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Impact of major roads on bats and effectiveness of bat overpasses

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Bats & Infrastructure
Stockholm, 27th November 2018



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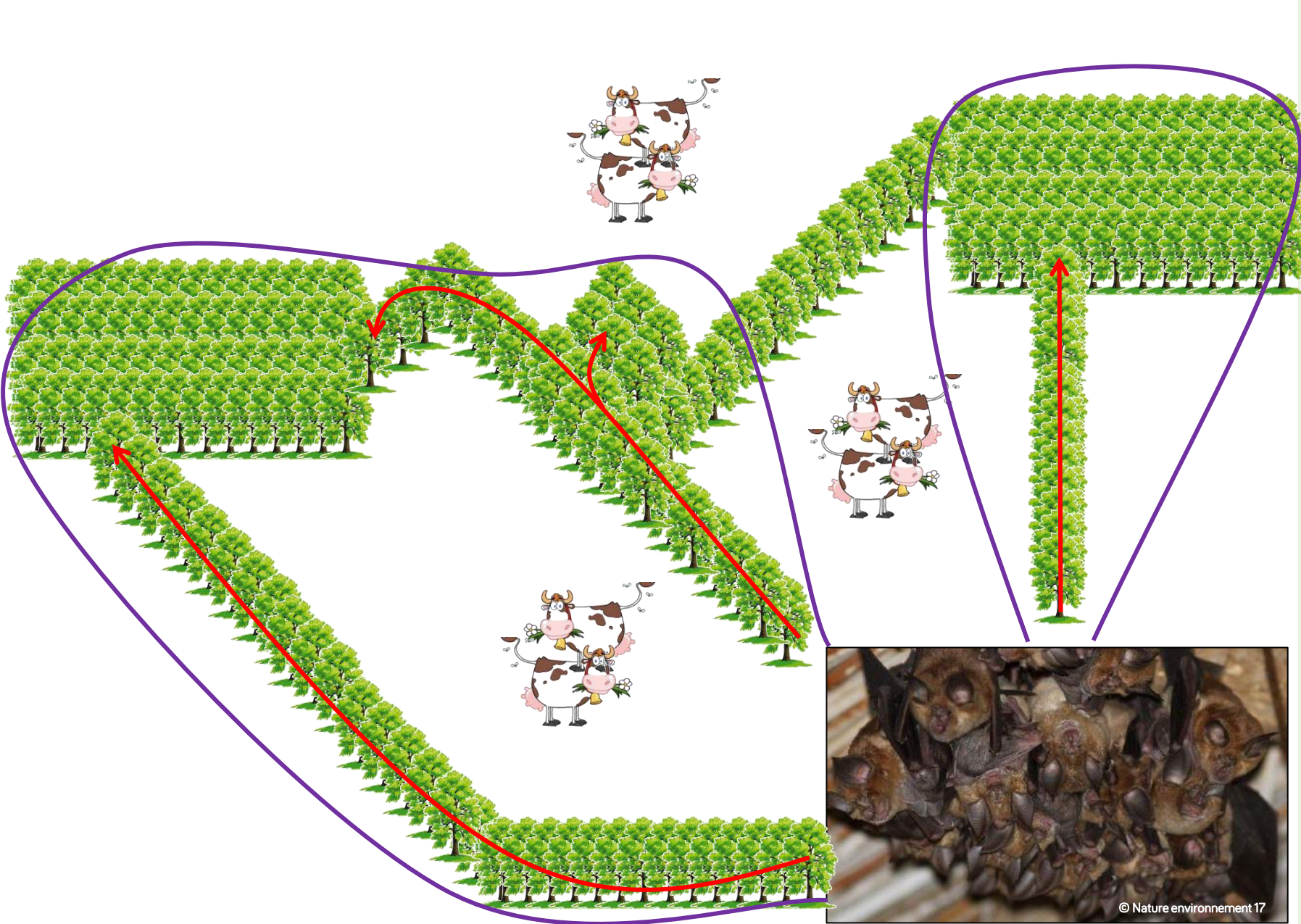
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Introduction

ROADS

Known impacts on bats (reminder)



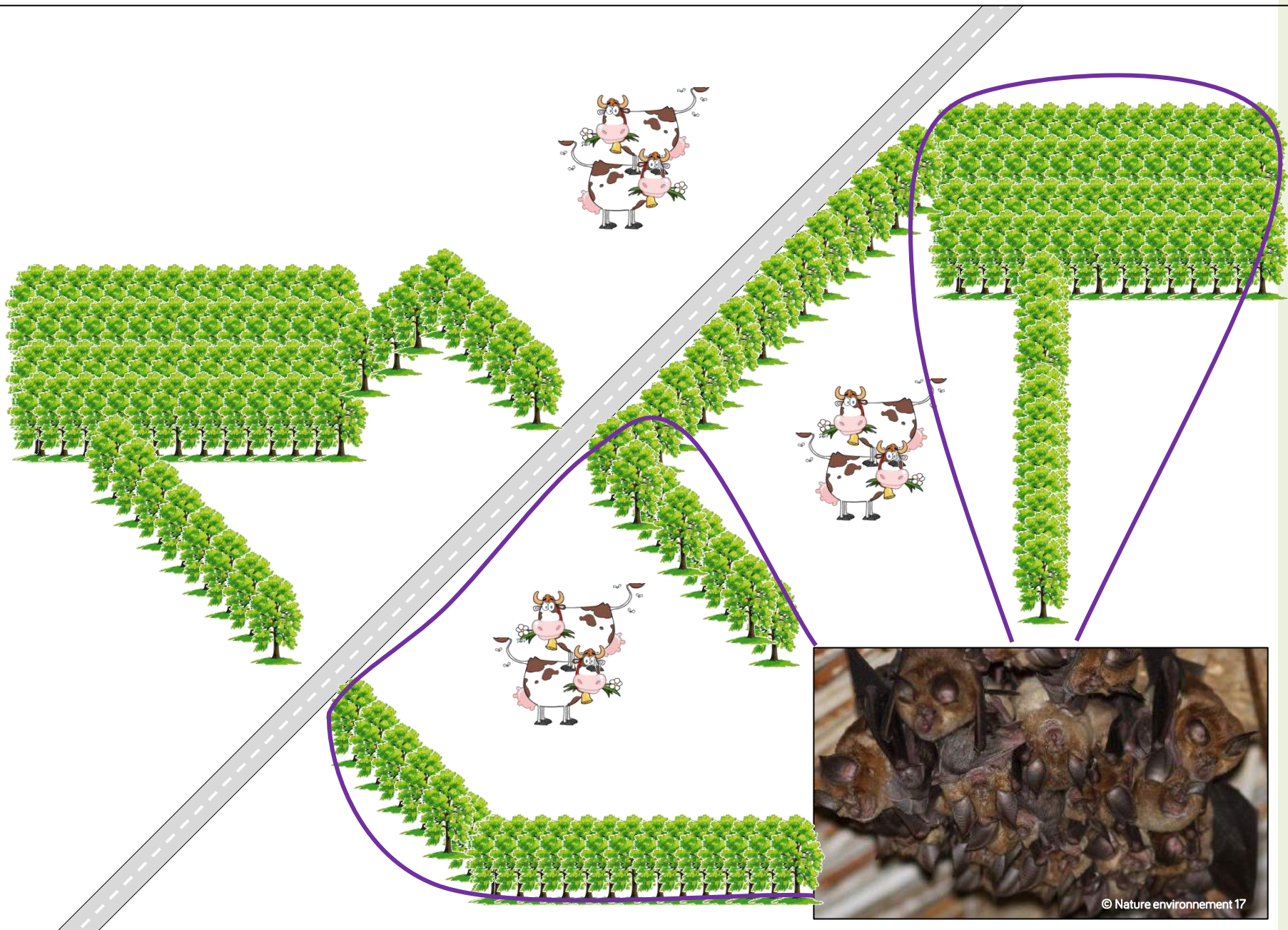
Introduction

Part 1

Part 2

Discussion/Conclusion



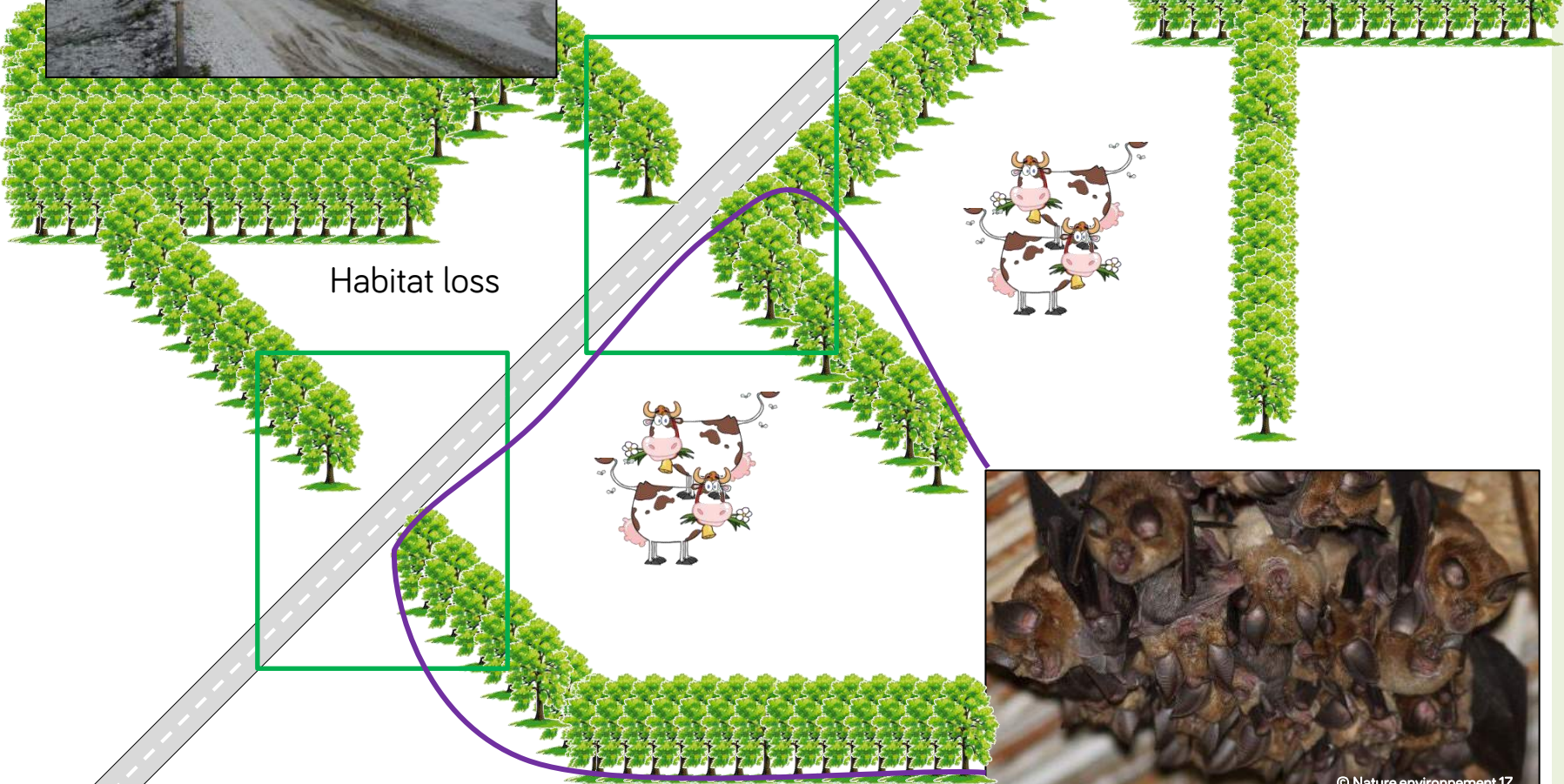


Introduction

Part 1

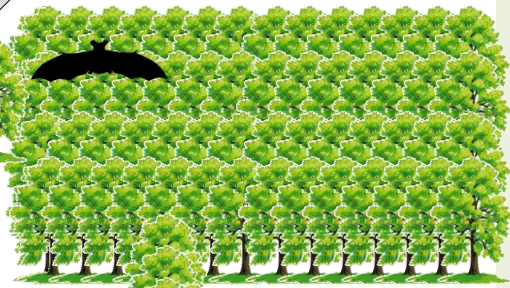
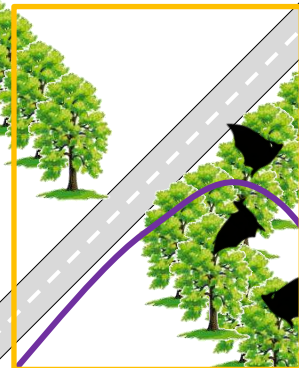
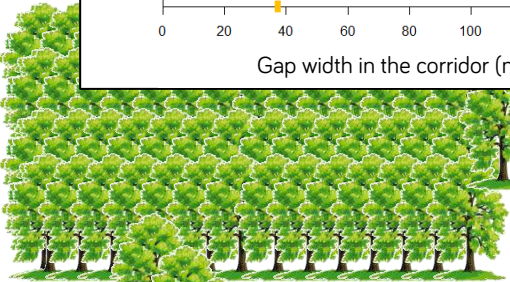
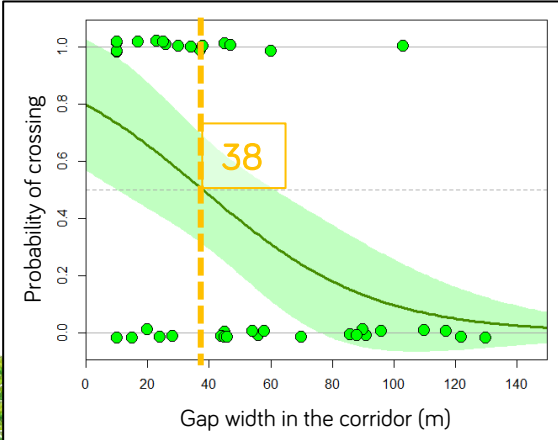
Part 2

