantify the respective role of habitat quality and connectivity (using past and present landscape composition and configuration as proxies) in explainig local biodiversity in hedgerows

- Detect plant/carabid* species richness response to changes over time of both local and connectivity variables

  Comparison between forest specialists and generalists

- Detect plant trait syndromes to connectivity dynamics

  Different responses depending on plant traits

- Generalize patterns accross taxonomic groups (birds)

*carabid were finally not considered

Methods

1- Assessing connectivity changes over time

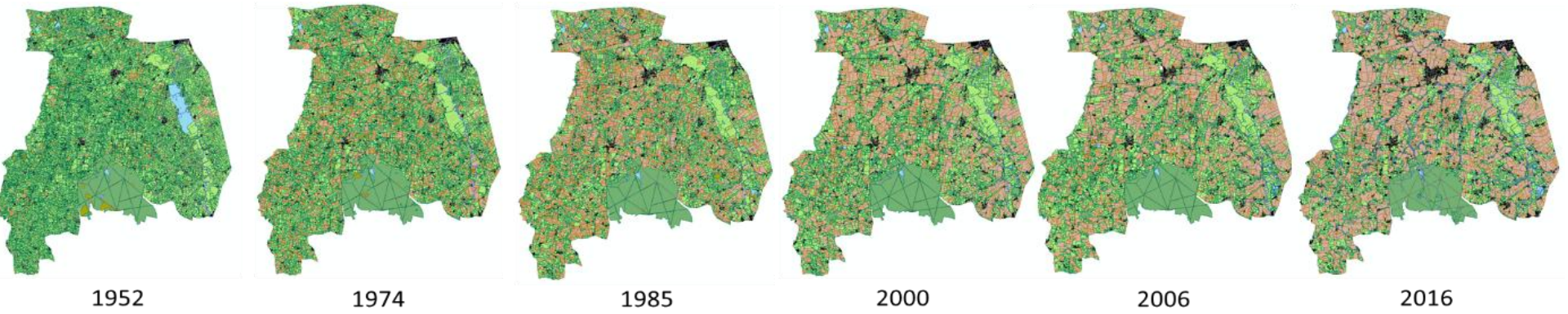
- Mapping from aerial photographs: landcover and hedgerows

- Selection of 6 dates: 1952, 1974, 1985, 2000, 2006 and 2016
in relation with various policies (Common Agricultural Policy, land reallotment program)

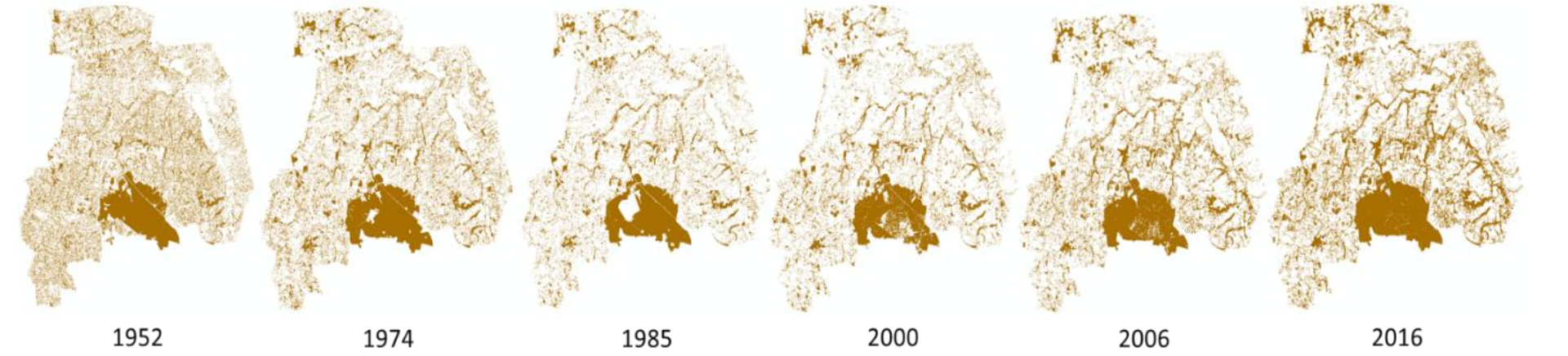
Task 2.1. Understanding the main drivers of connectivity dynamics

Land-use maps *(source: Zone Atelier Armorique)*

Rennes

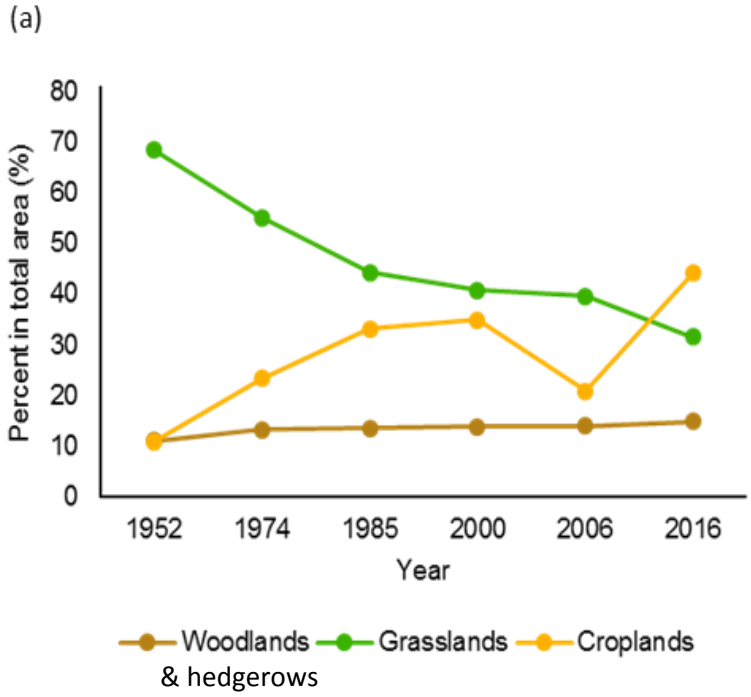


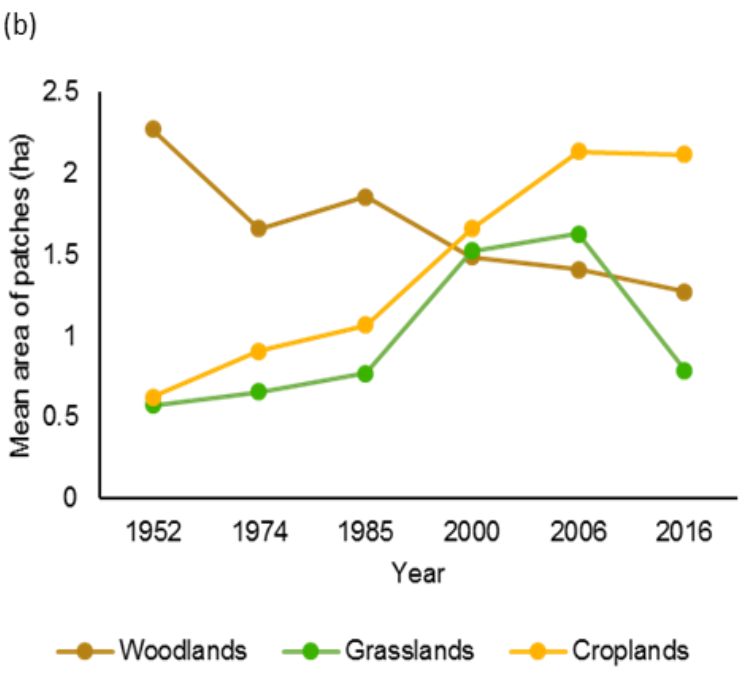
Hedgerows and woodlots maps *(source: Kermap)*



