Long term local and regional colonization patterns of European beavers in France

Laura Plichard, Jérôme Bélliard, Clément Calenge, Yoann Bressan

A long decline up to protection status and reintroductions

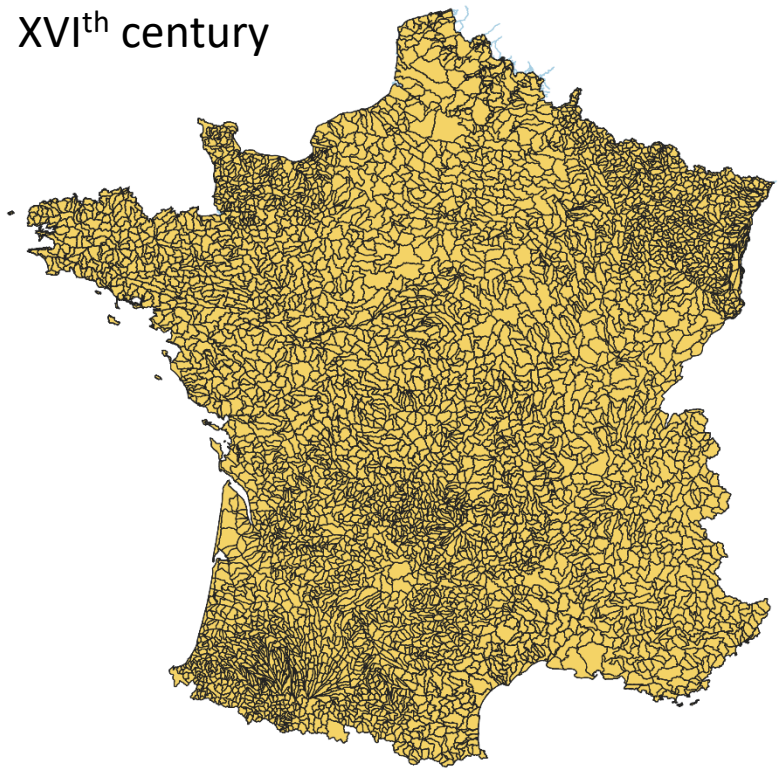
Historicaly widely present

Threatened

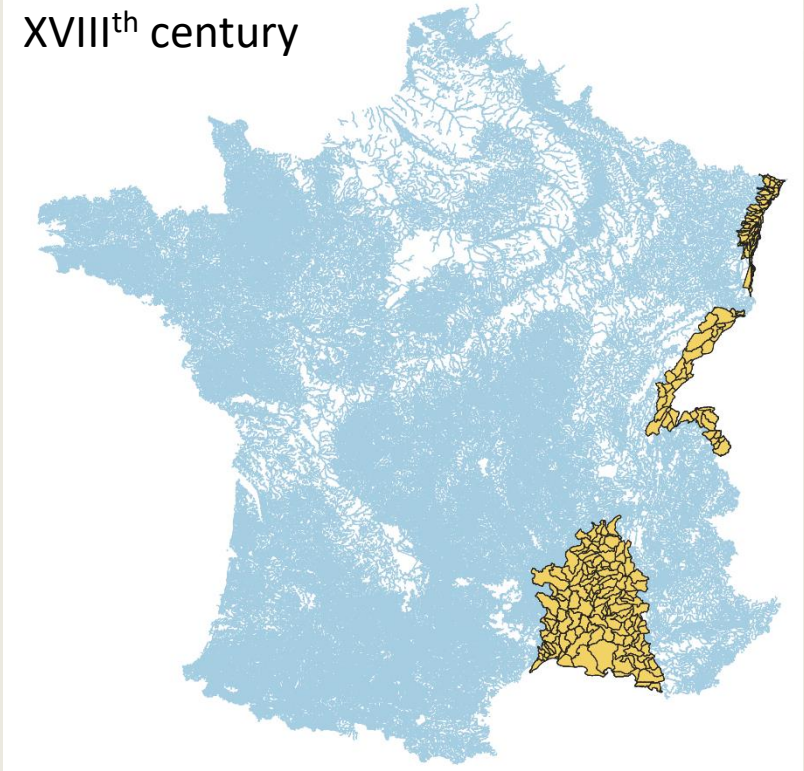
Near extinction

~ 400 years

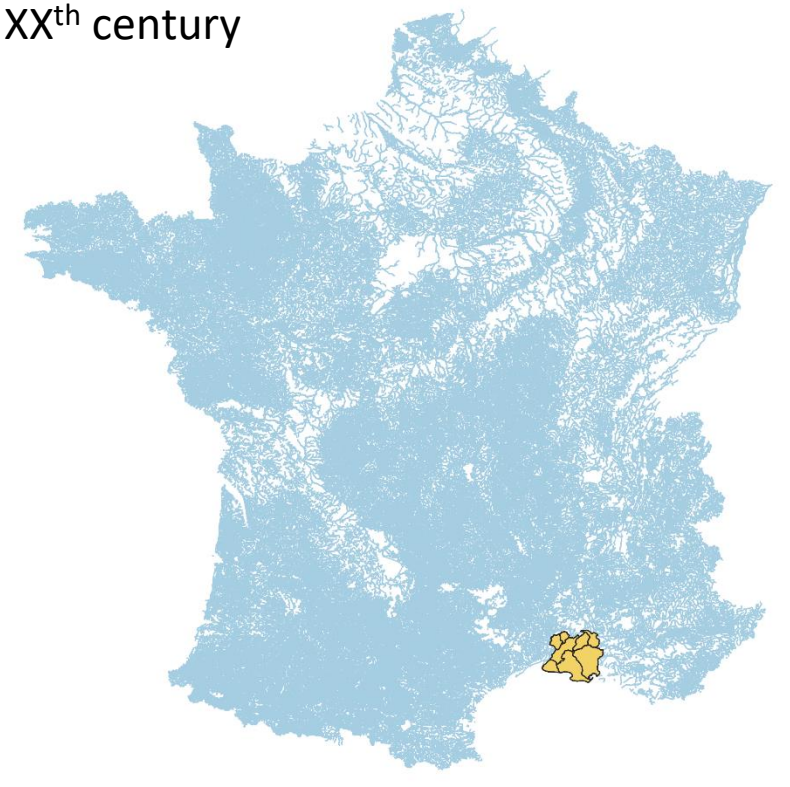
XVIth century



XVIIIth century



XXth century

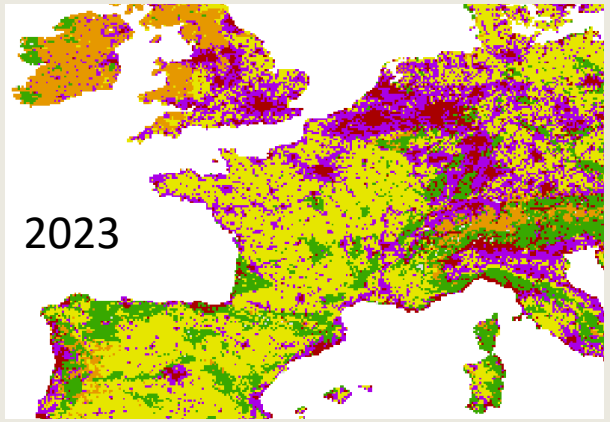