Discussion/Conclusion



Habitat loss





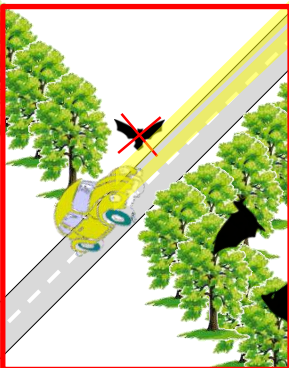
Rupture of commuting route



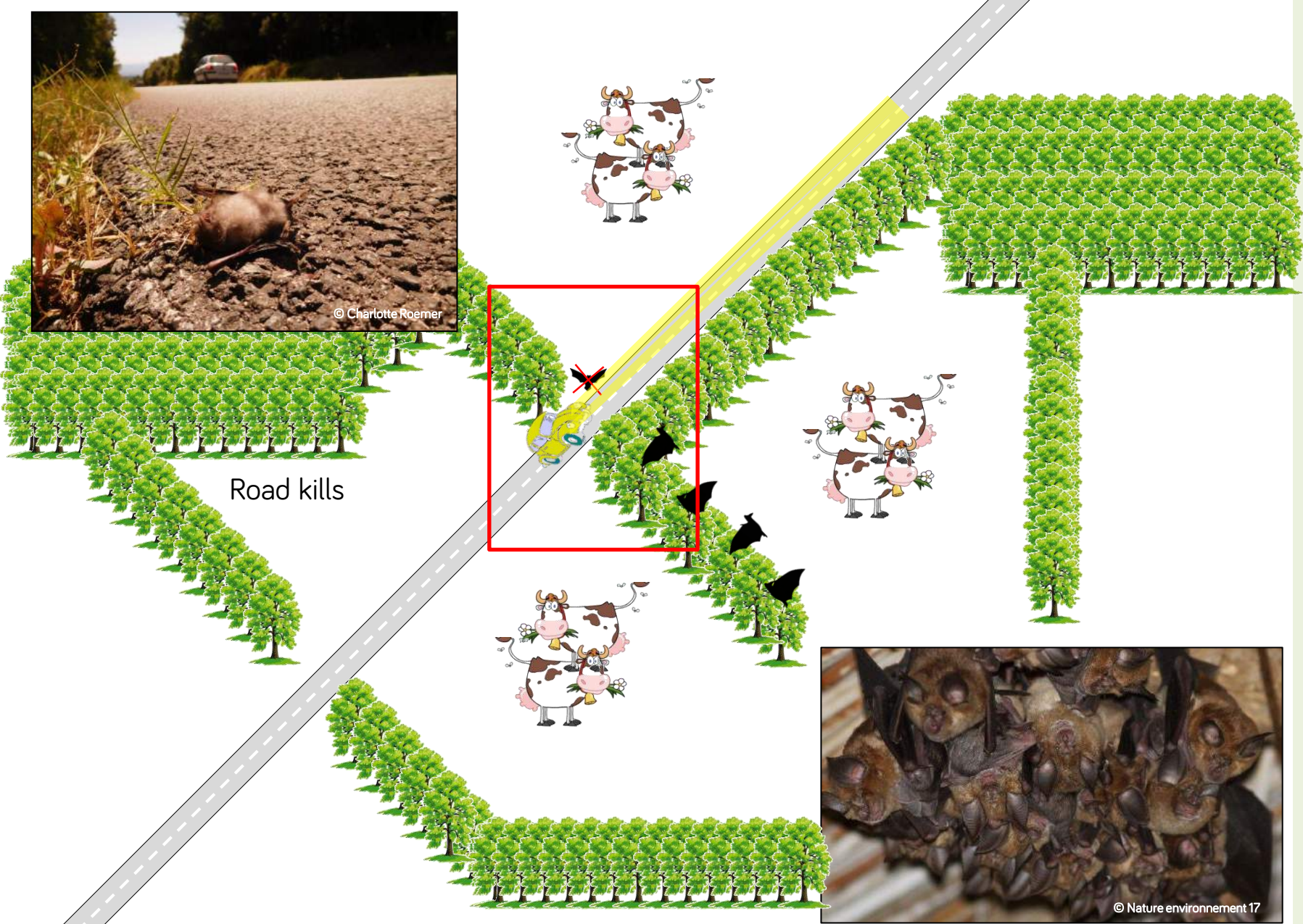
Pinaud D, Claireau F, Leutchmann M, Kerbiriou C (2018)
 Modelling landscape connectivity for greater horseshoe bat using an empirical quantification of resistance.
Journal of Applied Ecology. 55:2600-2611.



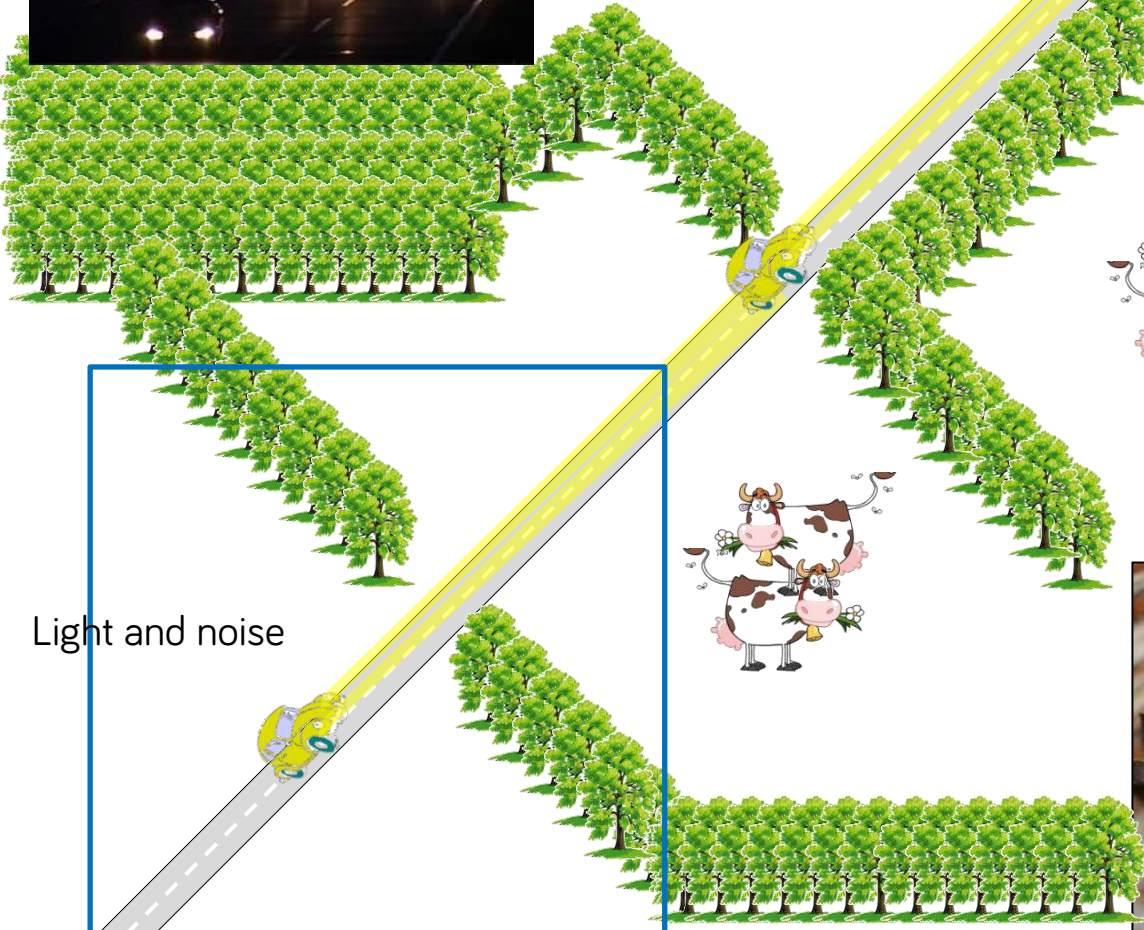
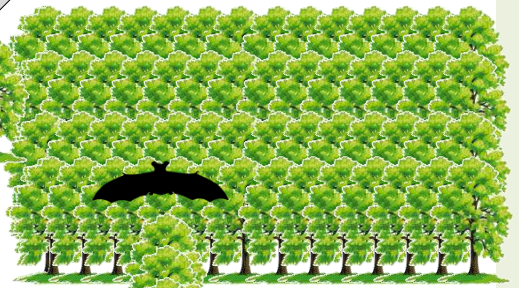
© Charlotte Roemer