Rennes

Landscape changes in the study area





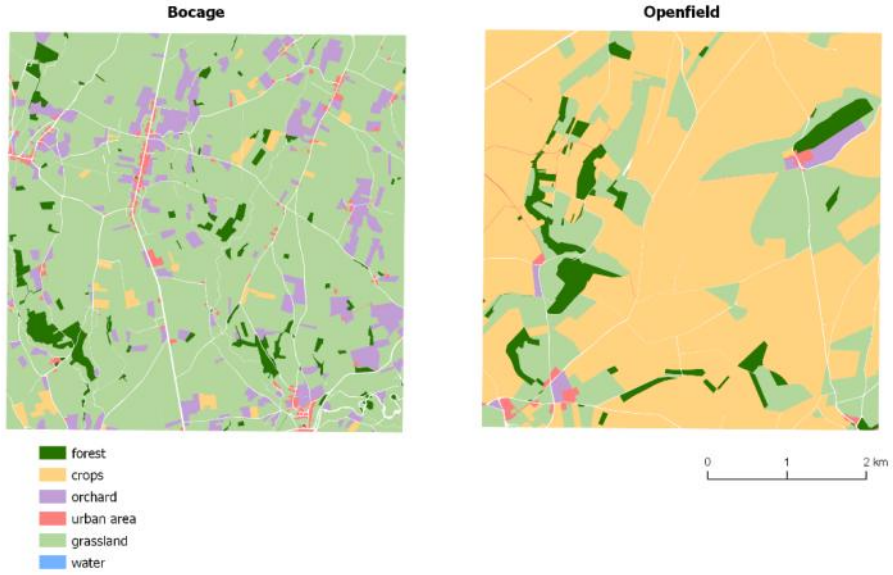
Increase of croplands
Decrease of grasslands

Increase of crop field size (reallotment)
Decrease of woodlot areas

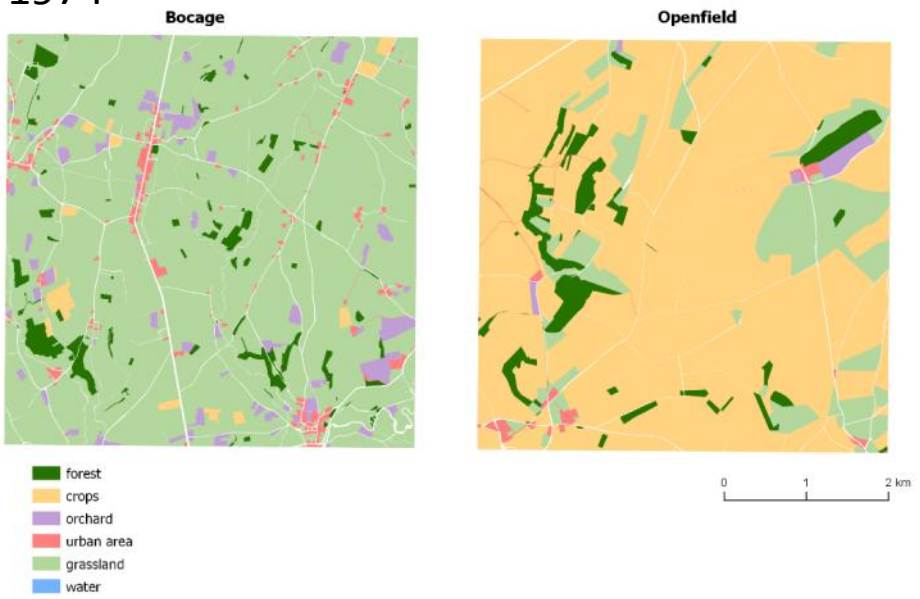
Source: L. Uroy (2019)