Data from Véron (1992) and French Biodiversity Agency (OFB) – Beaver network

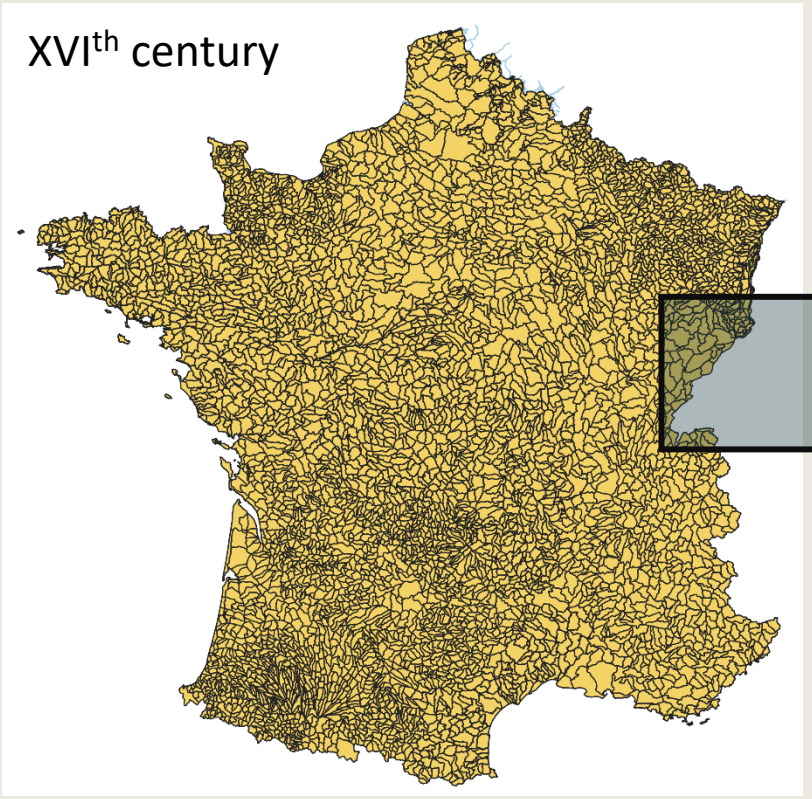
A long decline up to protection status and reintroductions

Variations in terrestrial environment

(Ellis et al. 2021)

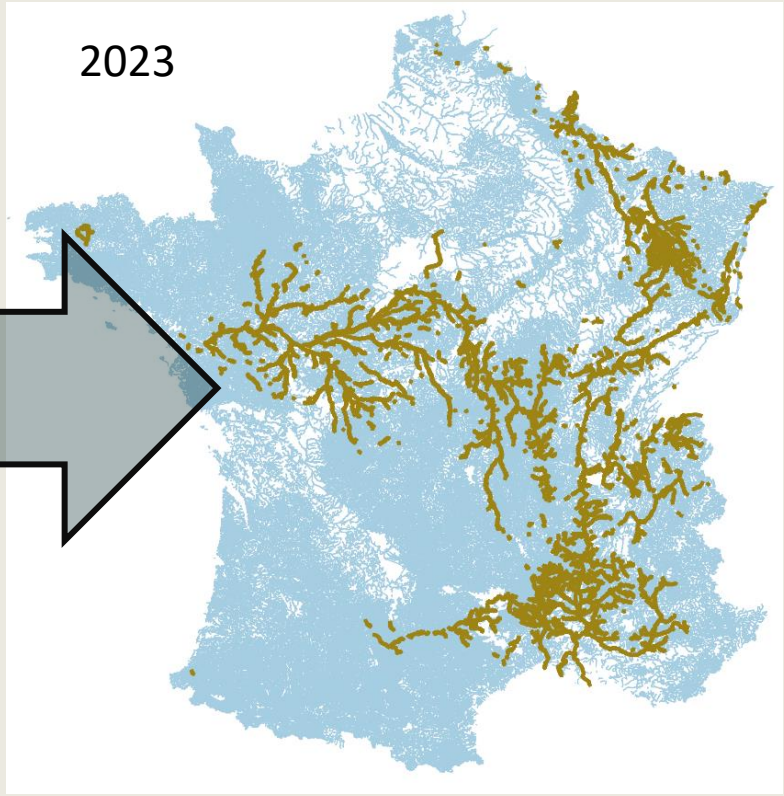


Can we identify local and regional colonization patterns ?



& Global warming

Variations in aquatic environment



Data from Véron (1992) and French Biodiversity Agency (OFB) – Beaver network

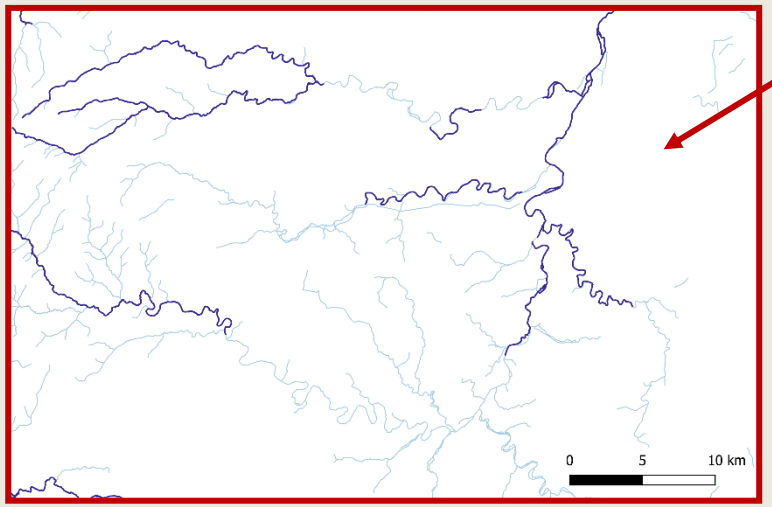
Identify colonization patterns: Data collection