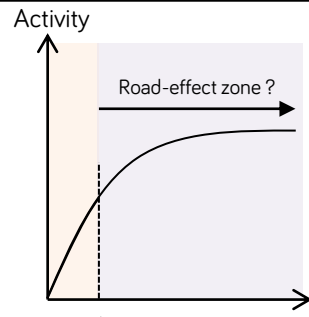
Road kills



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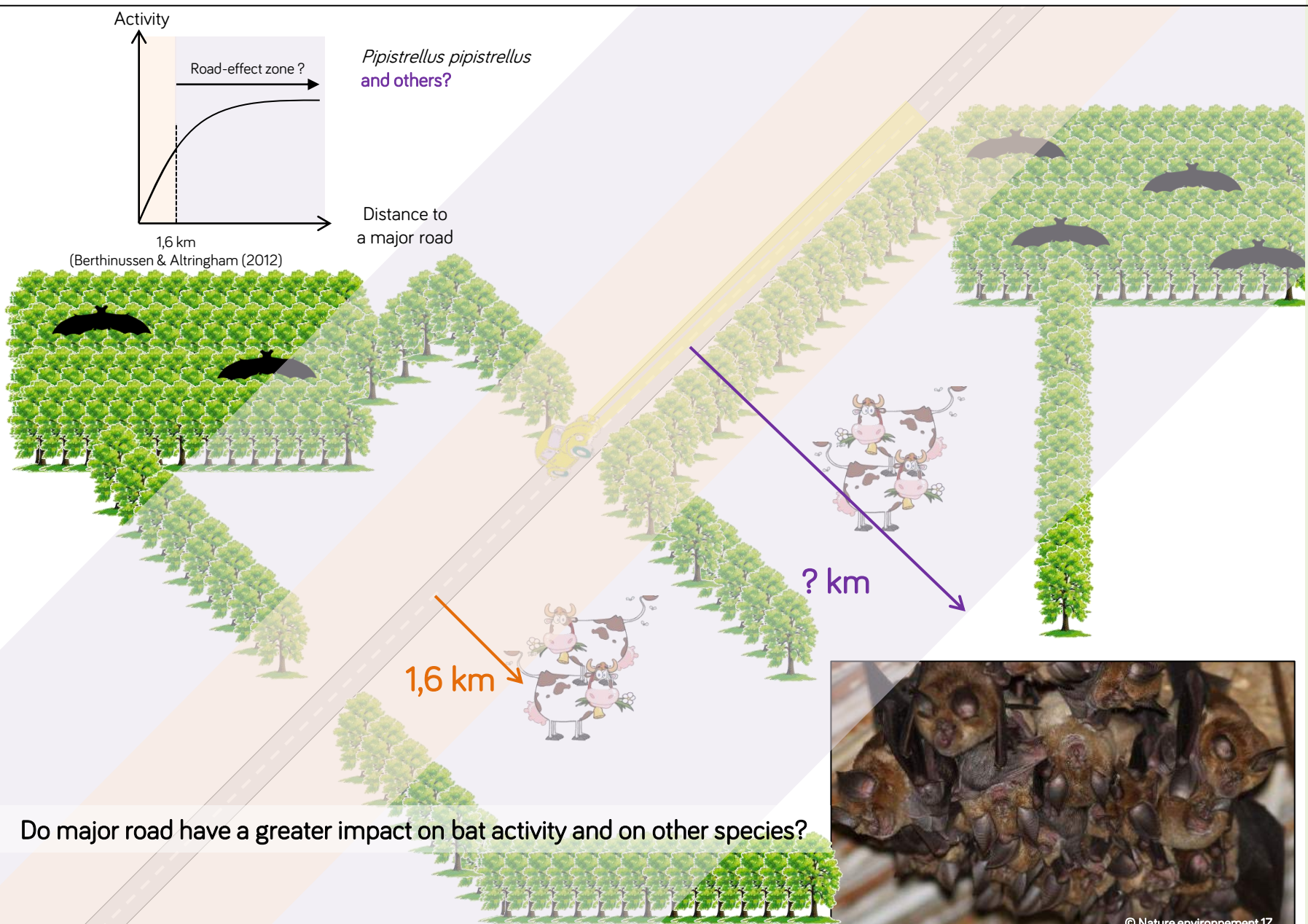


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Pipistrellus pipistrellus
and others?

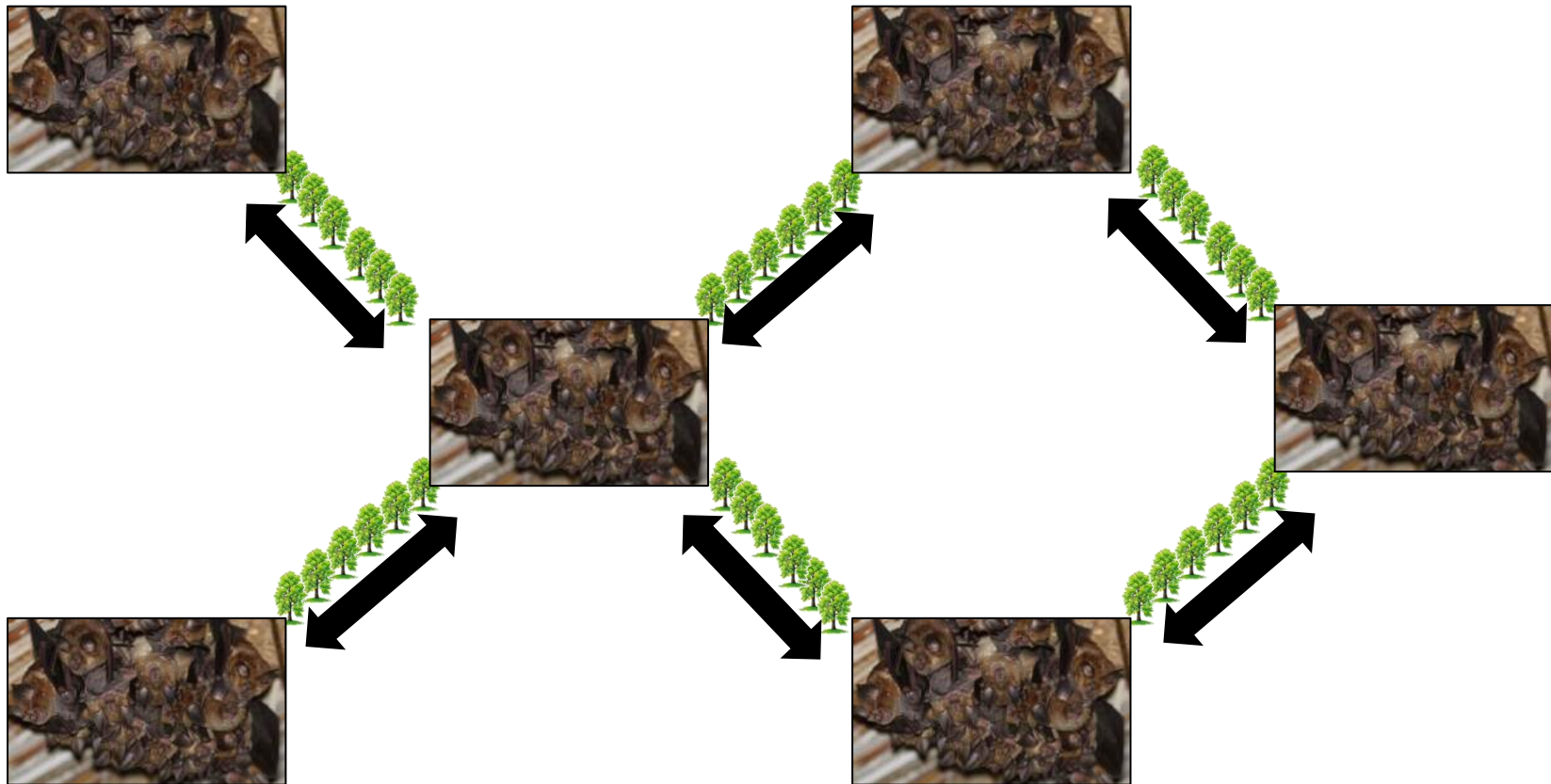
(Berthinussen & Altringham (2012))



Do major road have a greater impact on bat activity and on other species?

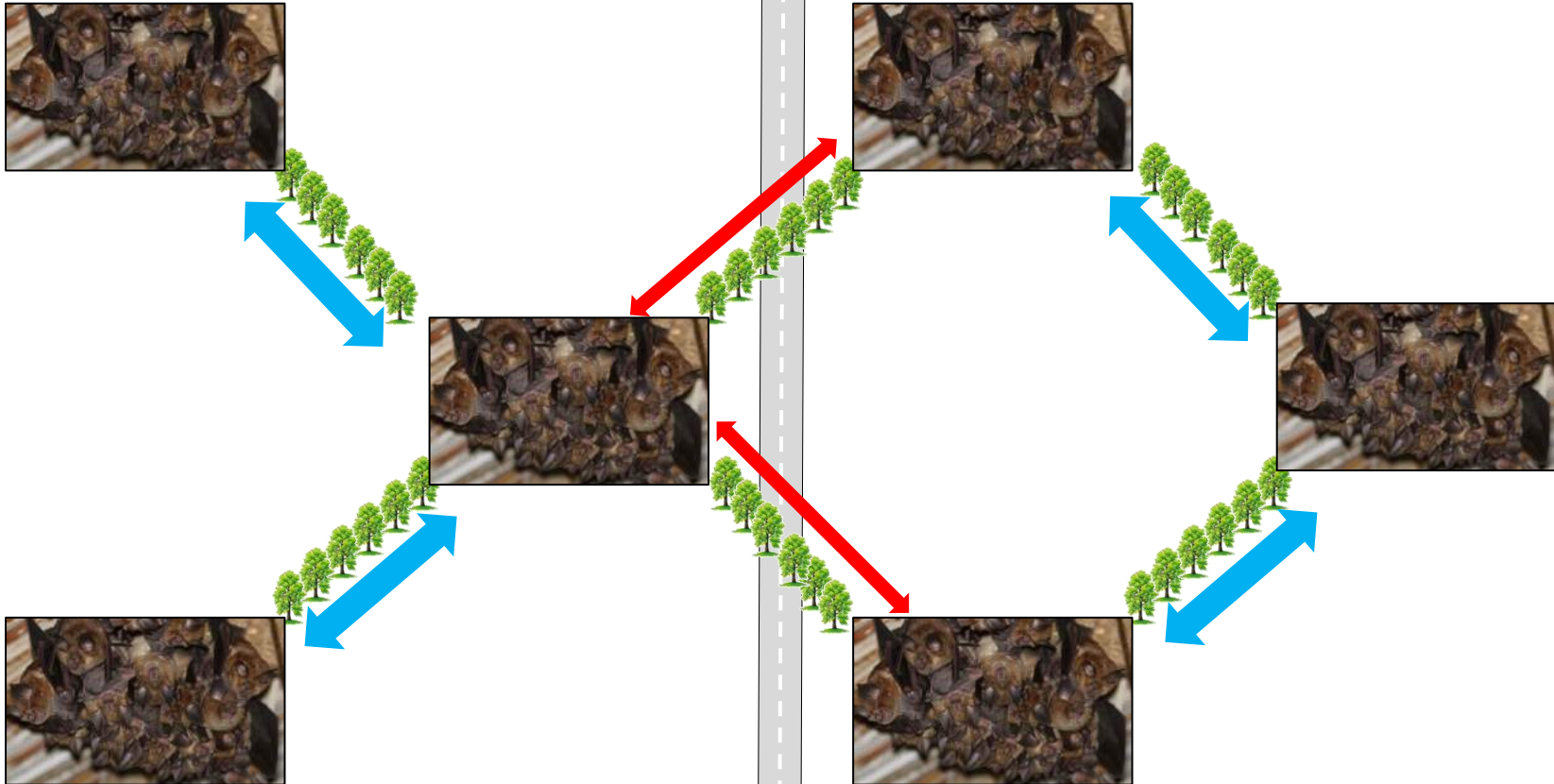


Equivalent genetic exchange flow





Lower genetic exchange flow between roosts disconnected by roads

Greater genetic exchange flow between roosts no-disconnected by roads



Do major roads have an impact on genetic structure?

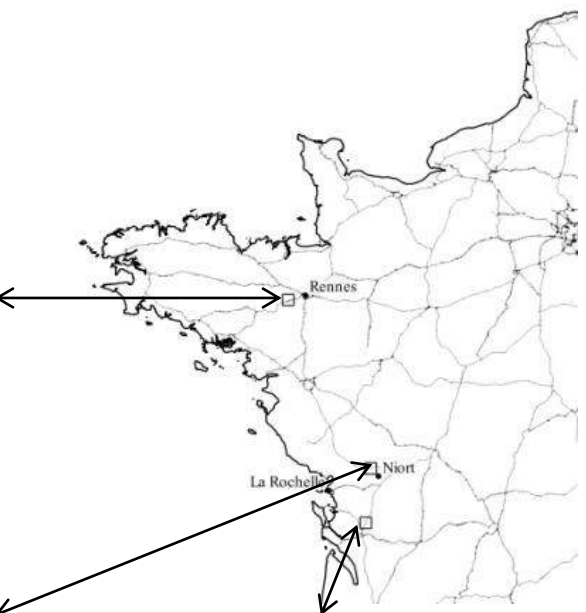
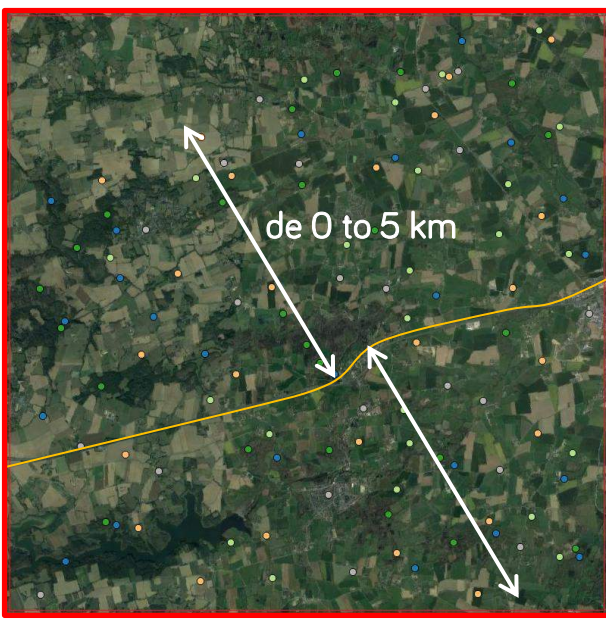
Part 1: impact of major roads on bats