Amiens

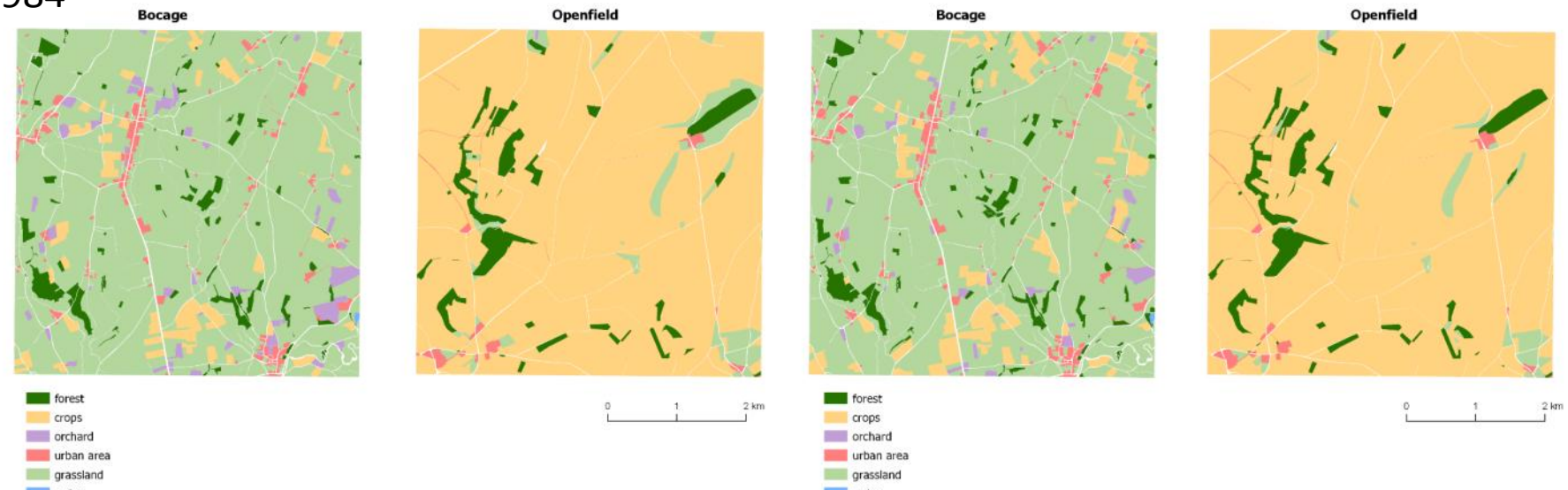
1949



1974



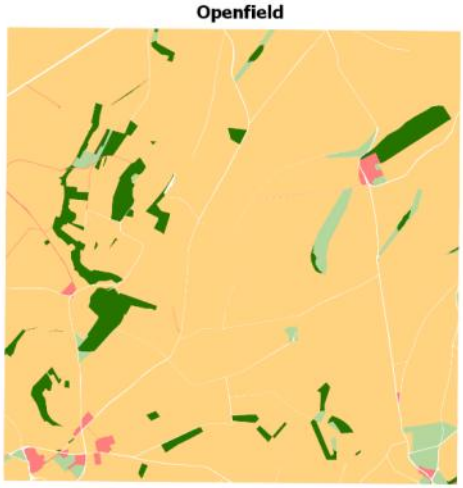
1984



Task 2.1. Understanding the main drivers of connectivity dynamics

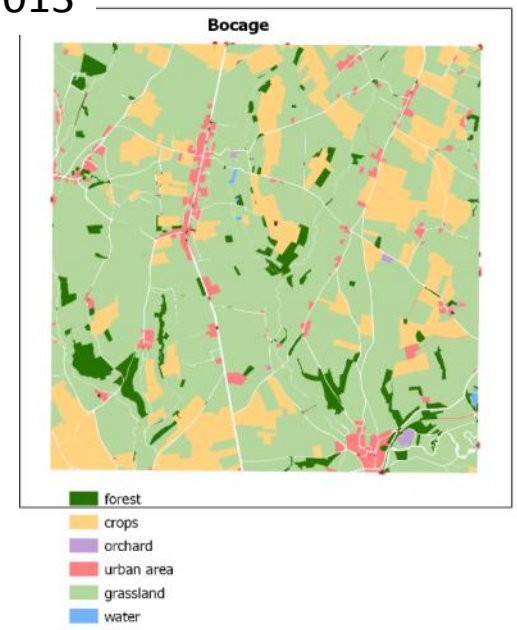
Amiens

2001



forest
crops
orchard
urban area
grassland
water

2013



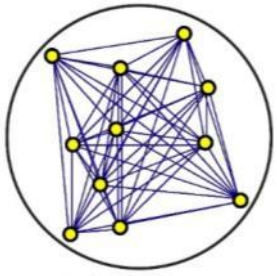
Methods

1- Assessing connectivity changes over time

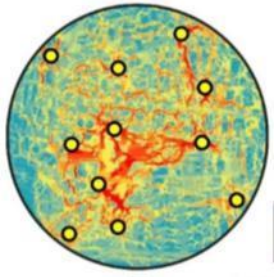
- Mapping from aerial photographs: landcover and hedgerows
- Selection of 6 dates: 1952, 1974, 1985, 2000, 2006 and 2016
in relation with various policies (Common Agricultural Policy, land reallotment program)
- Measuring connectivity indices for each date

Patch isolation measures

- Euclidean distances



- Resistance distances



$$dF_k^* = \frac{\sum_{i=1,i\neq k}^{n-1} p_{ik}^*}{\sum_{i=1}^{n}\sum_{j=1,i\neq j}^{n} p_{ij}^*}$$

p*ij is the maximum product probability of all possible paths between 2 forest fragments, i and j, in the landscape

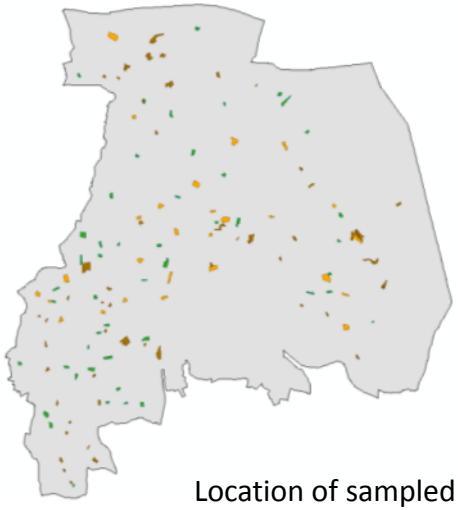
dF*k assessed the percentage of dispersal flux among all forest fragments

Williams et al. 2013

Methods

2- Analyze plant (and bird) assemblages

2a - Floristic surveys in woodlands



Location of sampled woodlands (in green)

➢ Rennes: 50 woodlands sampled (PhD thesis L. Uroy)
Woodland standardized in age, management, size

Protocol: 8 quadrats (10 x 5m for a total of 200-500m²)

➢ Amiens: 91 woodlands sampled (PhD thesis A. Jamoneau)
n=62/29 in the bocage/openfield 5*5km window

Protocol: exhaustive survey of vascular plant species over the whole patch area + 1 quadrat of 1000 m² in 30 patches (15 in each window)

+ Rennes: 30 woodlands sampled for birds (additional work to Woodnet: S. Croci & A. Butet)

Methods

2- Analyze plant (and bird) assemblages

2b - Floristic surveys in hedgerows

- Rennes: 30 hedgerows (see WP1)
- Amiens: 49 hedgerows (see WP1)
  n=31/18 in bocage/openfield window

Methods

2- Analyze plant (and bird) assemblages

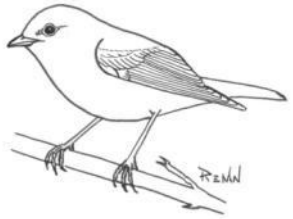
- Ecological and functional traits databases

  Establishment of specialist/generalist lists

  Establisment of functional traits list for plants (LEDA, TRY databases)

  Dispersal traits

Same work has to be done for birds



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Amiens

Methods

3- Determine hedgerow ancienty

We assembled a chronosequence of 99 dated (1725-2008) hedgerows, which were surveyed for forest plant species and a number of local-proximal descriptors.

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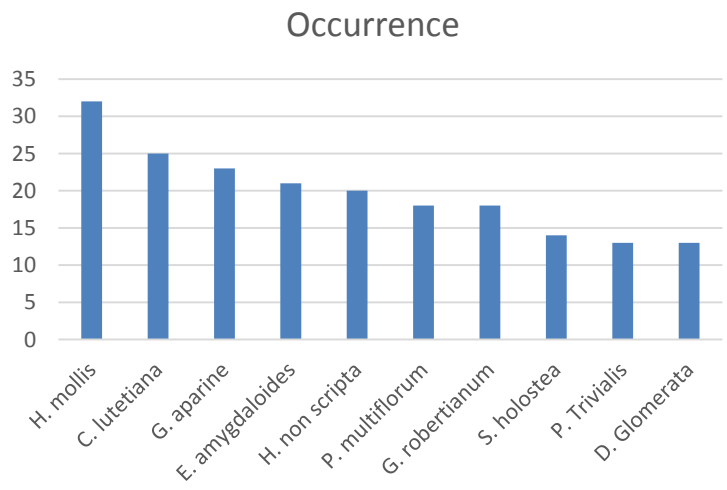
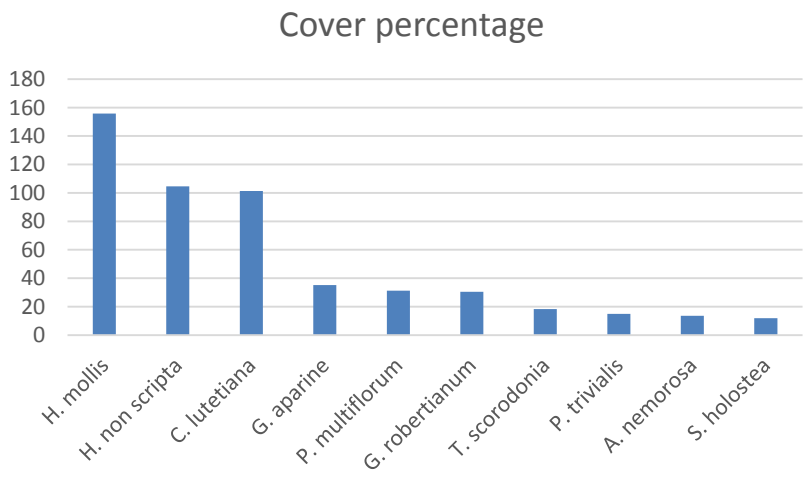
Preliminary results – Analysis of woodland assemblages

Rennes

Herbaceous species: 0-28 species per woodland

Most abundant species:





Preliminary results – Analysis of woodland assemblages

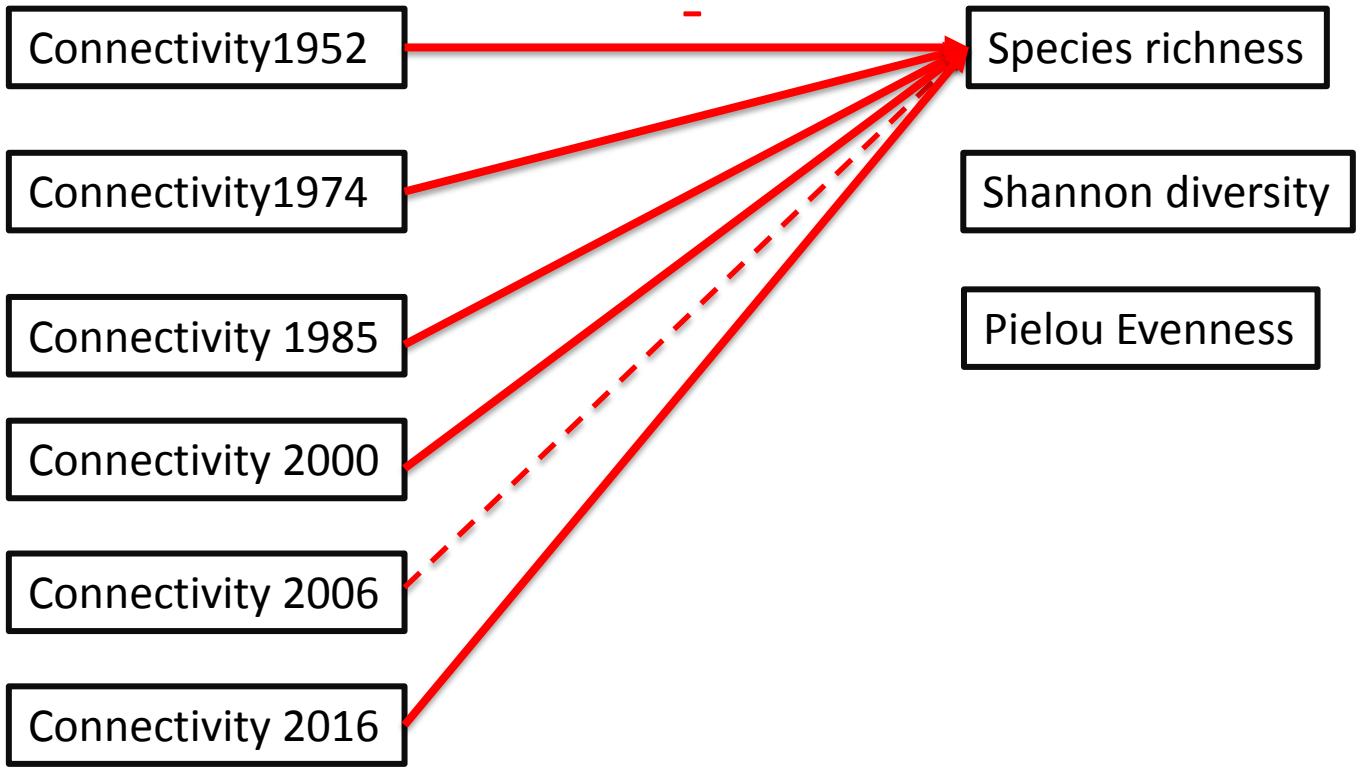
Amiens

Herbaceous species: 11-83 species per woodland

Most abundant species: *Arum maculatum*, *Ranunculus ficaria*, *Geum urbanum*, *Rubus fruticosus* agg., *Glechoma hederacea, Hedera helix, Urtica dioica, Galeopsis tetrahit, Stachys sylvatica, Adoxa moschatellina*

Preliminary results – Analysis of woodland assemblages

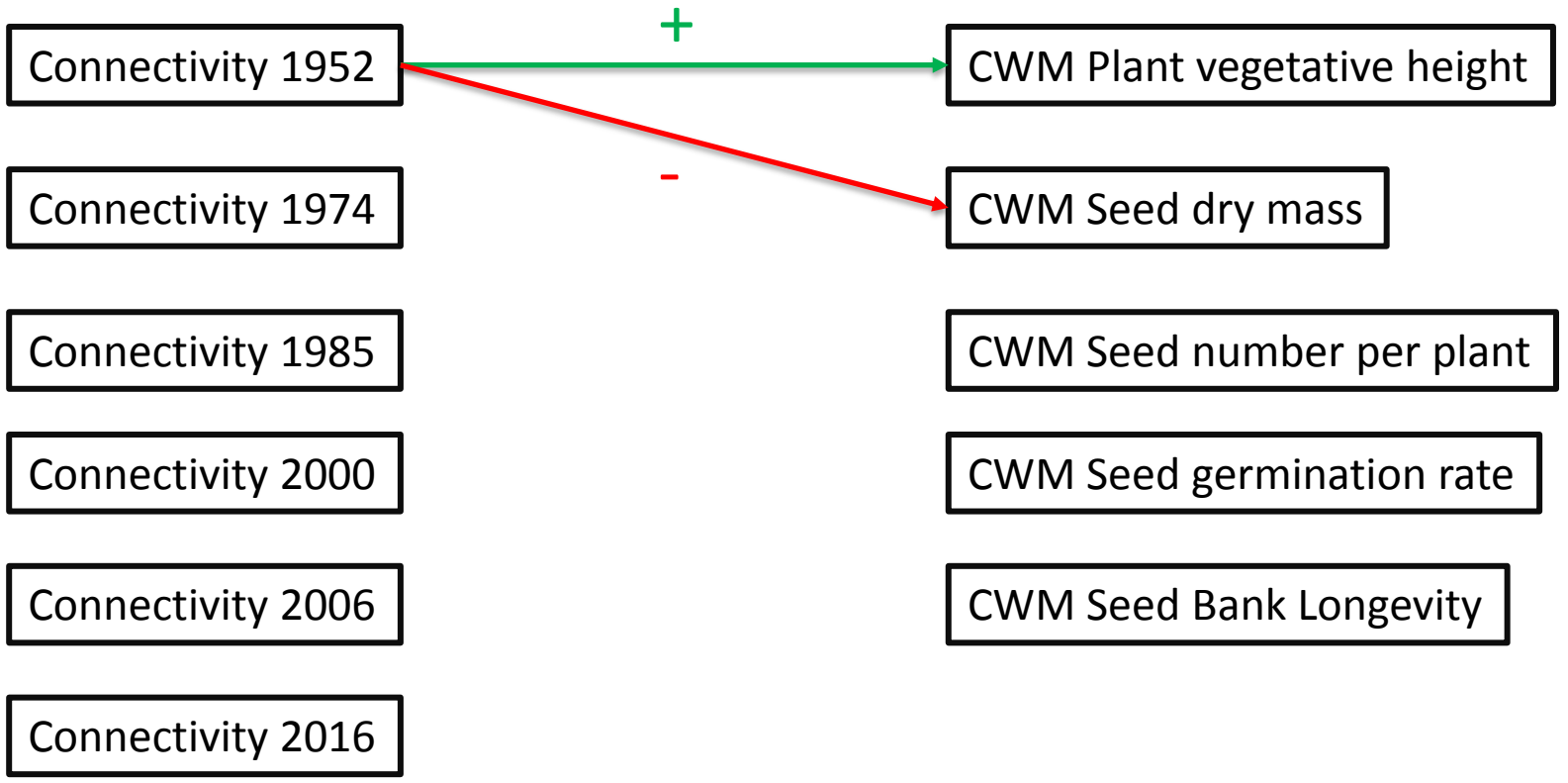
Rennes



Source: L. Uroy (2019)

Preliminary results – Analysis of woodland assemblages

Rennes



Source: L. Uroy (2019)