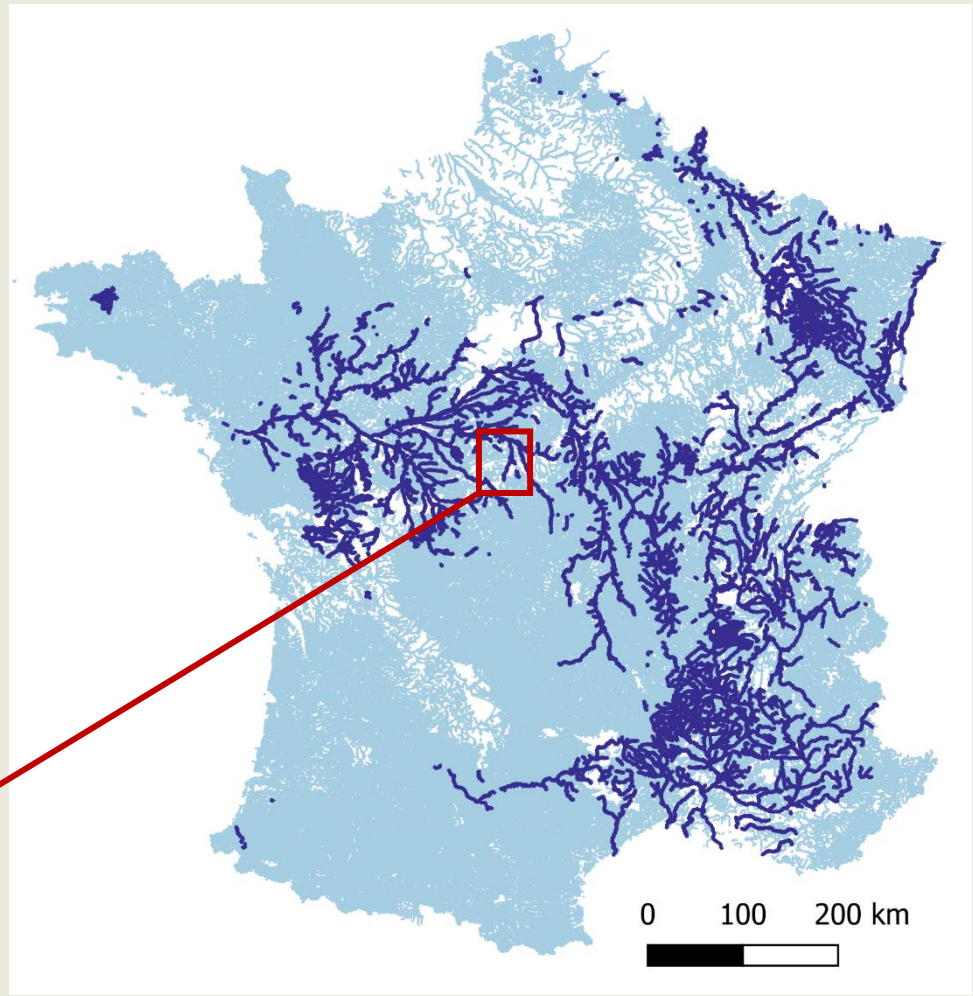
Data collection

Data from French beaver network from 1987 to 2023 (for our study)

> 67 000 reaches of 500 m-long opportunistic & protocoled sampling method with priority given to new areas and/or colonization fronts

(see Poster Y. Bressan et al.)





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Réseau Castor

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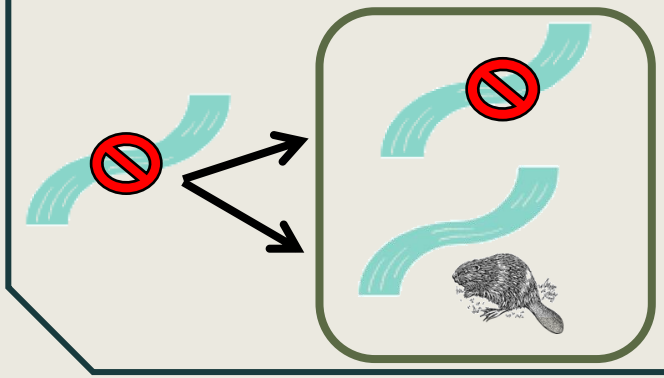
A subset of **12% data** *(n = 7780 reaches)*

Colonization process

1st occasion

2nd occasion



A subset for identifying colonization patterns

Identify colonization patterns: Data collection

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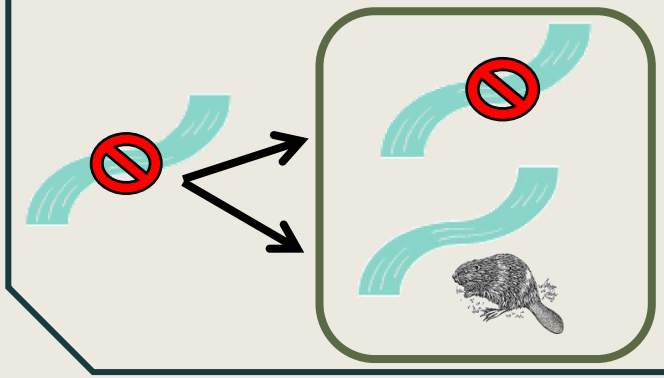
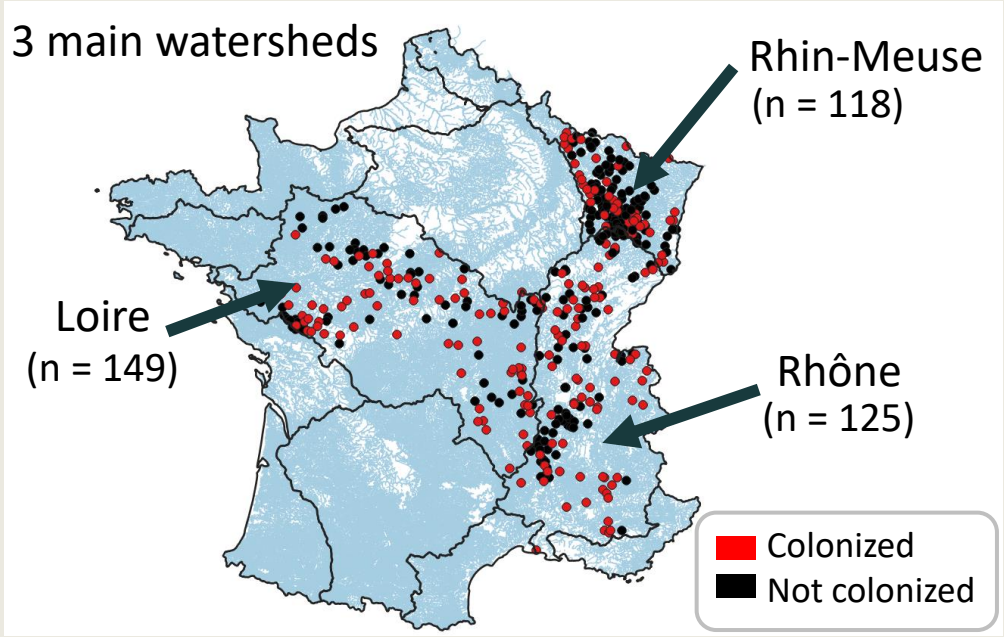


A subset for identifying colonization patterns

A subset of **5% data** *(n = 392 reaches)*

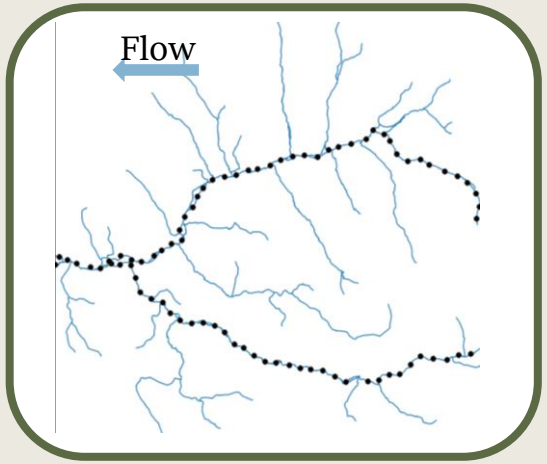
Final data sets

3 main watersheds



A subset for limiting spatial autocorrelations

minimum hydrological distance = 10 km



Identify colonization patterns: Environmental data

Hydrology
(4 variables)

(Database RHT, Pella et al. 2012)

Catchment area
[3 - 23 000 km²]

Altitude *[20 – 820 m]*

Slope *[0 – 122 ‰]*

Specific discharge = $\frac{\text{Discharge}}{\text{Catchment area}}$
[*0,001 – 0,06 m3/s/km2*]

Identify colonization patterns: Environmental data

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Dispersal (1 variable)

Hydrological distance from the nearest colonized reach
[*100 – 102 000 m*]

Identify colonization patterns: Environmental data

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Time (1 variable)

Time between 2 sampling occasions
[1 – 24 years]

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Identify colonization patterns: Environmental data

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Land use (5 variables)

(Database OSO Theia, 2016 - 2023)

Territory scale (buffer of 100 m x 500 m)

% woody area [*0 - 100*]