- on bat activity 
- on genetic structure 

Part 2: effectiveness of bat mitigation measures

- on existing sites  
- on experimental site 

Part 1 : Impact of major roads on bats

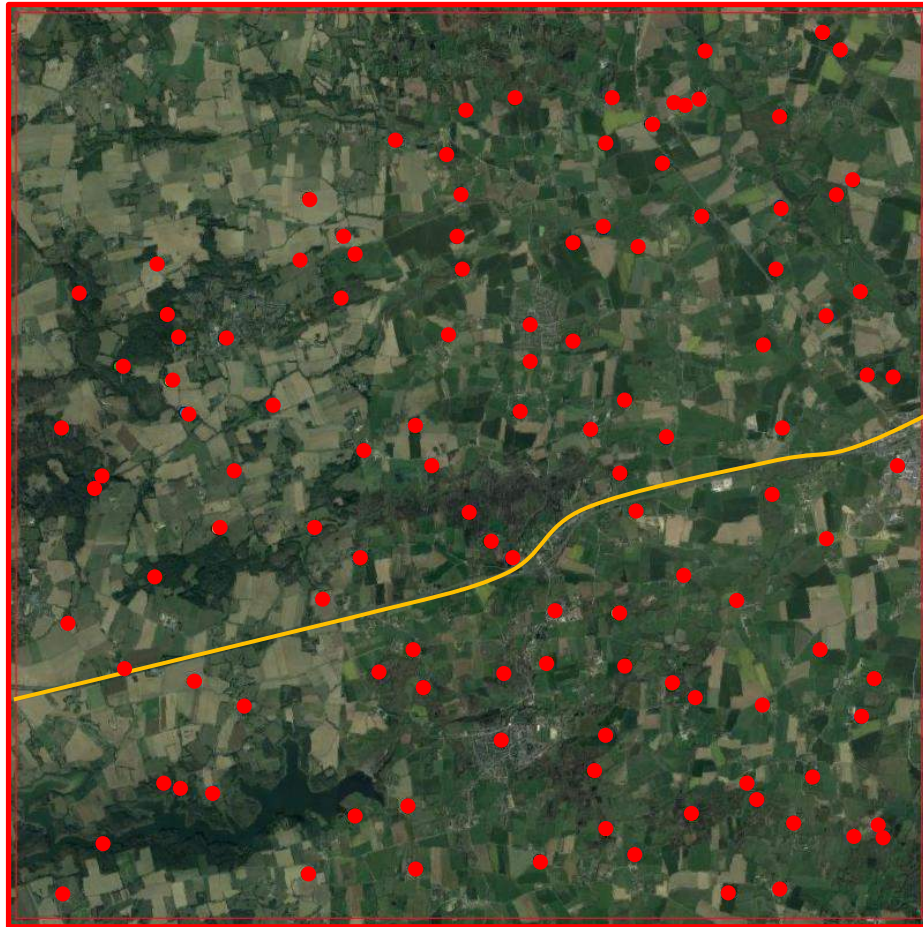


3 sites in western France
 100 km² of study area
 306 survey points
 0 to 5 km distance to the road
 Period: in summer 2016

- 5 main habitat types:
- hedgerow
 - woodland
 - wetland
 - agricultural land
 - urban



Focus on one site: N24



- Habitats sampled simultaneously
- In different distance classes

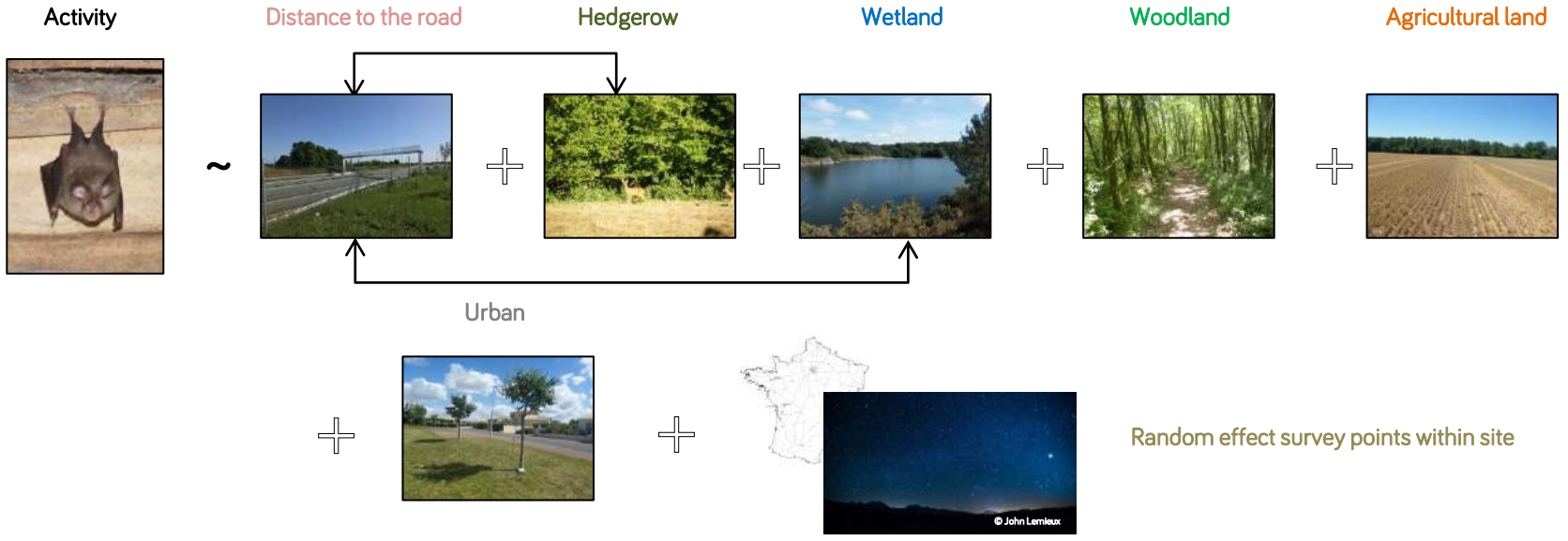
⇒ Control of the daily variability

Total (N24):

120 survey points on 10 successive days

Day 1 to day 10 with 12 acoustic recorders per night





Selection of the best model



IMPACT ON BAT ACTIVITY

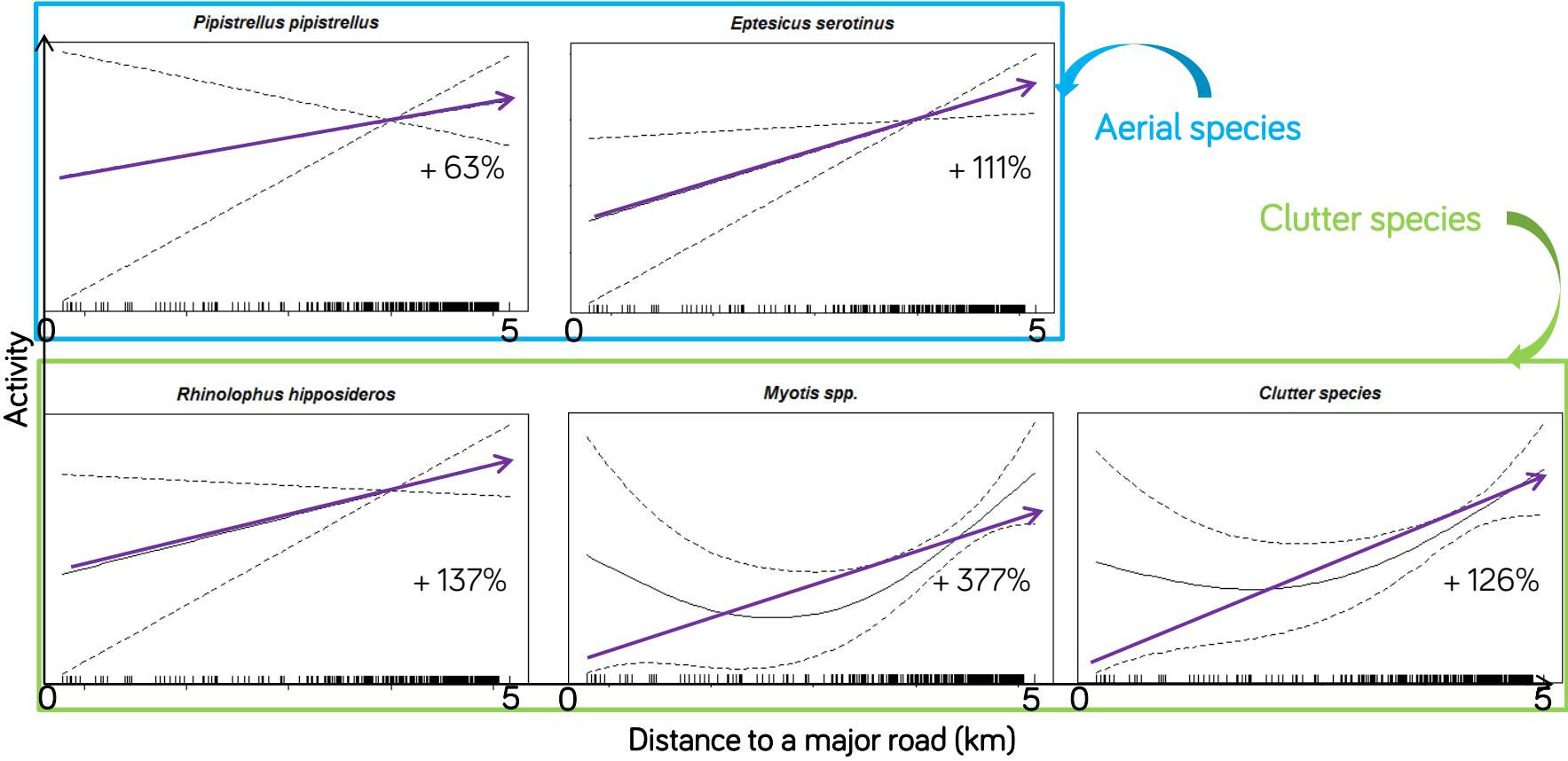
Results – Distance impact on bat activity

Among the 13 taxa studied:

5 are negatively affect drastically

Up to 5 km distance of a major road

Effect seems to be linear



Road effect zone is greater than the actual knowledge

Potential impacts on:

- ⇒ landscape scale
- ⇒ access to foraging areas
- ⇒ decrease of home range
- ⇒ can affect population dynamics

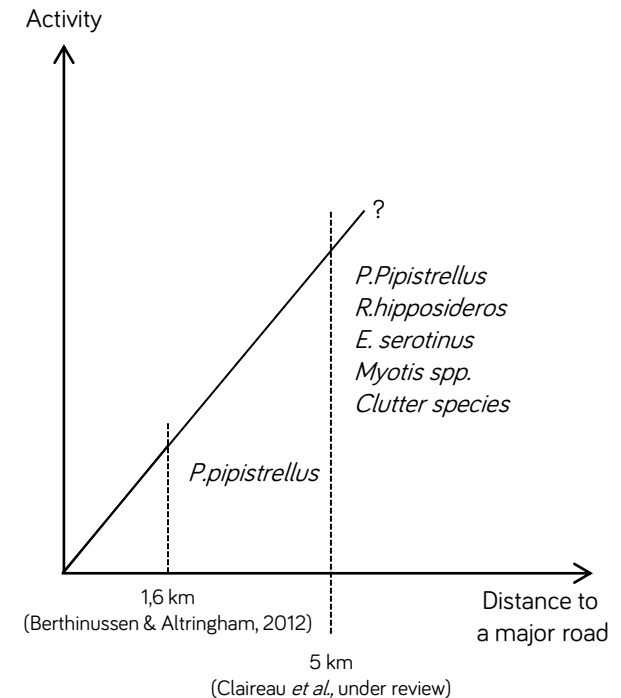
Clutter species seems to be more affect than aerial species, in keeping with actual knowledge (Fensome & Matthews, 2016; Capo, Chaut & Arthur, 2006)

Possible causes:

- ⇒ rupture of commuting routes
- ⇒ avoidance of lit areas and noise traffic
- ⇒ collision risk (flight behaviour)

Another studies could be employed in order to evaluate the importance of these mechanisms

Do these impacts have a consequence on genetic structure?