Amiens

Preliminary results – Analysis of hedgerow assemblages

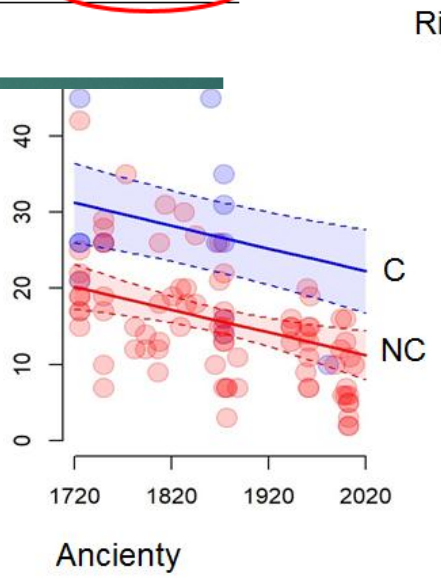
GLM: R^2 = 0.62; R^2 adjusted = 0.59

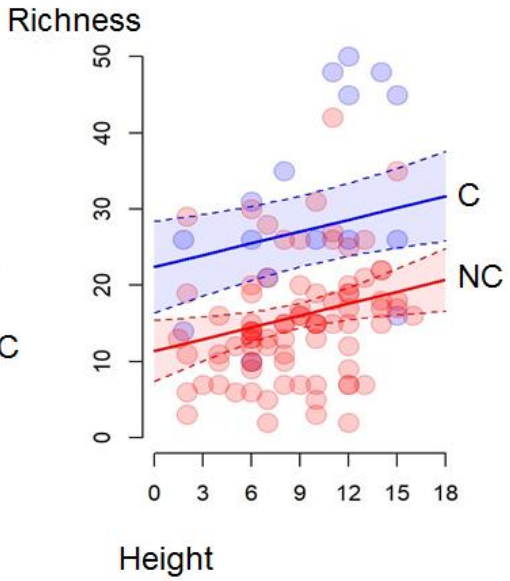
	Coefficient	S. E	Student (*t*)	(*p*)
Richness (X_i = 0)	79.95	16.245	4.922	(***) <0.001
Ancienty	-0.029	0.009	-3.407	(***) <0.001
Length	0.006	0.009	0.655	(n.s.) 0.514
Width	1.461	0.873	1.674	(n.s.) 0.097
Height	0.518	0.209	2.478	(*) 0.015
Height heterogeneity	-0.113	0.144	-0.780	(n.s.) 0.437
Connectivity	11.007	2.661	4.136	(***) <0.001
Forest area	0.000	0.000	1.258	(n.s.) 0.211
Land Use Intensity	-2.137	0.539	-3.966	(***) <0.001

Hedgerow age and length interacted to increase forest plant species richness.

Hedgerows attached to woodlands hosted systematically more species = +11

Taller and wider hedgerows with a lower intensity of adjacent land uses hosted more forest plant species.





Task 2.1. Understanding the main drivers of connectivity dynamics

Difficulties

Not enough sample sites for carabids in Rennes (10 woodlands sampled for WP1)

Not the same protocole between Amiens and Rennes for plant sampling
➡ need to check that they are comparable

Planning for the end of the sub-task

November 2019 - February 2020: Statistical analysis and writing

Submission deadline: March 2020
Paper 1: Effect of connectivity dynamics on functional structure of forest plants (Amiens and Rennes sites)

Objective: Disentangling the effect of dispersal from recruitment limitation of forest species in hedgerows

- **Dispersal limitation**

  Seed arrival in the site

- **Recruitment limitation**

  Abiotic factors (habitat quality)

  Biotic factors (competition with existing vegetation)

- **Seed germination ability**

  Seed germination power

Methods

1 - Plant species selection

- Seed collection on mature individuals (June-September 2017) in spatially distant populations over the ZA Armorique and in the Amiens Region + Transplants collection (one population only)
- 10 to 12 populations sampled
- Same plant species list between the two sites (10 for Rennes *versus* 15 for Amiens)

Methods

1 - Plant species selection

Specialist plant species:

Hyacinthoides non-scripta (A,R)
Melica uniflora (A,R)
Carex sylvatica (A,R)
Stachys sylvatica (A,R)
Viola reichenbachiana (A,R)
Lamium galeobdolon (A,R)
Oxalis acetosella (A)
Stellaria holostea (A)
Poa nemoralis (A)
Milium effusum (A)
Galium odoratum (A)

Generalist plant species:

Potentilla sterilis (R)
Veronica hederifolia (A,R)
Circaea lutetiana (A,R)
Lapsana communis (A,R)
Senecio ovatus (A)
Aegopodium podagraria (A)
Fragaria vesca (A)

Methods

2 - Site selection

- 5 hedgerows and 1 woodland *per* site
- Criteria for hedgerows standardization (age < 20 yrs, tree composition, structure, no management over the study period…)

Rennes

Amiens

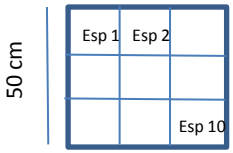
Methods

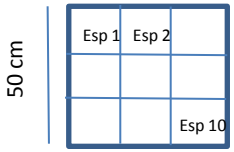
3 - Experimental design

Species sowing

With vegetation

Without vegetation



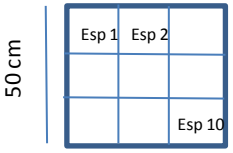


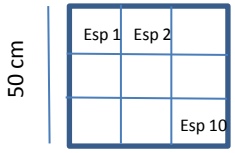
- 4 replicates per hedegerow
- 25 seeds per quadrat
- Each quadrat = 20x20cm

Species transplantation

With vegetation

Without vegetation





- 2 replicates per hedegerow
- 5 transplants per quadrats
- Each quadrat= 20x20cm

1 control

Greenhouse

- 100 seeds

In total, 1200 seeds sown *per* species

Task 2.2. Disentangling dispersal from recruitment limitation in hedgerow corridors

Amiens

Seed sowing and transplantation

Seed germination in greenhouse

Methods

4 - Surveys

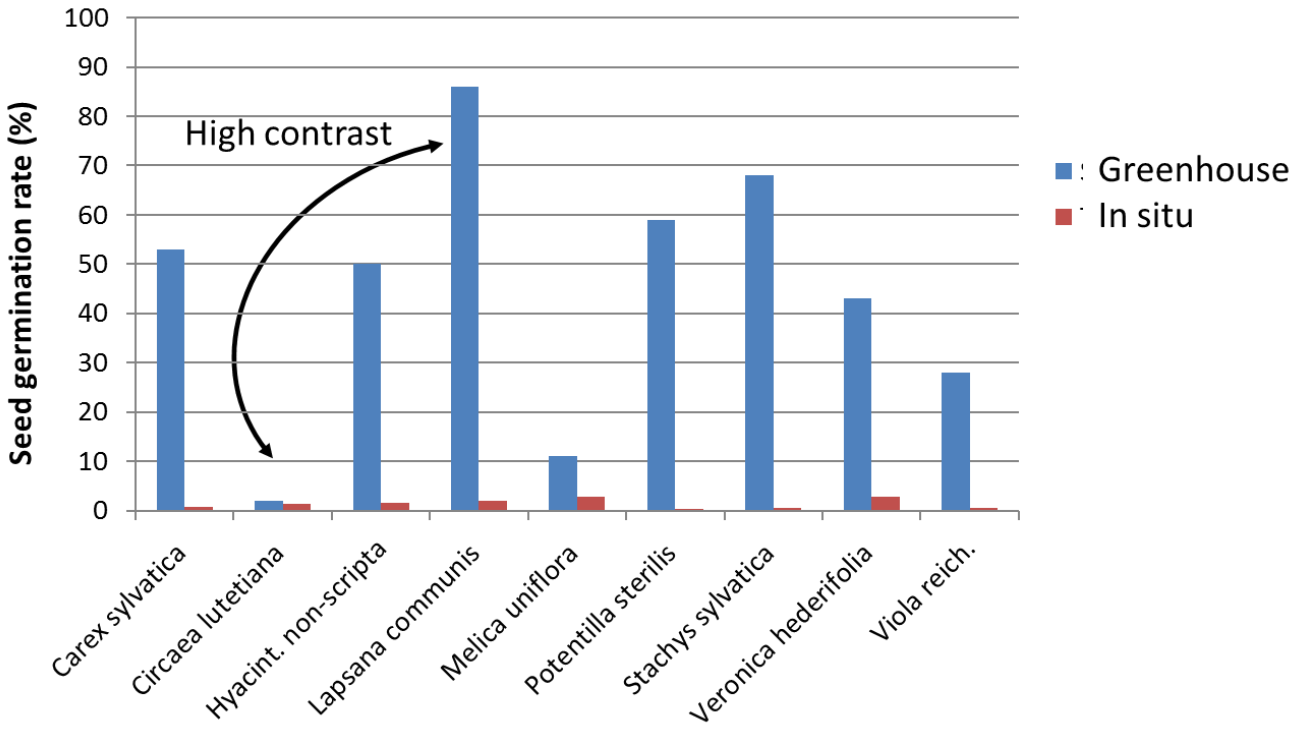
	3 years after launching (April 2018)
Number of seeds germinated (greenhouse)	April, June & October 2018-2020
Number and size of the germinated seeds	April, June & October 2019-2020
Number and size of the transplants	April, June & October 2019-2020