% perennial culture area *[0 – 96]*

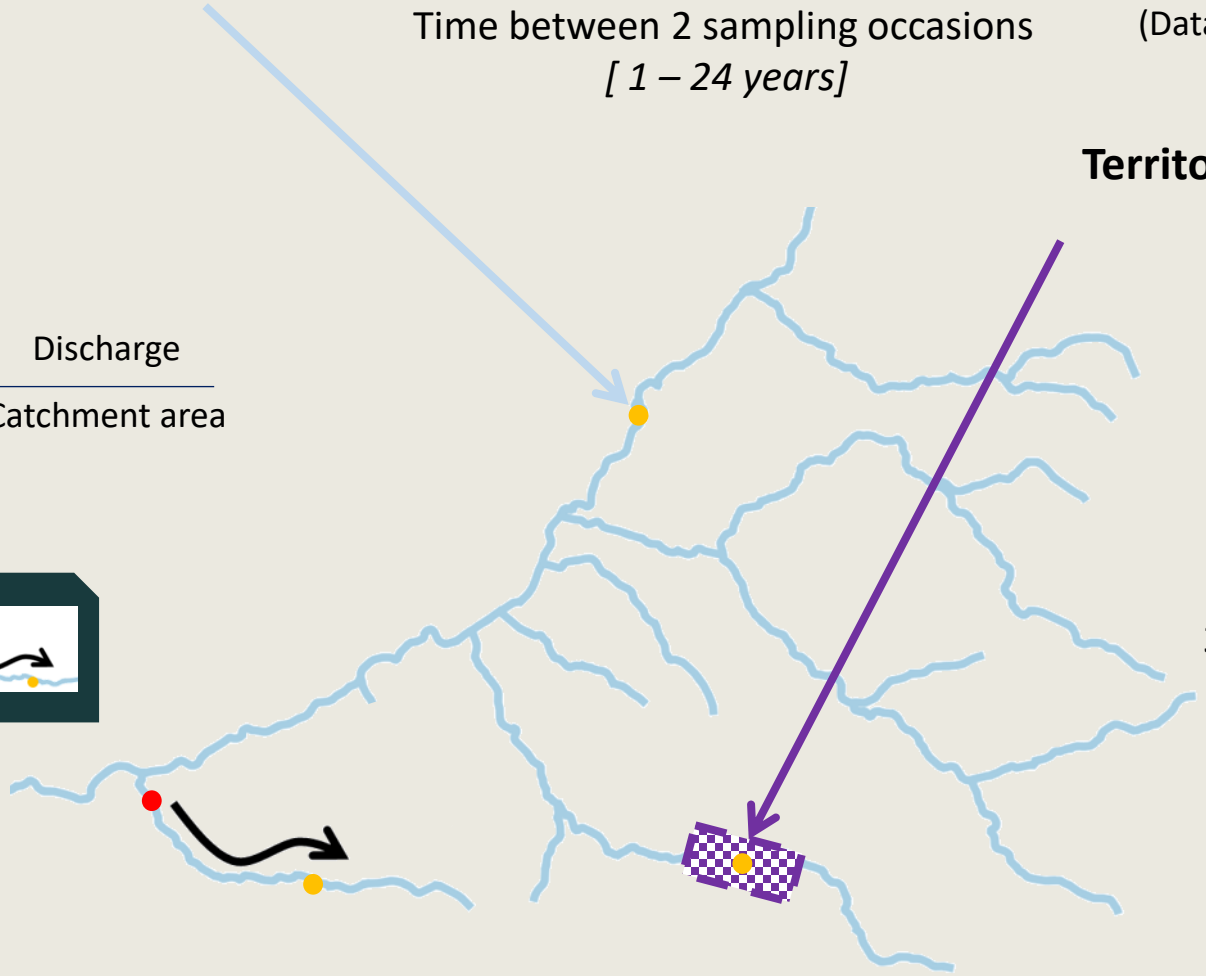
% annual culture area *[0 – 95]*

% urban area *[0 – 100]*

3 classes
1 *[0 – 15%]*
2 *[15 – 30 %]*
3 *[30 – 100 %]*

Dispersal (1 variable)

Hydrological distance from the nearest colonized reach
[*100 – 102 000 m*]



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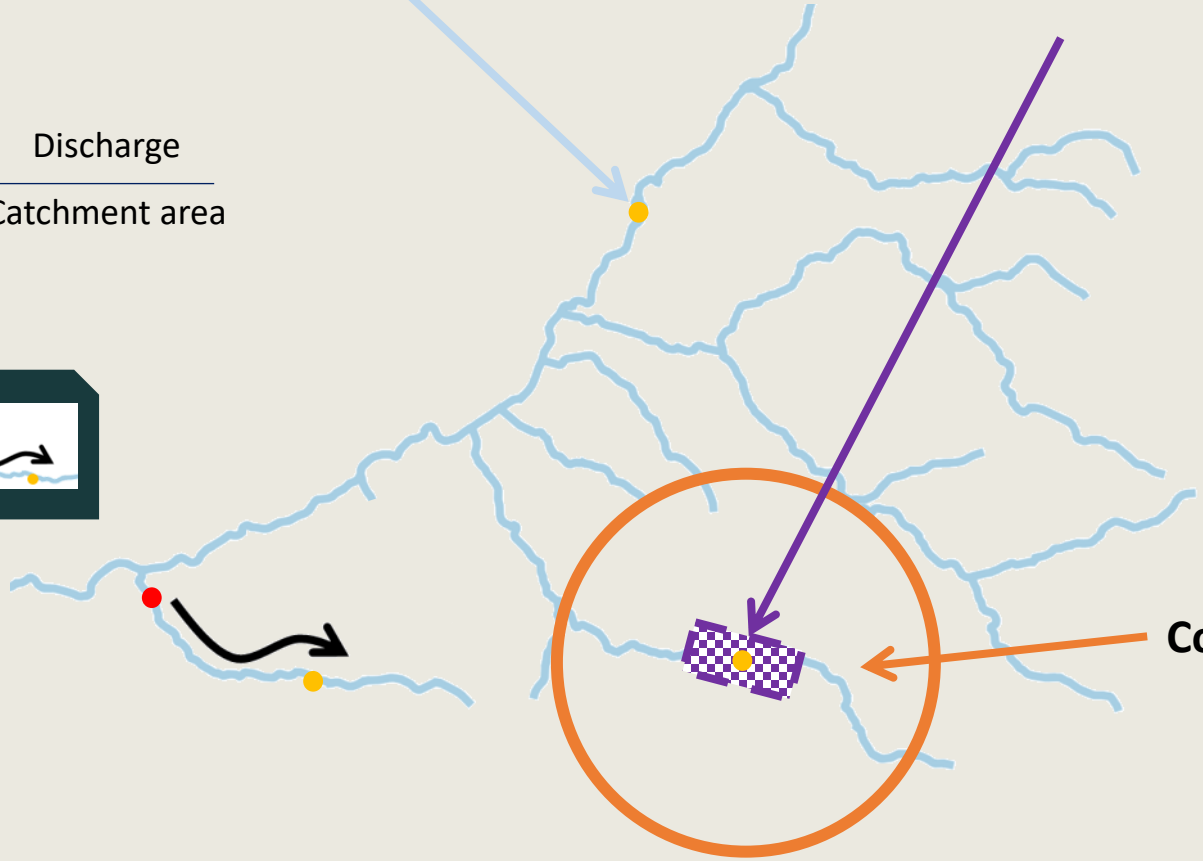


Context scale (buffer of 2 000 m)

% woodlands *[1 – 99]*

Dispersal (1 variable)

Hydrological distance from the nearest colonized reach
[*100 – 102 000 m*]

Identify colonization patterns: Modelling approach (TopDown)

From a full model

Dispersal characteristic
(1 variable)