Species: the Lesser Horseshoe bat

Based on droppings: identification of individuals (ADN)

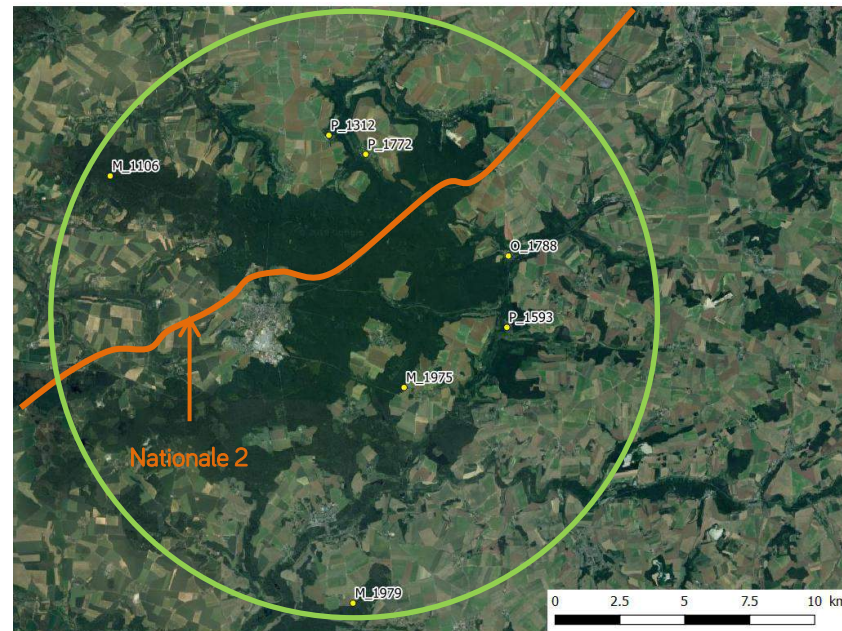
Sampling plan:

- roosts parturition
- with roosts on both sides a major road

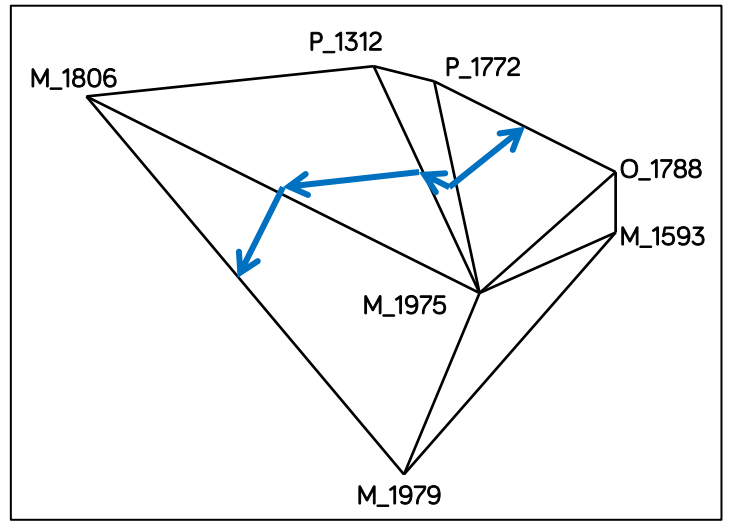
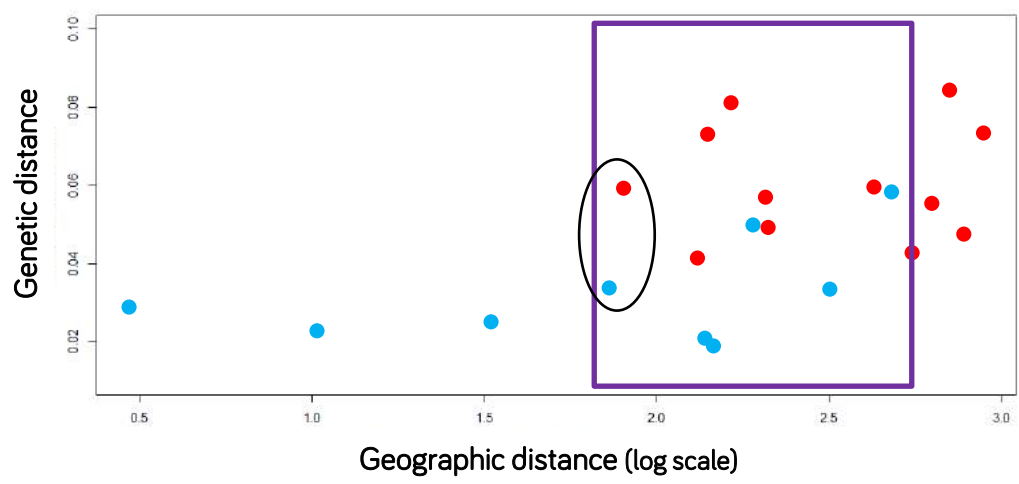
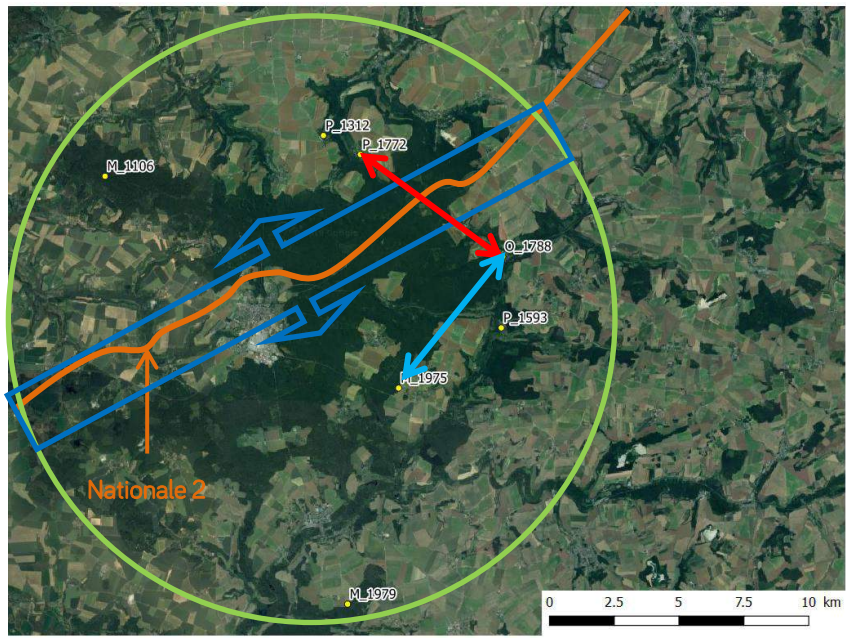
Here, just one site

Isolation by genetic distance
and geographic distance

Research of a genetic barrier



Results – Isolation by genetic distance and geographic distance

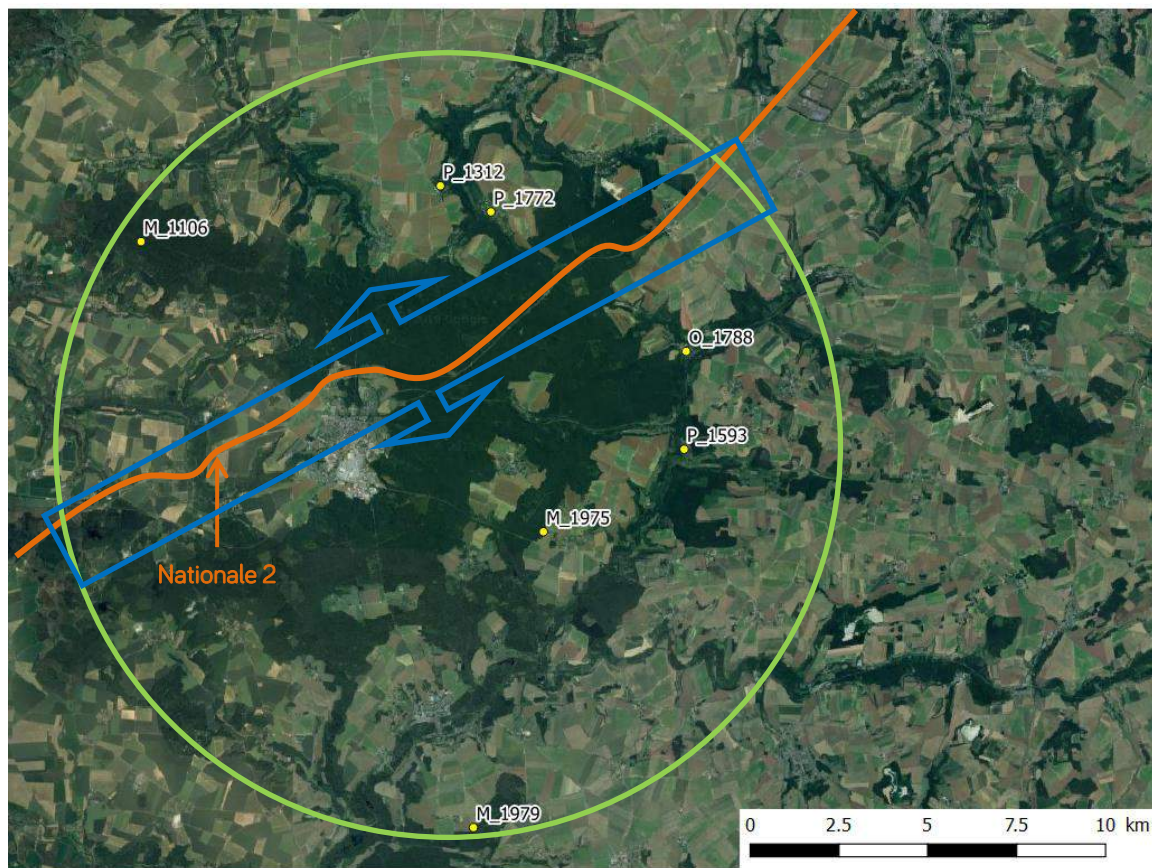


Collaborations : Pierre-Loup Jan, Éric Petit (UMR ESE), Christian Kerbiriou, Nathalie Machon & Sébastien J. Puechmaille
 Structures partenaires : Picardie Nature, SHNA, Bretagne-Vivante, LPO-37 & GCPDL

Genetic barrier detected, probably the major road (N2)

⇒ need to confirm results with other study sites

Genetic structure of bat population can not be explain only by the geographic distance



Major roads have a **negative impact on bat activity** with consequence on genetic structure

Despite a small occupied area, major roads are a **important pressure on bats**

Need to **take into account these impacts** in Environmental Impact Assessment studies

But, when major roads are already in function, if avoidance is impossible, apply mitigation and offset measures

How to reduce impact of major roads on bats?

Part 2 : Evaluation of mitigation measures

What are they?

1- Structure above the road (bat overpasses (e.g. gantry), wildlife crossing...)

2- Structure under the road (bridge, culvert...)

3- Other: speed reduction, deterrence....)

An overview of bat mitigation on roads in Europe :

Møller, J.D. *et al* (2016) *Effectiveness of Mitigating Measures for Bats – a Review*. CEDR Transnational Road Research Programme.

Bat overpass:

It is a structure:

- which can “attract” bats
- function as a linear feature (e.g. hedgerow) that can be perceived by bats with echolocation
- in order to cross the road safely



How evaluate and what methods used?

Measure of the effectiveness:

- 1- Are bat overpasses are attractive? (perception of the structure?)
- 2- Do bat overpasses can permit to bat to cross the road safely? (above 5 m of the road)

What are the methods?