+ environmental measurements: Hedgerow structure, soil pH, LAI (Leaf Area Index)

Rennes

Preliminary results (sowing)

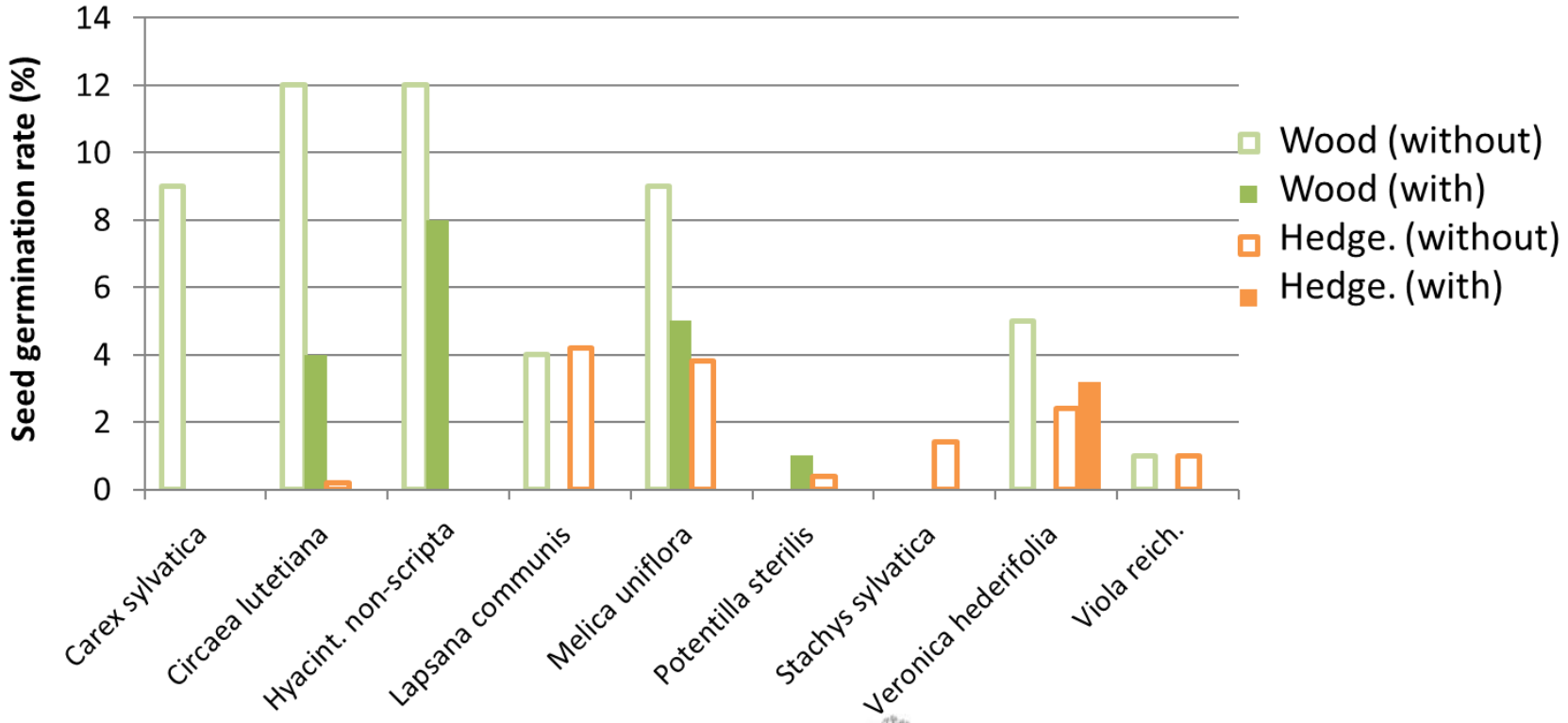
- Very low germination *in situ* compared to greenhouse
- *Circea lutetiana* had very low germinative power



Rennes

Preliminary results (sowing)

- Overall, more germination in woodlands than in hedgerows
- Better seed germination rates in « without vegetation » quadrats (excluding competition)



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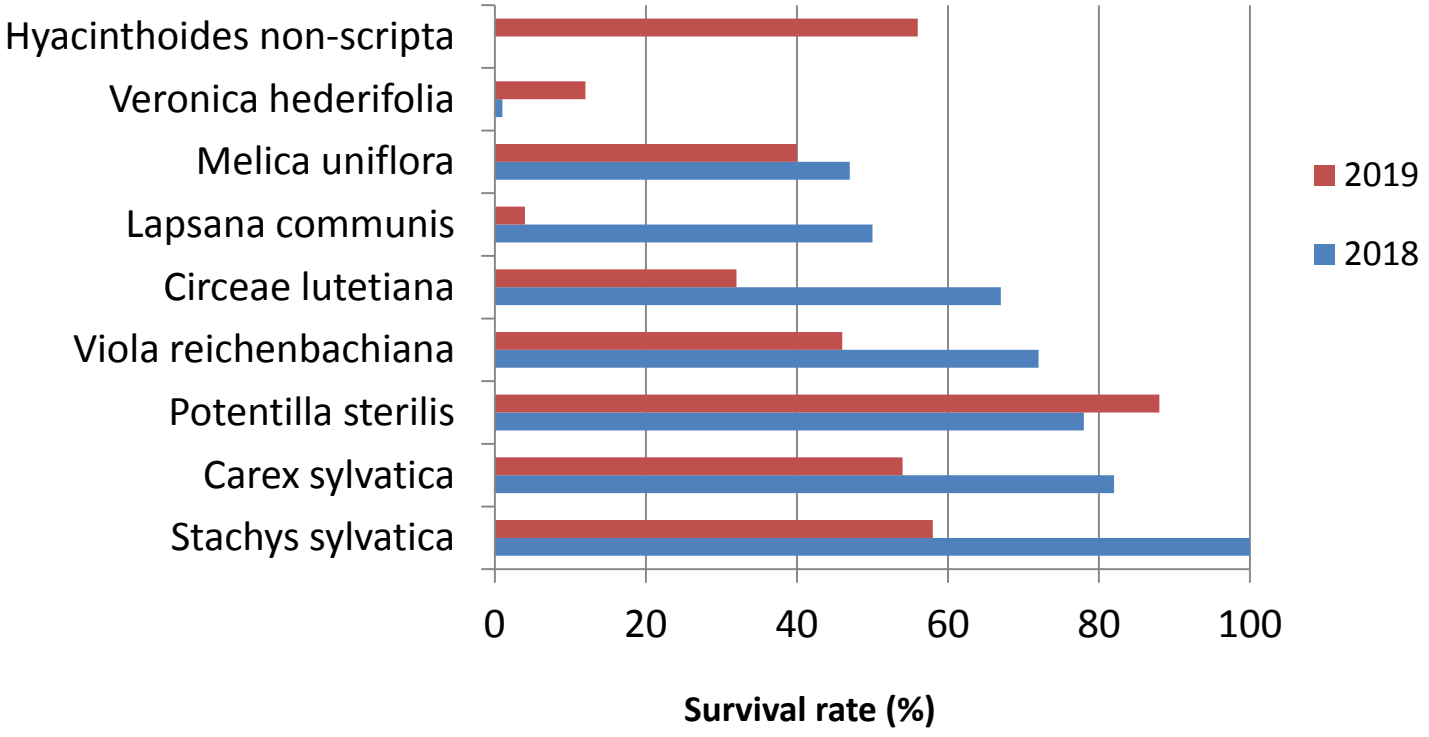
Rennes