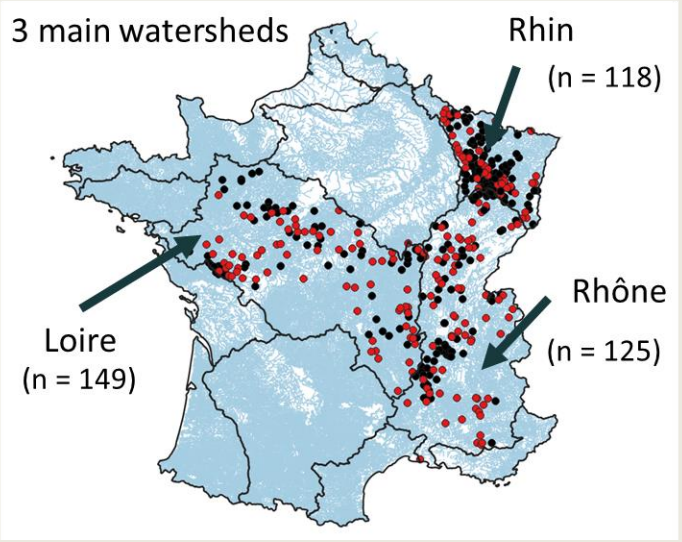
Hydrological variables
(4 variables)

Land use
(5 variables)

Temporal variable
(1 variable)

Logistic regression

$$logit[P(Y=1)] = \beta_0 + \sum_{i=1}^{n\ variables} \beta_i X_i + \varepsilon$$



Colonized Not colonized

Identify colonization patterns: Modelling approach (TopDown)

From a full model

Dispersal characteristic (1 variable)

Hydrological variables (4 variables)

Land use (5 variables)

Temporal variable (1 variable)

To a model with significant variables

Temporal variable (1 variable)

Dispersal characteristic (1 variable)

Colonization characteristics

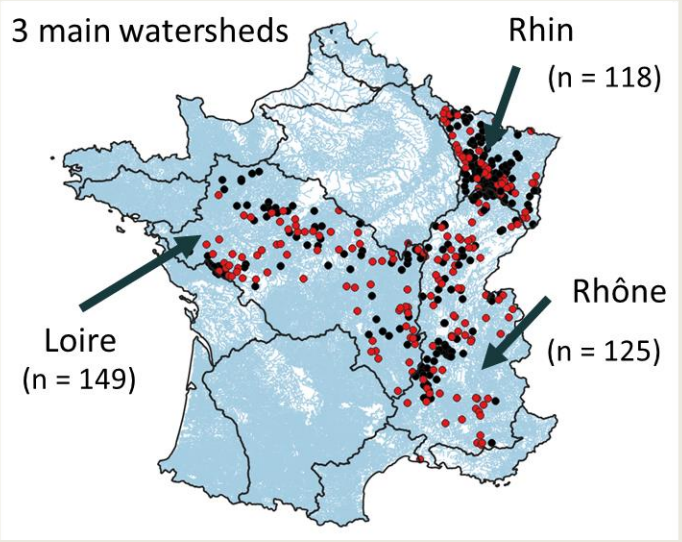
Hydrological variables (4 variables)

Land use (5 variables)

Environmental characteristics

Logistic regression

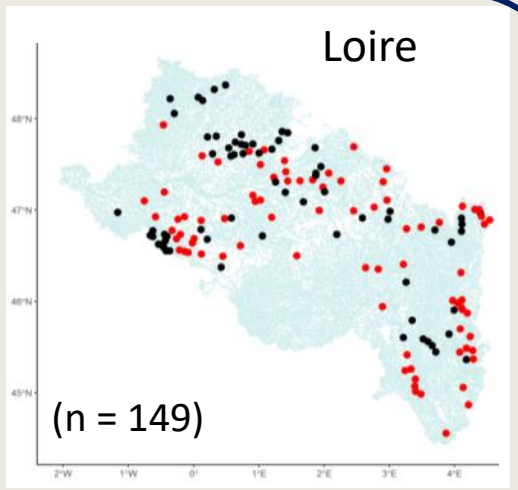
$$logit[P(Y=1)] = \beta_0 + \sum_{i=1}^{n\ variables} \beta_i X_i + \varepsilon$$



Identify colonization patterns: Results

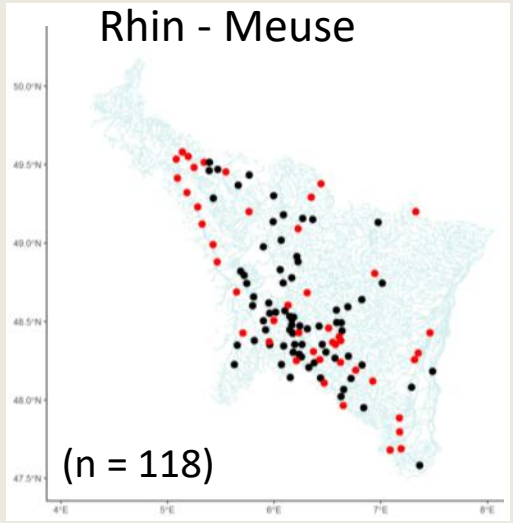
Colonized
Not colonized

Colonization characteristics



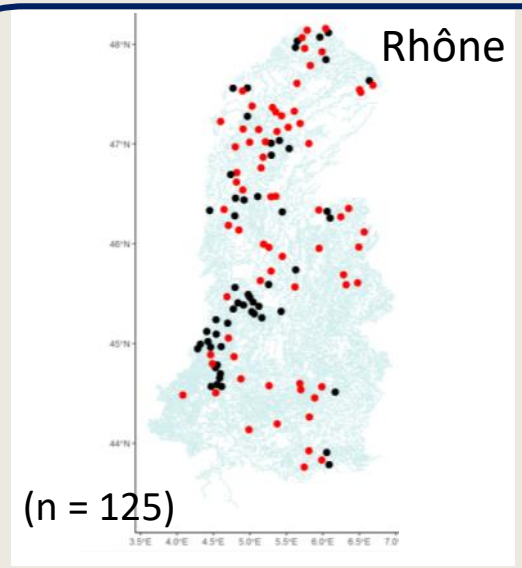
ΔT Between 2 sampling occasions (0,38 ± 0,19)

Hydrological Distance (-1,1 ±0,22)



ΔT Between 2 sampling occasions (0,91 ± 0,22)

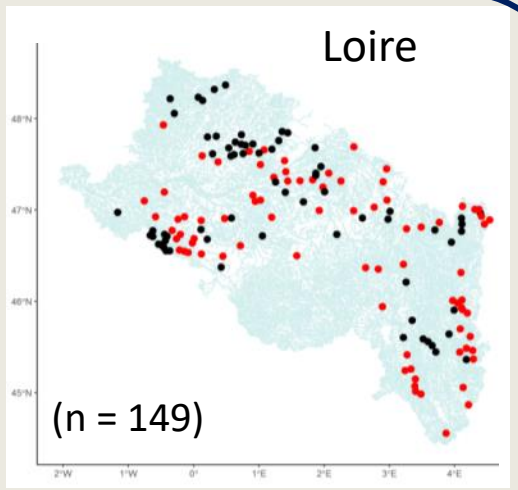
Hydrological Distance (-0,66 ± 0,2)