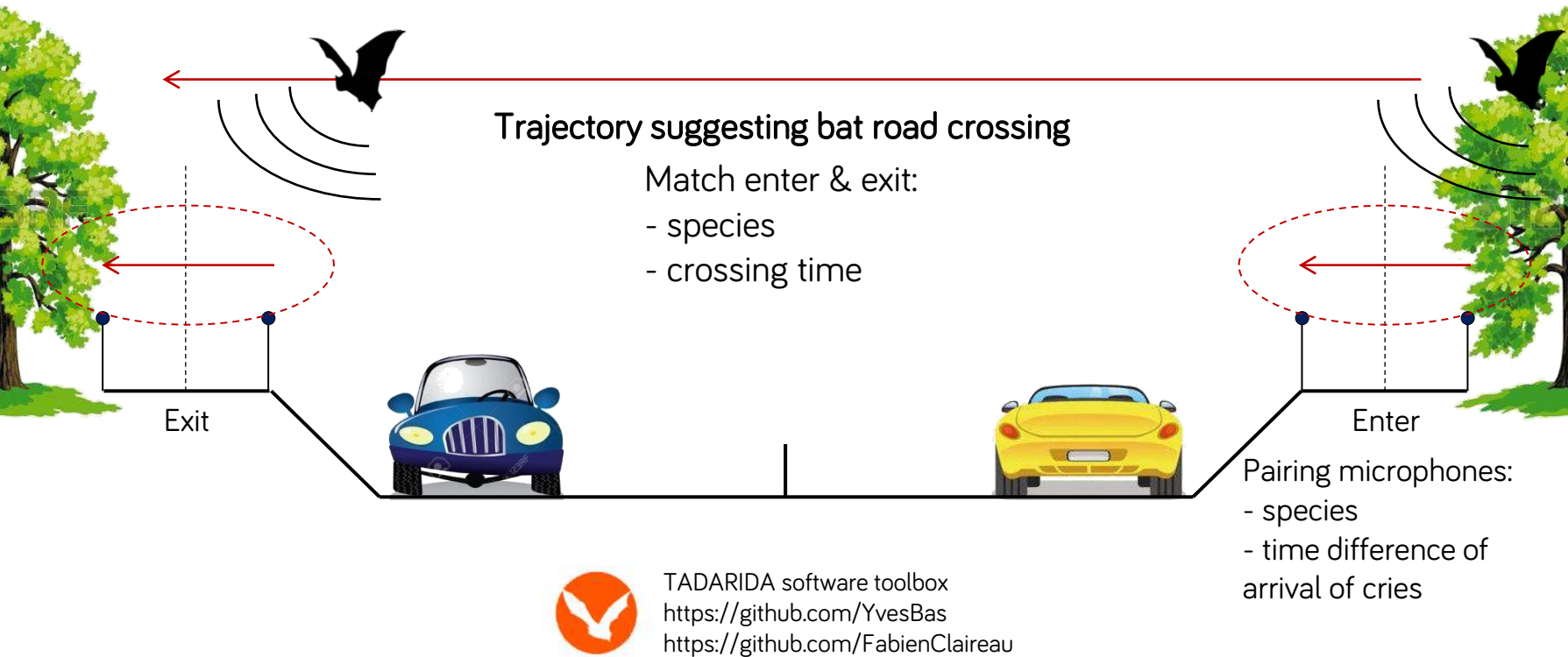
- 1- Acoustic surveys: acoustic recorder in stereo recordings
- 2- Visual surveys: thermal camera



Two steps:

1- Detect bat crossing event

⇒ Trajectory reconstruction in 1D (Acoustic Flight Path Reconstruction, AFPR)

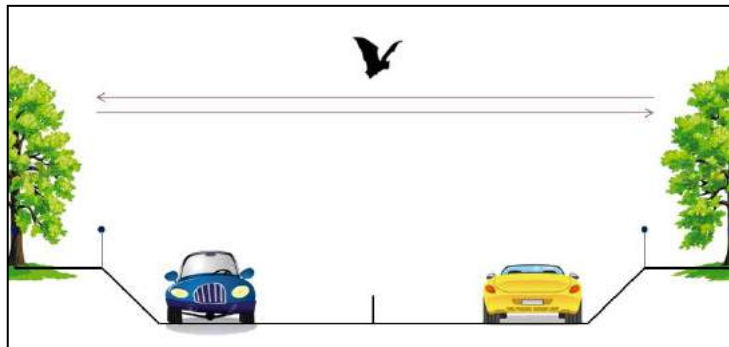


Two steps:

2- Test the difference of bat crossing in different context, including overpass

=> Used model (GLMM) in order to characterize where bats cross the road the most

Number of bat crossings



Pairs



(1|Date)



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EVALUATION OF MITIGATION MEASURES

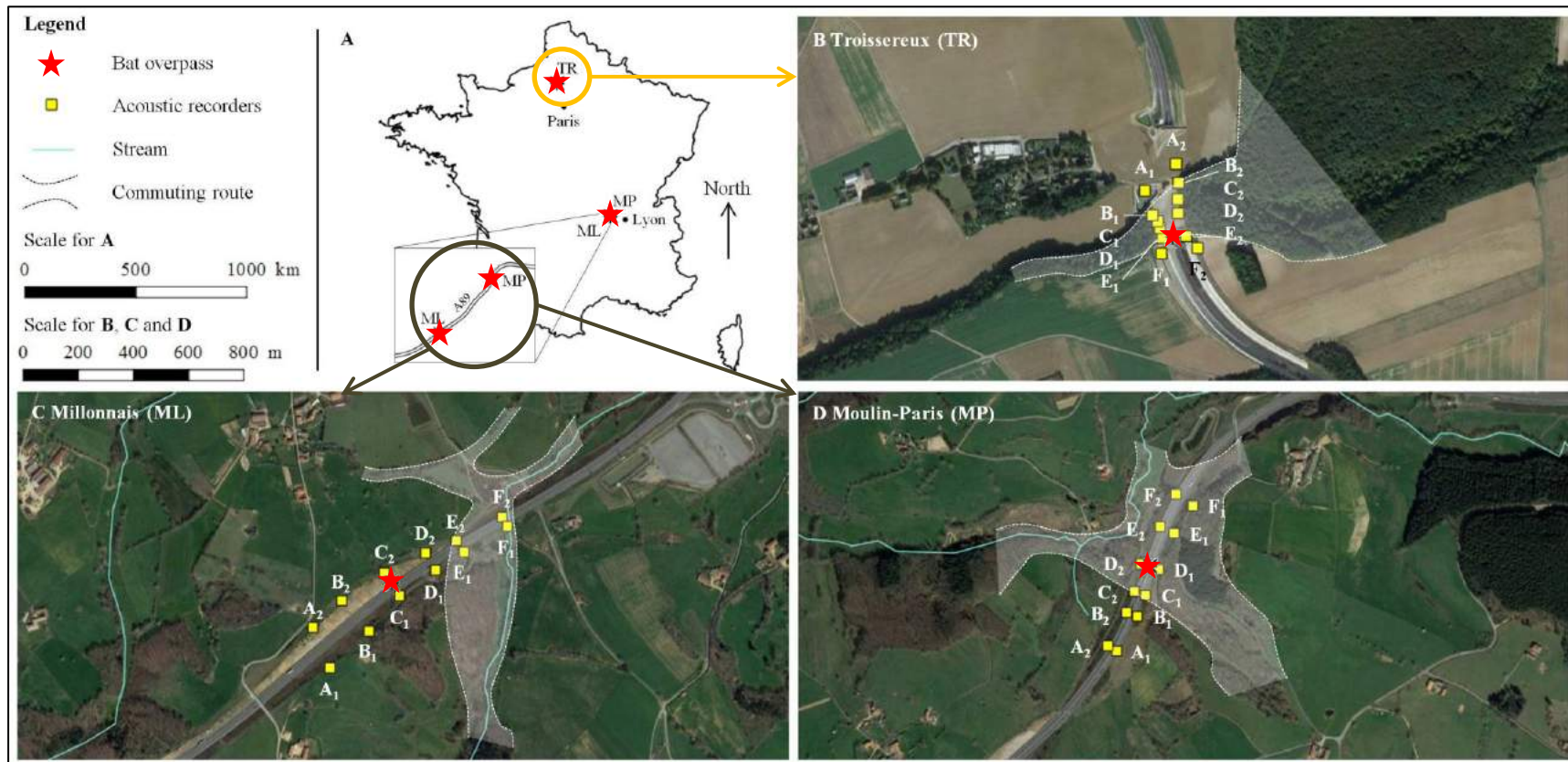
Acoustic method – existing sites

3 sites in France near de Lyon on A89 and Beauvais on D301

6 pairs of acoustic recorders per site

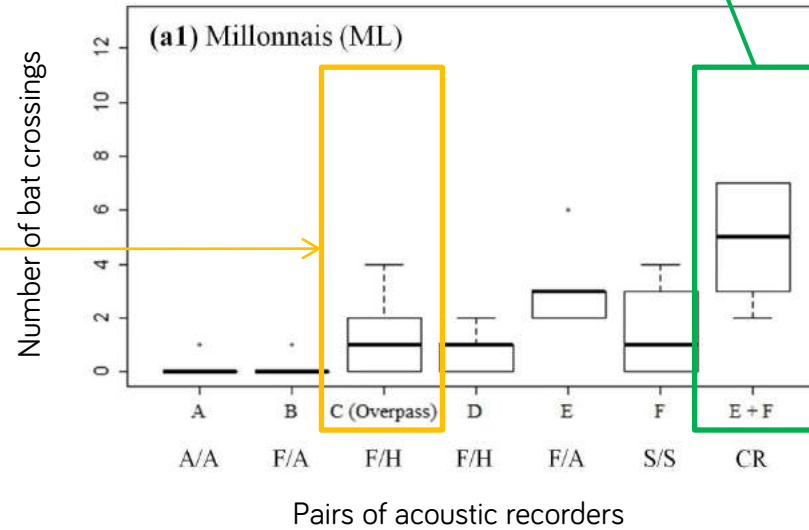
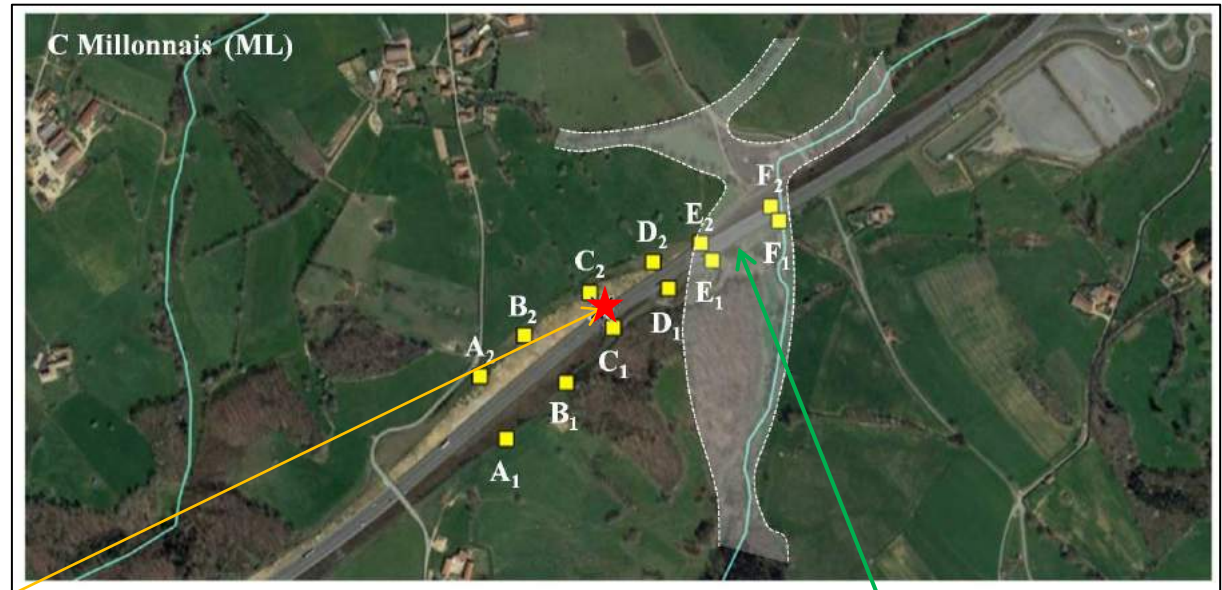
5 consecutive nights sampled for ML et MP and 4 for TR