Preliminary results (transplants)

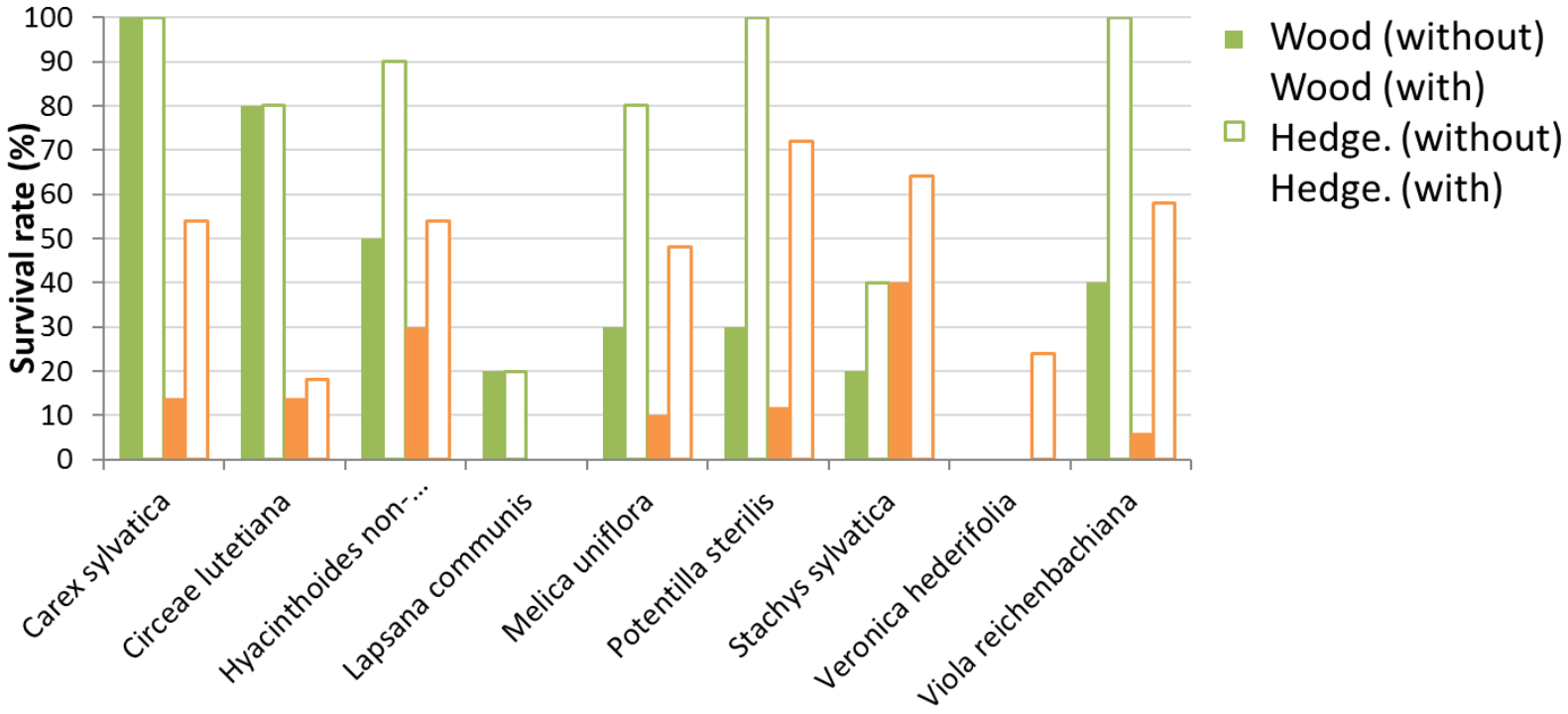
- Highest survival of the transplants in the first year of the study
- Good persistance (> 40% for 6 / 9 species)



Rennes

Preliminary results (transplants)

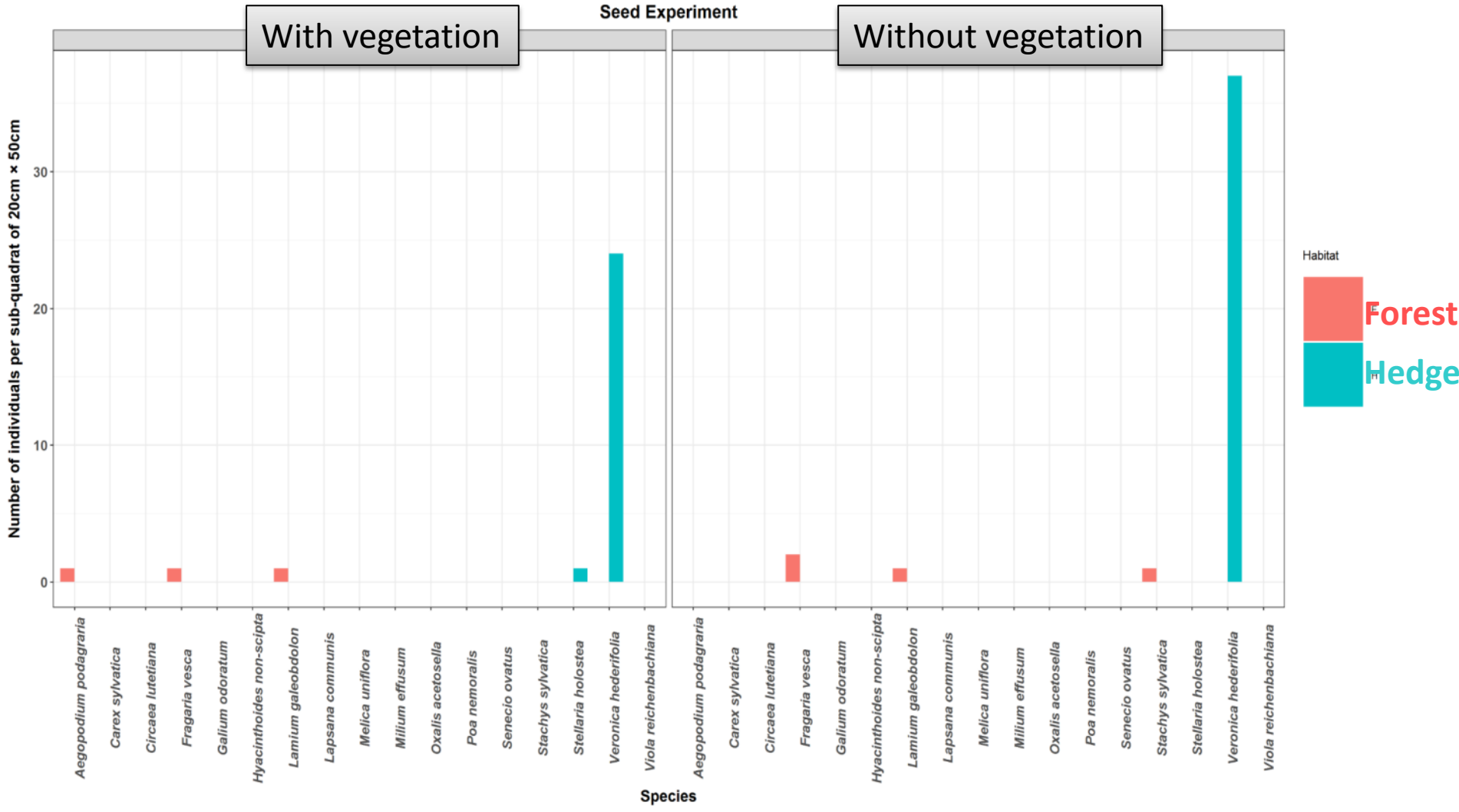
- Highest survival rates in « without vegetation » quadrats (excluding competition)