Identify colonization patterns: Results

Colonized
Not colonized

Colonization characteristics



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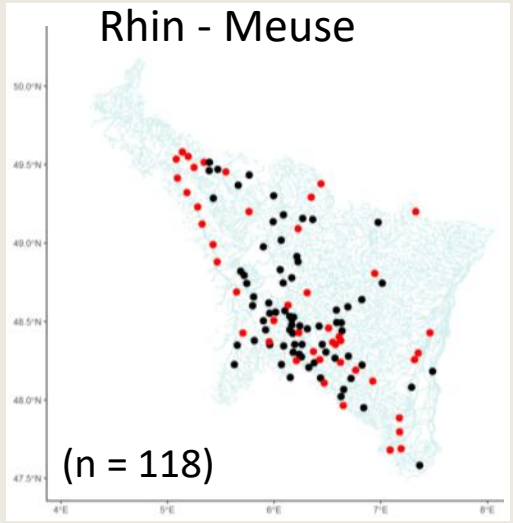

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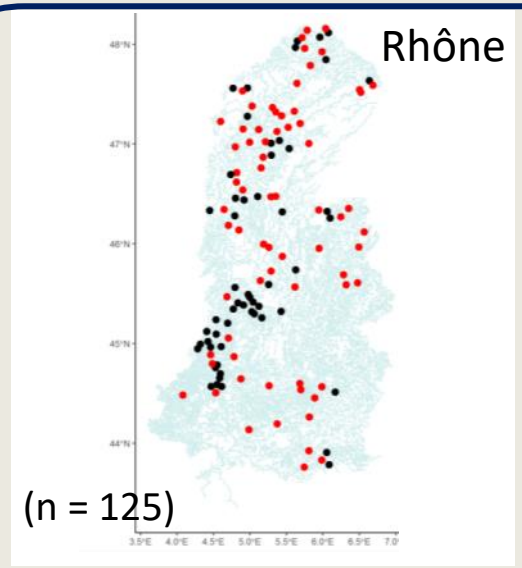
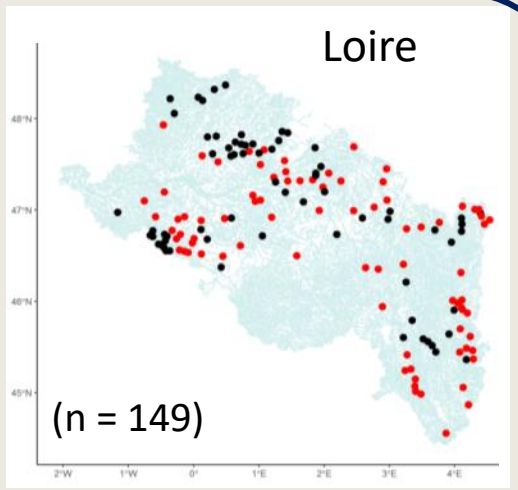


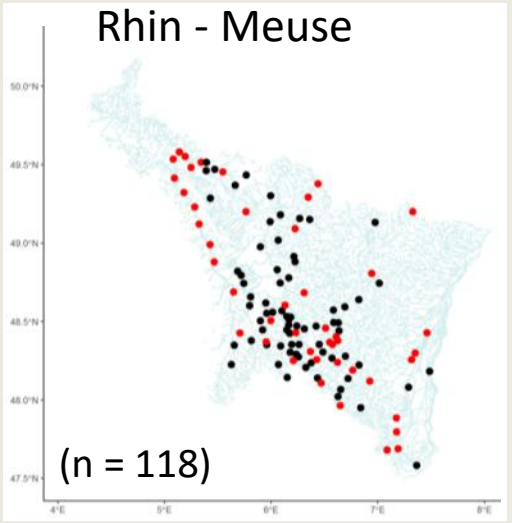
Watershed historically recolonized (last population)

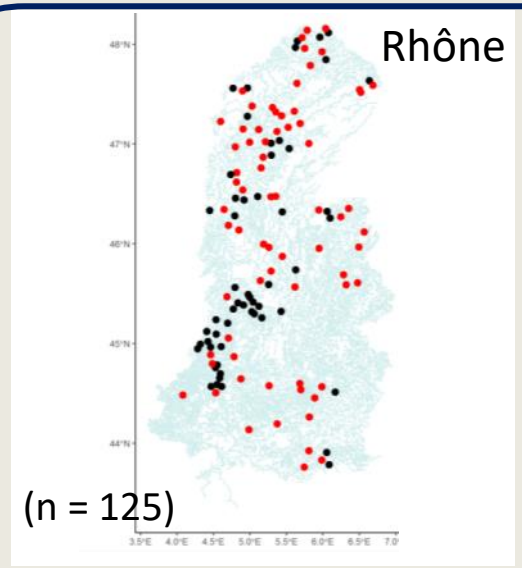
Watershed with high landscape heterogeneity

Identify colonization patterns: Results

Colonized
Not colonized







Colonization characteristics

Loire: ΔT Between 2 sampling occasions ↗ (0,38 ± 0,19); Hydrological Distance ↘ (-1,1 ±0,22)

Rhin - Meuse: ΔT Between 2 sampling occasions ↗ (0,91 ± 0,22); Hydrological Distance ↘ (-0,66 ± 0,2)

Rhône: Watershed historically recolonized (last population)

Watershed with high landscape heterogeneity

Environmental characteristics

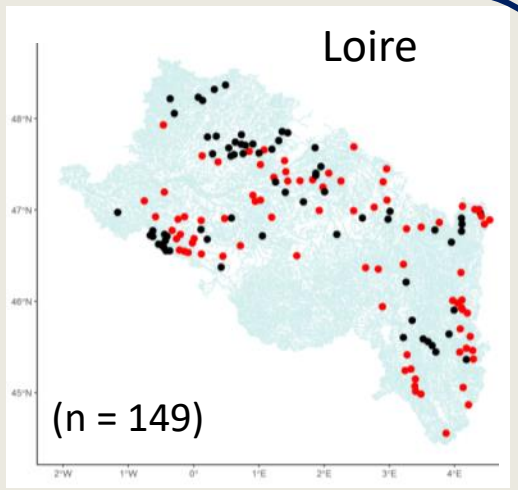
Loire: % Urban area (-0,30 ± 0,19) ↘

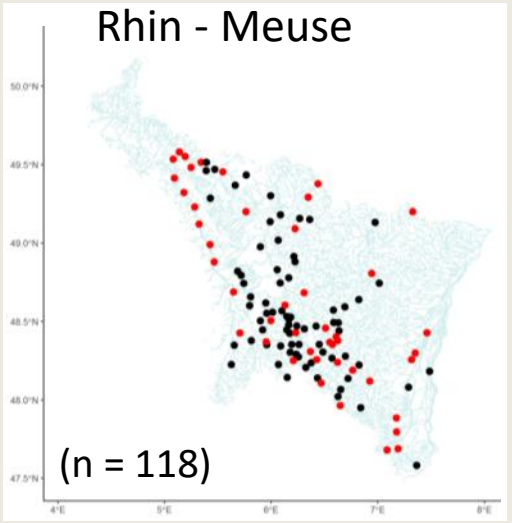
Rhin - Meuse: Slope (-0,61 ± 0,21) ↘; % Perennial culture (-0,41 ± 0,2) ↘; % Annual culture (-0,42 ± 0,2) ↘