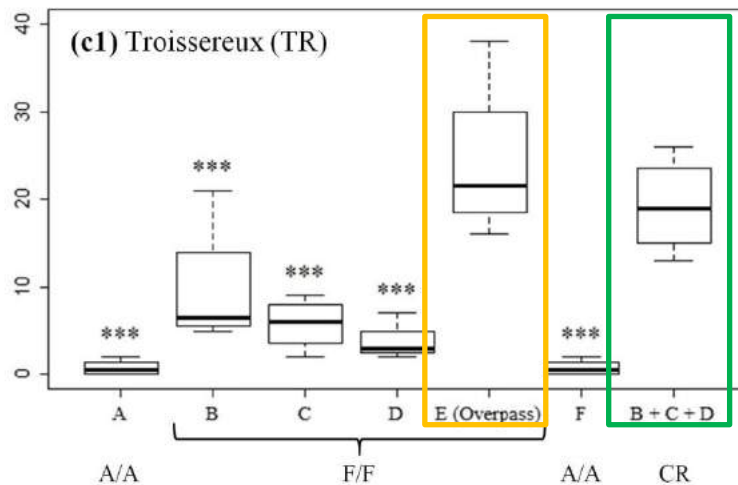
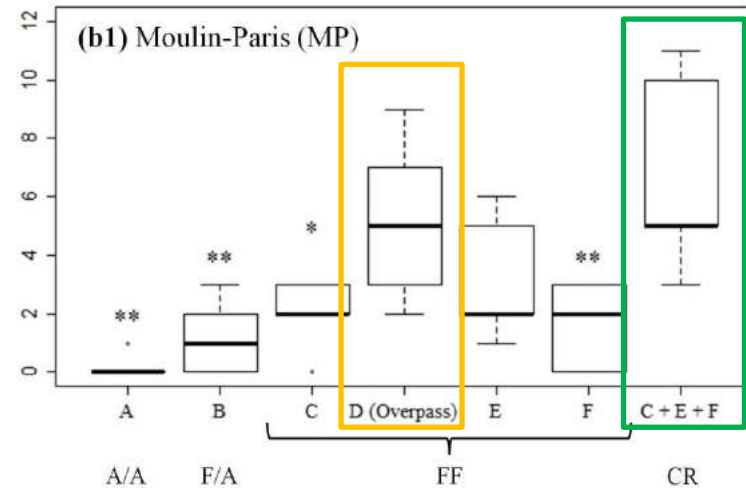
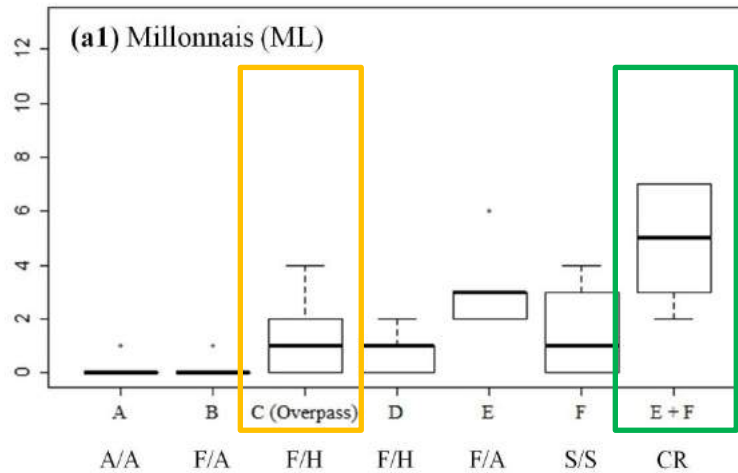
Summer 2016



EVALUATION OF MITIGATION MEASURES

Acoustic method – existing sites





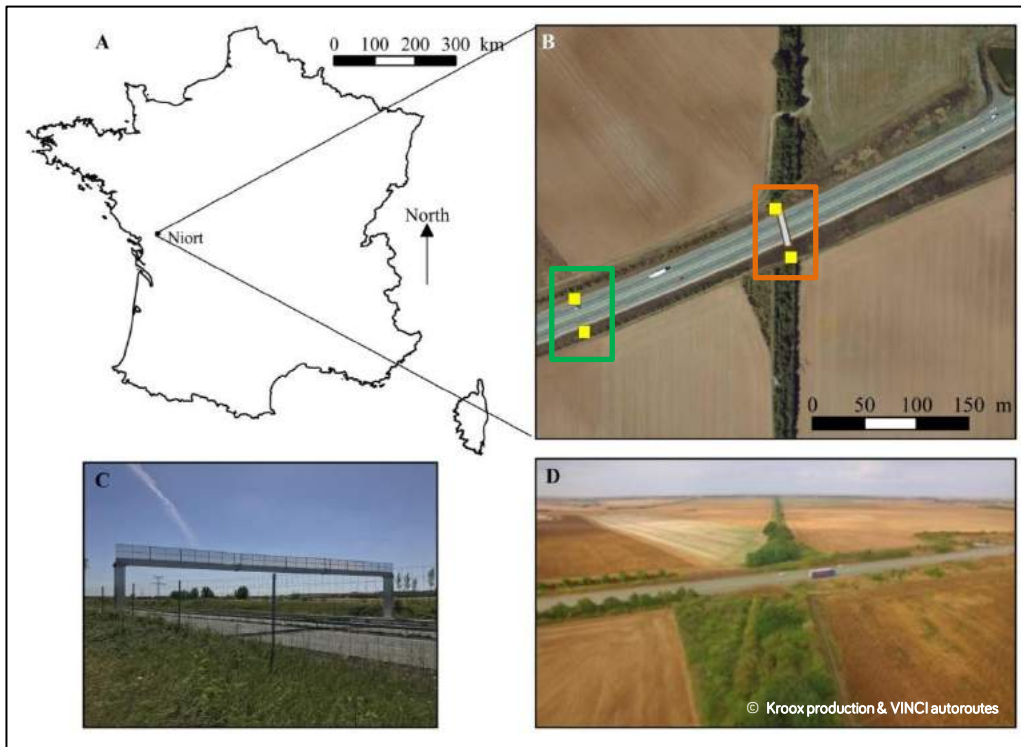
Pairs of acoustic recorders

- bats mostly cross the road where there are bat overpasses
- only if they are correctly placed in a bat commuting route
- a low attractiveness of bat overpasses in comparison of the number of bat crossings in the rest of the commuting route used by bats
⇒ an insufficient measure
- it is necessary to compare bat crossings before and after the installation of bat overpasses in order to know if bat overpasses increase bat crossings [before-after / control-impact (BACI) study]



EVALUATION OF MITIGATION MEASURES

Acoustic method – experimental site with a gantry



1 site in France near Niort on A83 highway

2 pairs of acoustic recorders:

- control
- treatment

Surveys:

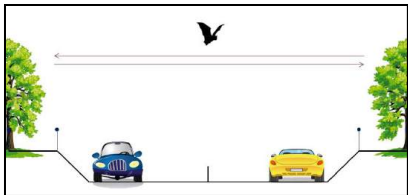
- 25 nights before
- 25 nights after

Sampling from April 2016 to May 2018

⇒ **Before-After-Control-Impact (BACI)**

Model used (GLMM):

Number of bat crossings



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Pairs



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Period



:

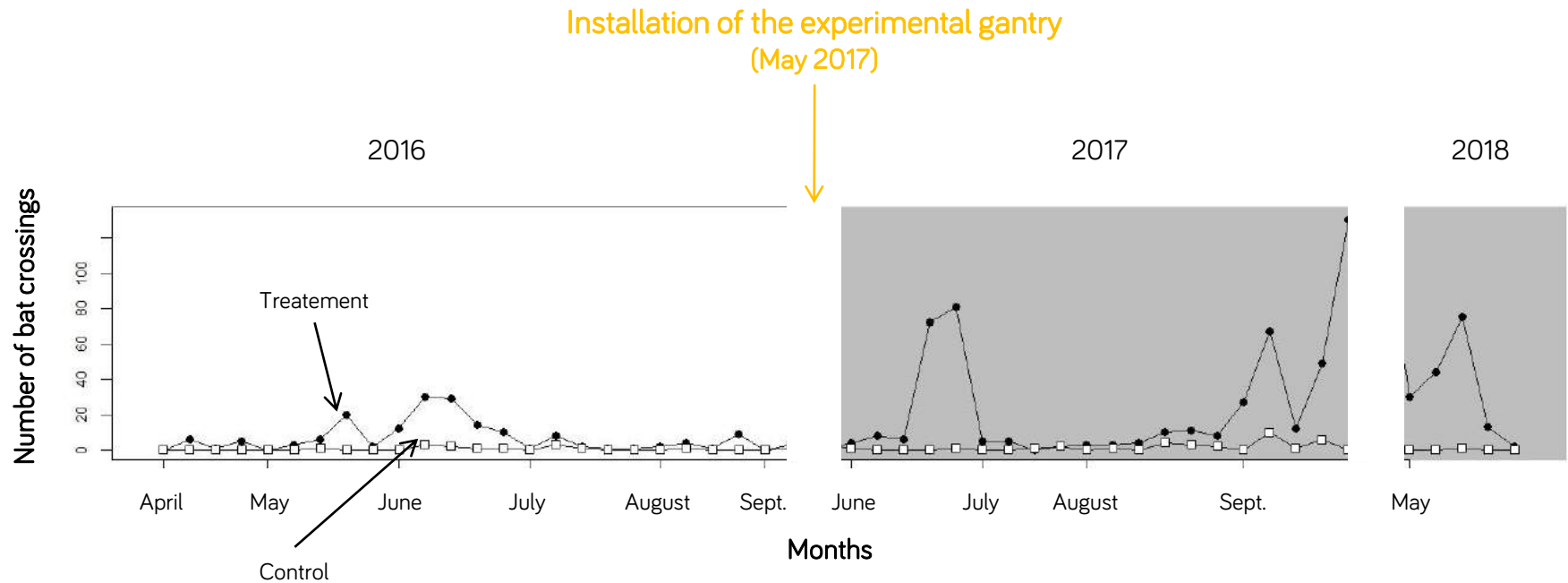
Pairs



+

(1|Date)





- bats mostly cross the road at the treatment than the control
- no change at the control but a **significantly increase of bat crossing at the treatment** before and after the installation of the gantry



Bats can cross the road at bat overpasses
 ⇒ if correctly placed on a commuting route

Bat overpasses offer mixed results: they seem to have a good function if they are placed on a narrow commuting route
 ⇒ without presume of a total reestablishment of habitat connectivity

Other studies needed in woodland in order to have a no net loss

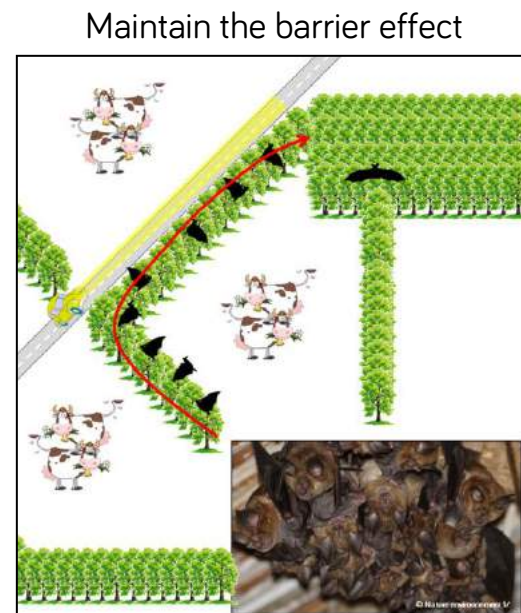
Stay prudent on the deployment of gantries: need to have more information about flight behaviour