Task 2.2. Disentangling dispersal from recruitment limitation in hedgerow corridors

Preliminary results

Amiens



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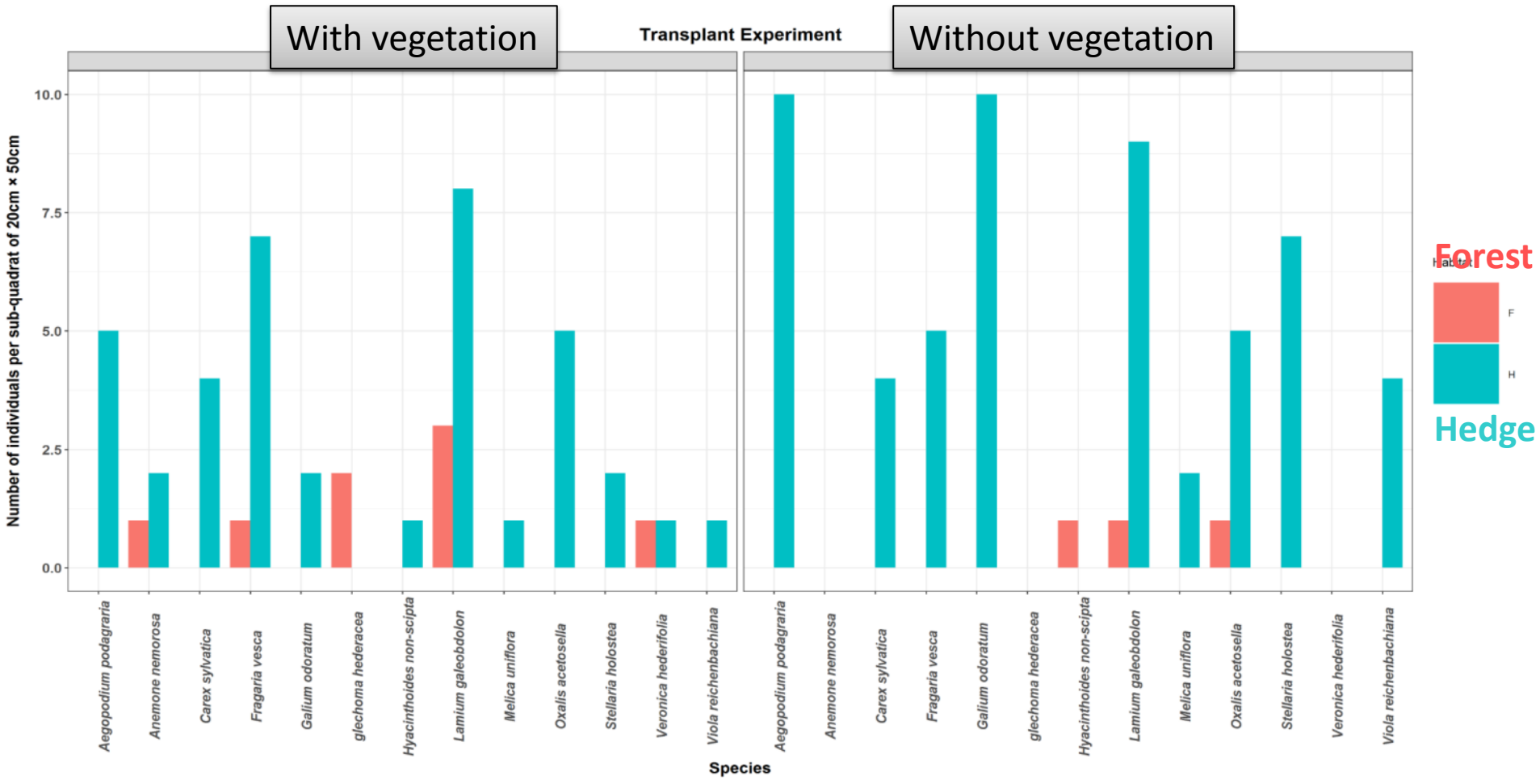
Task 2.2. Disentangling dispersal from recruitment limitation in hedgerow corridors

Preliminary results

Amiens



Amiens

Preliminary results

Proportion of individuals which successfully **germinated** or **persisted** within a given 20cm × 50cm sub-quadrat (i.e. the response variable)

~

- Habitat abiotic conditions (hedgerows *vs*. forest)
- Competition (disturbed *vs.* un-disturbed)
- Species ID as random variable

Symbol	Candidate Model	AIC
MG1	Y ~ competition (Y/N)	220.57
MG2	Y ~ habitat (H/F)	154.67
MG3	**Y ~ competition (Y/N) + habitat (H/F)**	**147.95**
MG4	Y ~ competition (Y/N) * habitat (H/F)	164.02
ME1	Y ~ competition (Y/N)	544.27
ME2	Y ~ habitat (H/F)	543.25
ME3	Y ~ competition (Y/N) + habitat (H/F)	523.11
ME4	**Y ~ competition (Y/N) * habitat (H/F)**	**517.65**

Best candidate model for germination

Best candidate model for persistence

Preliminary conclusions

- Some forest species succeeded in germinating into hedgerows (i.e. 7/10 species in Rennes; *Veronica hederifolia & Stellaria holostea in Amiens*) ➔ **There is dispersal limitation**
- Most of the forest herb species are limited by the hedgerows' habitat conditions ➔ **There is recruitment limitation in hedgerows**
- There is more germination and transplants survival in "without vegetation" quadrats ➔ **There is a competition effect in hedgerows**
- 9/13 studied forest plant species in Amiens and 8/10 in Rennes succeeded to establish in hedgerows ➔ **There is a low persistence rate in hedgerows**

Task 2.2. Disentangling dispersal from recruitment limitation in hedgerow corridors

Difficulties

Low germination power of seeds in the hedgerows (dry summer, high litter mater; germination ability for Amiens as 6/17 species succeeded to germinate in the greehouse)

Important delay in plant responses that need to have a long-duration experiment (3 years) and surveys after the end of the Woodnet project

Planning for the end of the sub-task

June 2020: Last sampling campaign

Submission deadline: Fall 2020
Paper 2: Disentangling dispersal, establishment and competition effects on forest plants (Amiens and Rennes sites)

Publications and data valorisation (1/2)

Symposium

- Special session: Bergès & Mony 2018. Current challenges in landscape ecology: habitat amount, landscape connectivity, landscape history.
- Closset-Kopp & Decocq G., 2018. Connectivity between forest patches in changing agricultural landscapes: times also matters! (SFE Rennes)
- Mony et al., 2018. Biodiversity response to landscape connectivity dynamics (SFE Rennes)
- Uroy et al., 2019. Trame verte et bleue et biodiversité: une vue d'ensemble des outils et méthodes pour caractériser la connectivité paysagère et son effet sur les communautés végétales. Colloque »La cartographie de la flore, un outil au service des politiques publiques de la biodiversité », Nantes.
- Closset-Kopp et al., 2018. Are rural hedgerows effective corridors for forest plant species? Yes, but this is a matter of time and spatial connectedness! IAVS 2018. Montana

Publications

- Paper 1 on going

- Historical continuity and spatial connectivity ensure hedgerows are effective corridors for forest plants: evidence from the species-time-area relationship. Lenoir et al. submitted

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Publications and data valorisation (2/2)

Collaboration

Collaboration with K. Litza from M. Diekmann's group – Univ. Bremen, Germany (meta-analysis on forest plant species throughout Europe)