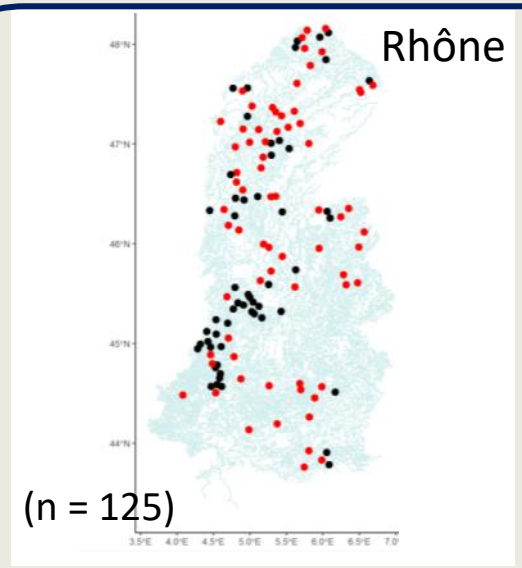
Rhône: Slope (-0,71 ± 0,21) ↘; % Perennial culture (-0,41 ± 0,2) ↘; % Annual culture (-0,43 ± 0,19) ↘

Identify colonization patterns: Results

Colonized
Not colonized







Colonization characteristics

Loire	Rhin - Meuse	Rhône
ΔT Between 2 sampling occasions ↗ (0,38 ± 0,19)	ΔT Between 2 sampling occasions ↗ (0,91 ± 0,22)	Watershed historically recolonized (last population)
Hydrological Distance ↘ (-1,1 ±0,22)	Hydrological Distance ↘ (-0,66 ± 0,2)	Watershed with high landscape heterogeneity

Environmental characteristics

Loire	Rhin - Meuse	Rhône
% Urban area (-0,30 ± 0,19) ↘	Slope (-0,61 ± 0,21) ↘	Slope (-0,71 ± 0,21) ↘
	% Perennial culture (-0,41 ± 0,2) ↘	% Perennial culture (-0,41 ± 0,2) ↘
	% Annual culture (-0,42 ± 0,2) ↘	% Annual culture (-0,43 ± 0,19) ↘

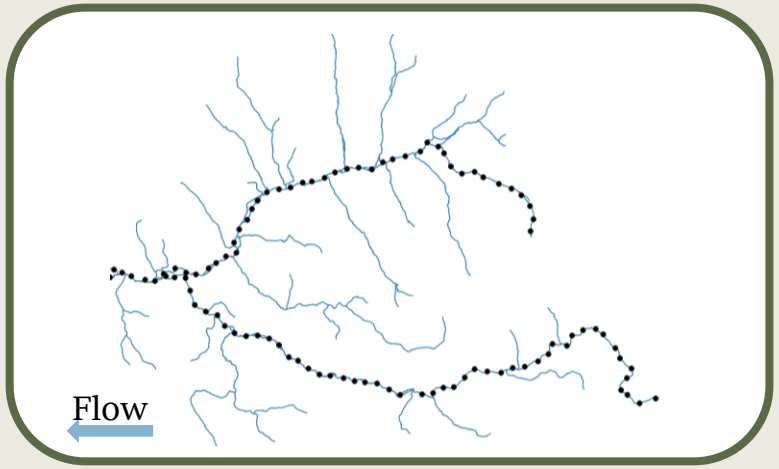
Be careful:

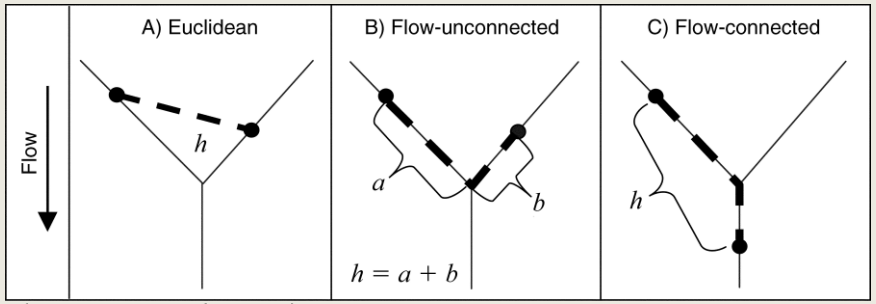
Small data set
Spatial autocorrelation of environmental data

Introducing streams as spatial patterns

Stream networks as spatial patterns

From the subset of
12% initial data
(n = 7780 reaches)





(Peterson et al. 2010)

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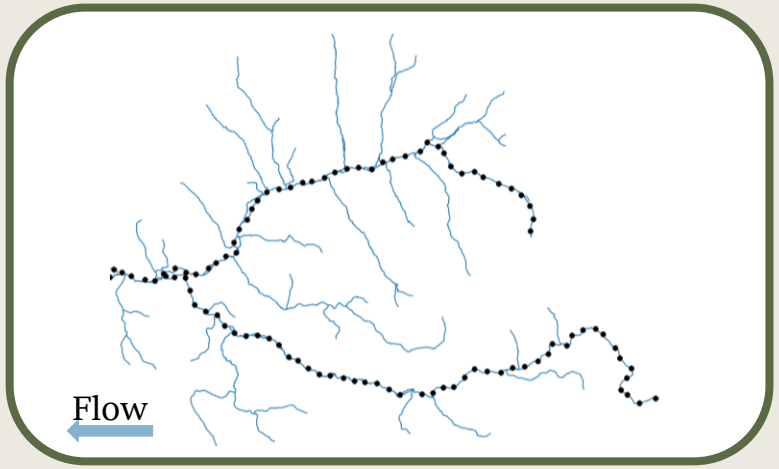

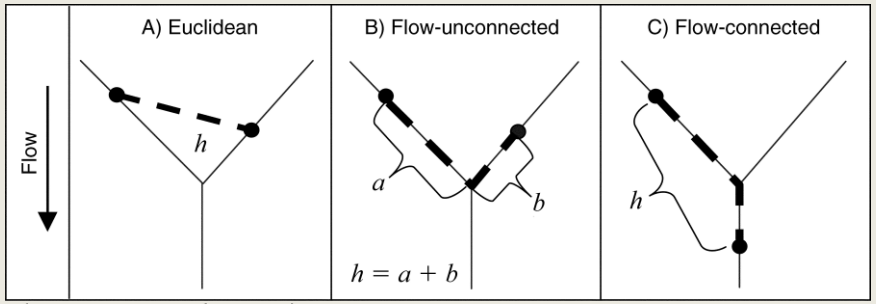

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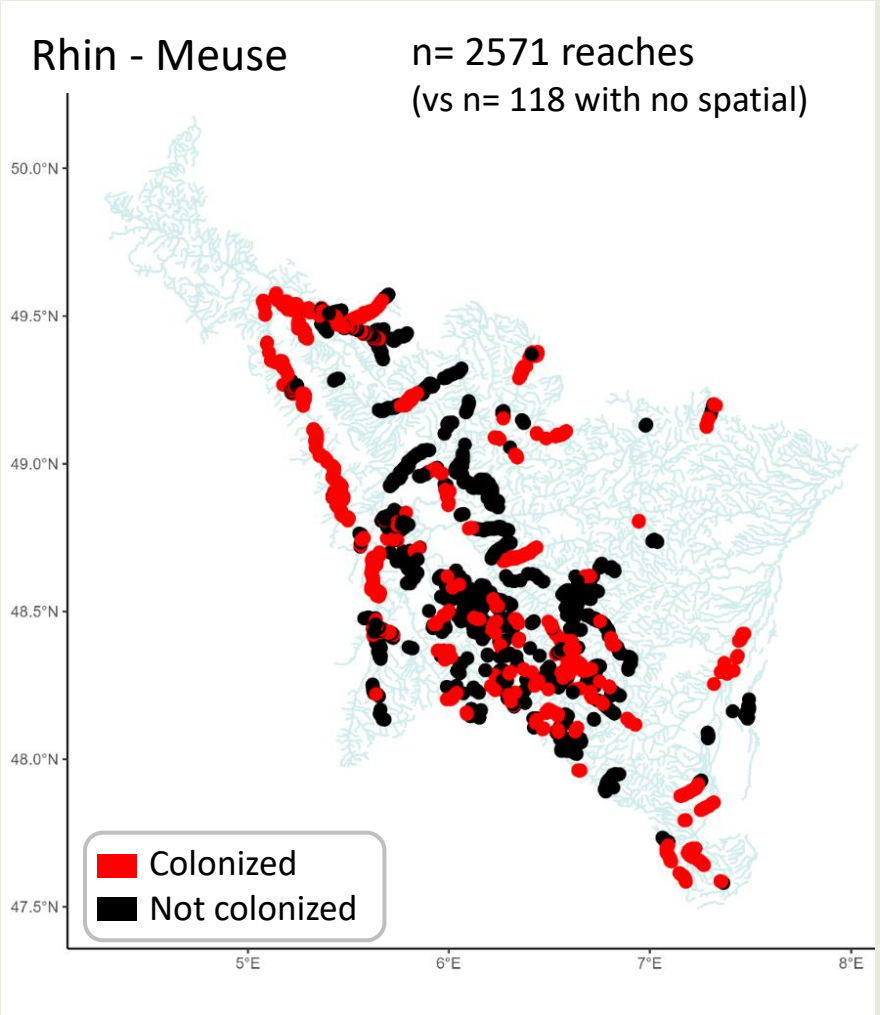
First results for 1 watershed