⇒ **What to do if these gantries do not raise the flight height of bats?**

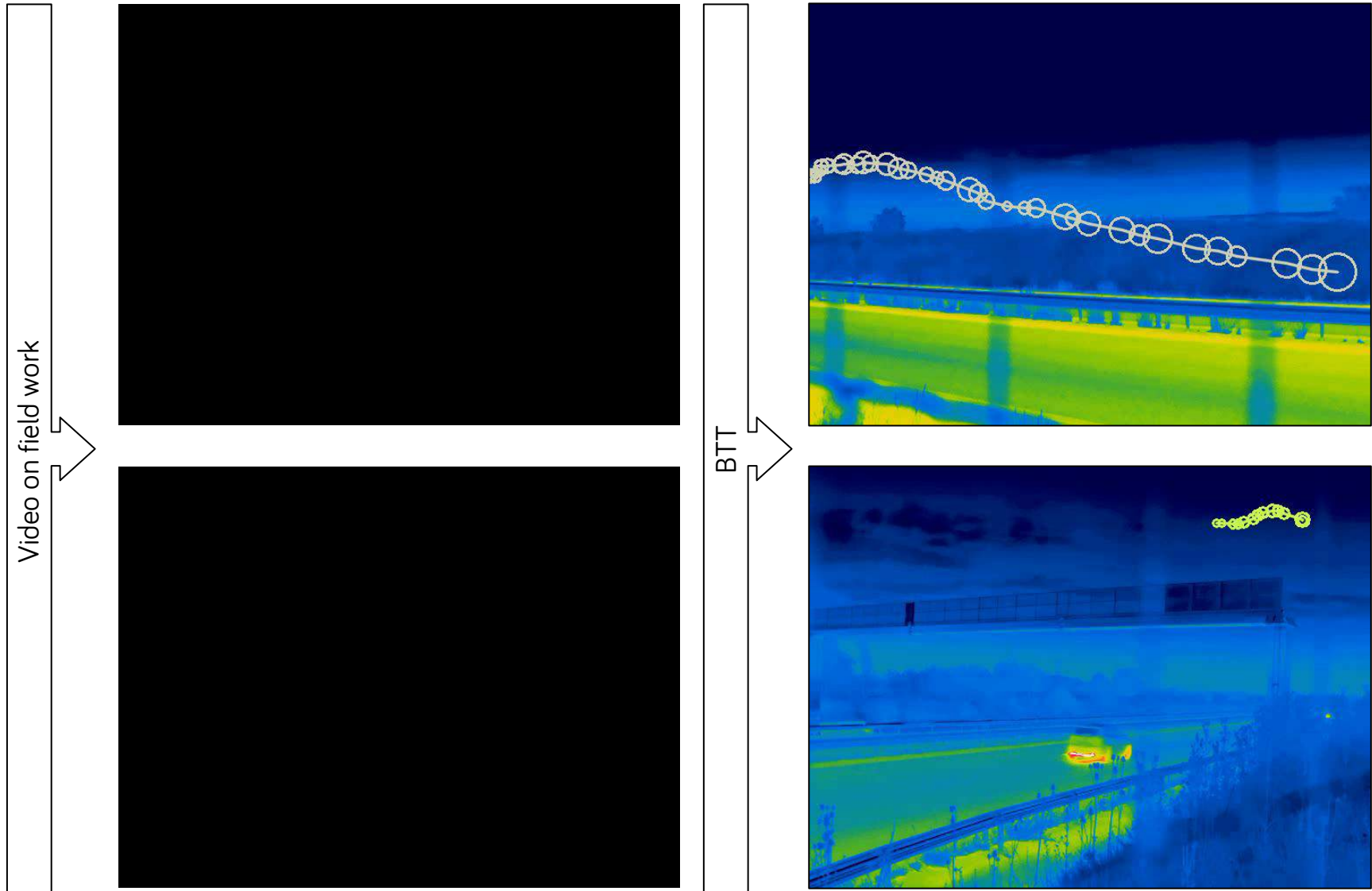
A better habitat connectivity with a great collision risk?



or



Development of the Bat Tracking Toolbox



Discussion / Conclusion

Impact on bat activity

Negative effects of major roads:

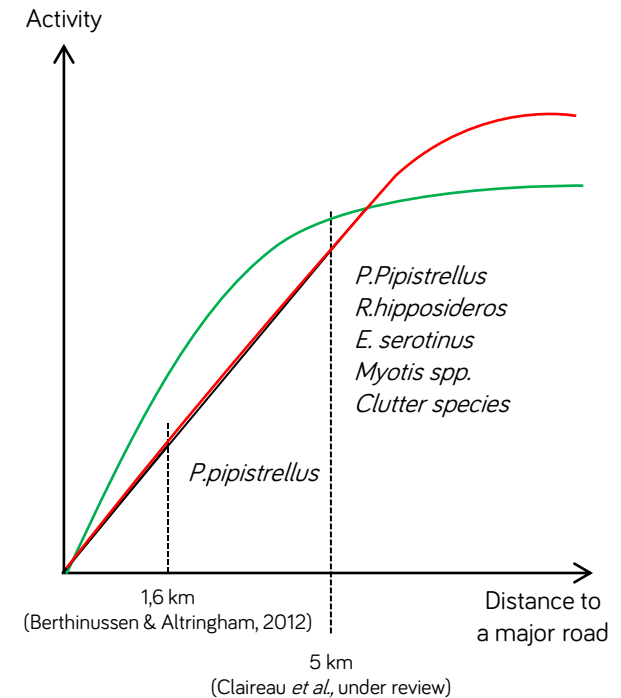
- confirmation of two studies
- generalisation at another species with conservation concern in Europe
- at greater distance, which reinforces conservation issue

Causes et perspectives :

- rupture of connectivity
- traffic et associate factors (collision risk, noise and light)
⇒ what are the mechanisms which can explain the negative effect
- refine the road effect zone: where is the end?

Applications :

- take into account these results in EIA studies
- how to do in our territory where the habitat loss was not (or very little) take into account in EIAs?



Impact on genetic structure

In one site:

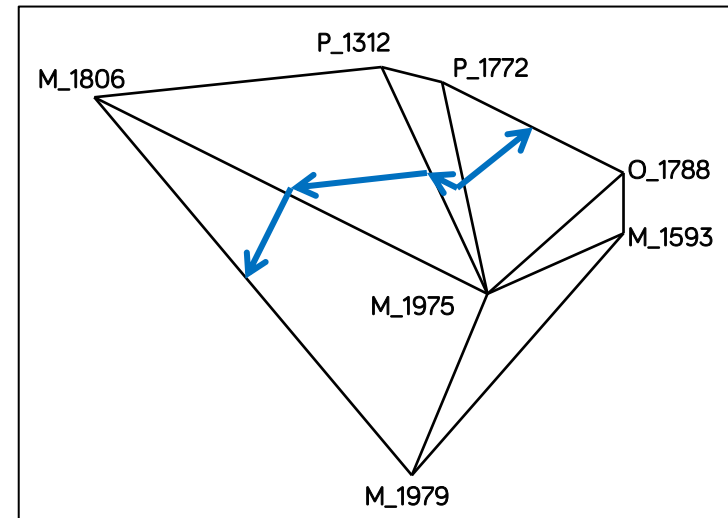
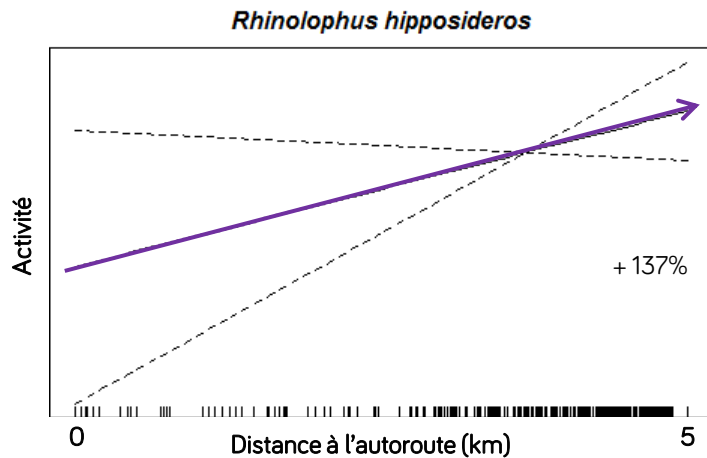
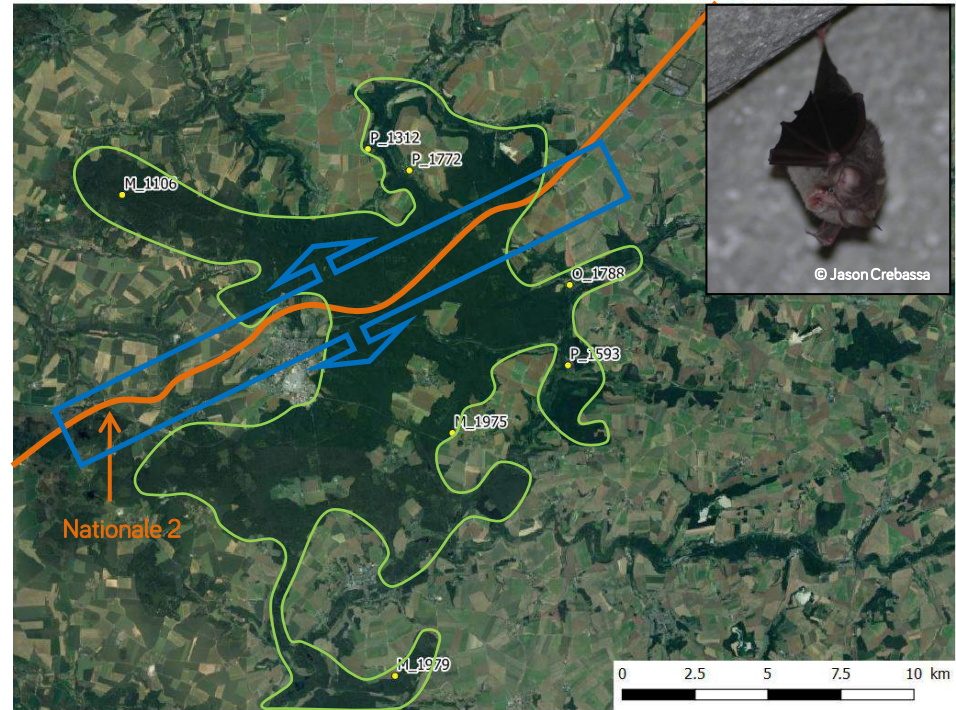
- genetic barrier detected
- despite roosts connected by the same forest

Causes et perspectives :

- probably the major road
- consequence of the negative effect detected on the Lesser horseshoe bat activity
- need to confirm with other sites (4 sites pending)

Applications :

- amelioration of the habitat connectivity



GENERAL DISCUSSION - SUMMARY

Bat overpasses as mitigation measure

Bats can use bat overpasses

If correctly placed in commuting route

Bat overpasses are an insufficient solution if they are placed in a large commuting route

⇒ another studies needed

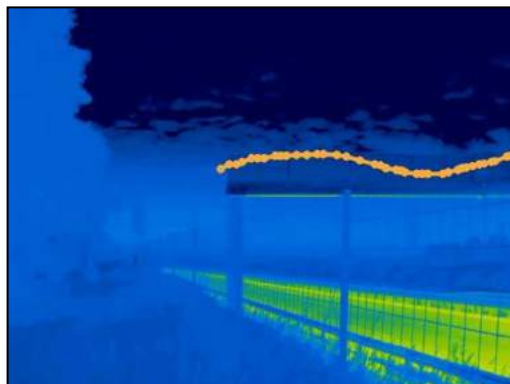
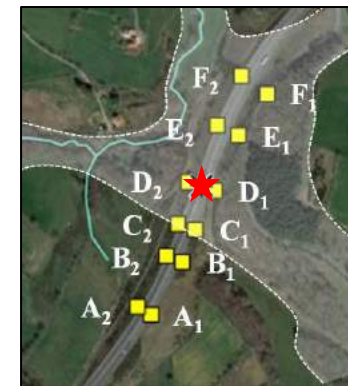
Bat overpasses seems to be more functional in a narrow commuting route

⇒ without presume of a total reestablishment (absence of an initial state before road construction)

⇒ confirmation of results needed with other sites

Need to evaluate if these structures can raise the flight height of bats

BACI is the best method to evaluate mitigation measures



MERCI !



Christian Kerbiriou



Sébastien J. Puechmaille



Nathalie Machon



Benjamin Allegrini



Yves Bas