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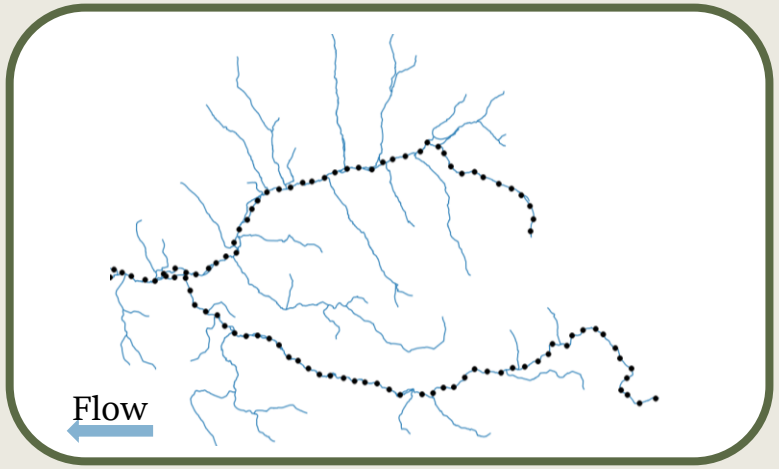

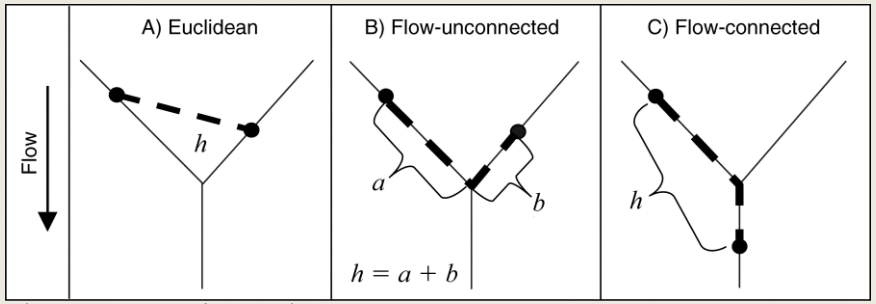

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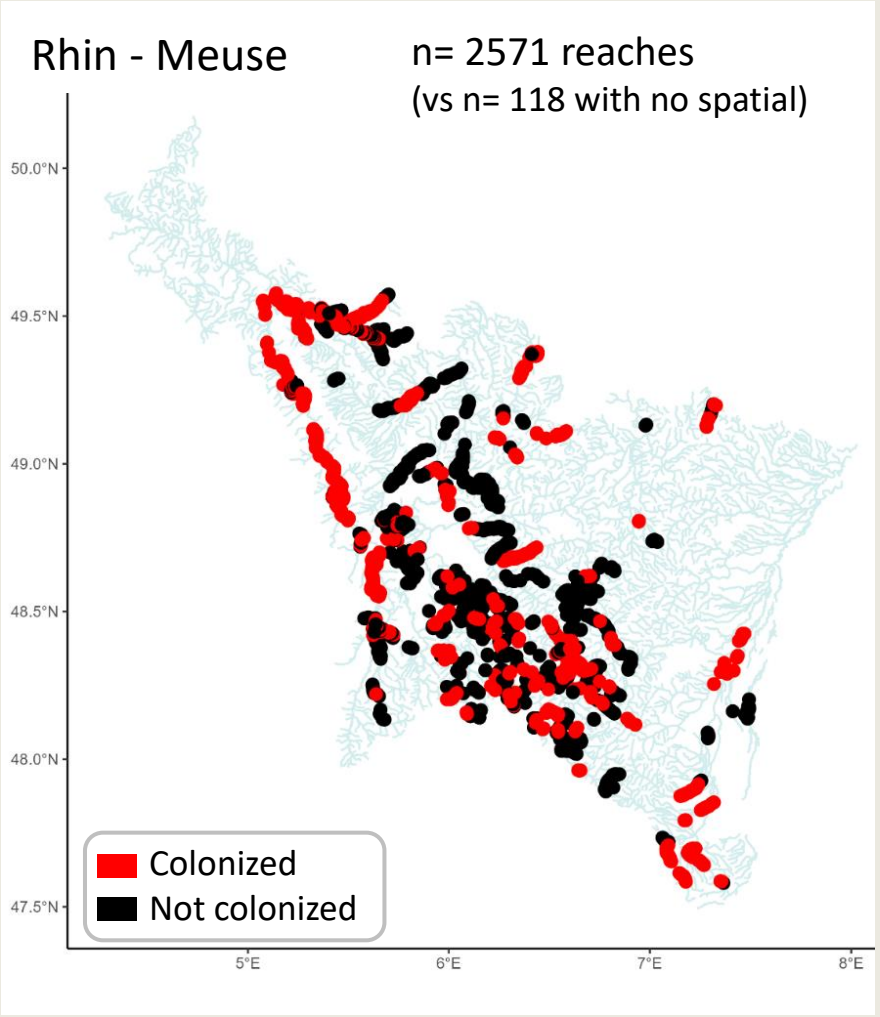

Top-down approach

Colonization characteristics

ΔT
Between 2 sampling occasions
(1,52 ± 0,25)

Hydrological Distance
(-1,22 ± 0,3)

Environmental characteristics

Catchment area
(1,56 ± 0,4)

Specific discharge
(-1,47 ± 0,6)

Conclusions & perspectives

Probability to sample a colonized reach increase with the time between 2 sampling occasions and decrease with the distance from the nearest colonized reach

➔ Consistent with the literatture: a species which progressively colonize by saltation with a mean dispersal distance of 5 km (Graf et al. 2016)

Conclusions & perspectives

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Low link with environmental variables to confirm with spatial analyses

Hydrology

➔ Suggest beavers colonized downstreams

Landuse at local and regional scale

➔ No signficant results with spatial analyses for the Rhin-Meuse watershed

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Can we predict next colonized reaches ?

Develop tools for stakeholders to help local people, farmers and industrialists live and work with beavers

10th INTERNATIONAL BEAVER SYMPOSIUM SCOTLAND 2025

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

INRAE

OFB
OFFICE FRANÇAIS DE LA BIODIVERSITÉ

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Thank you for your attention