

# Bioacoustics for the study of bat communities

Possible applications for the study of interactions with their prey

Charlotte Roemer

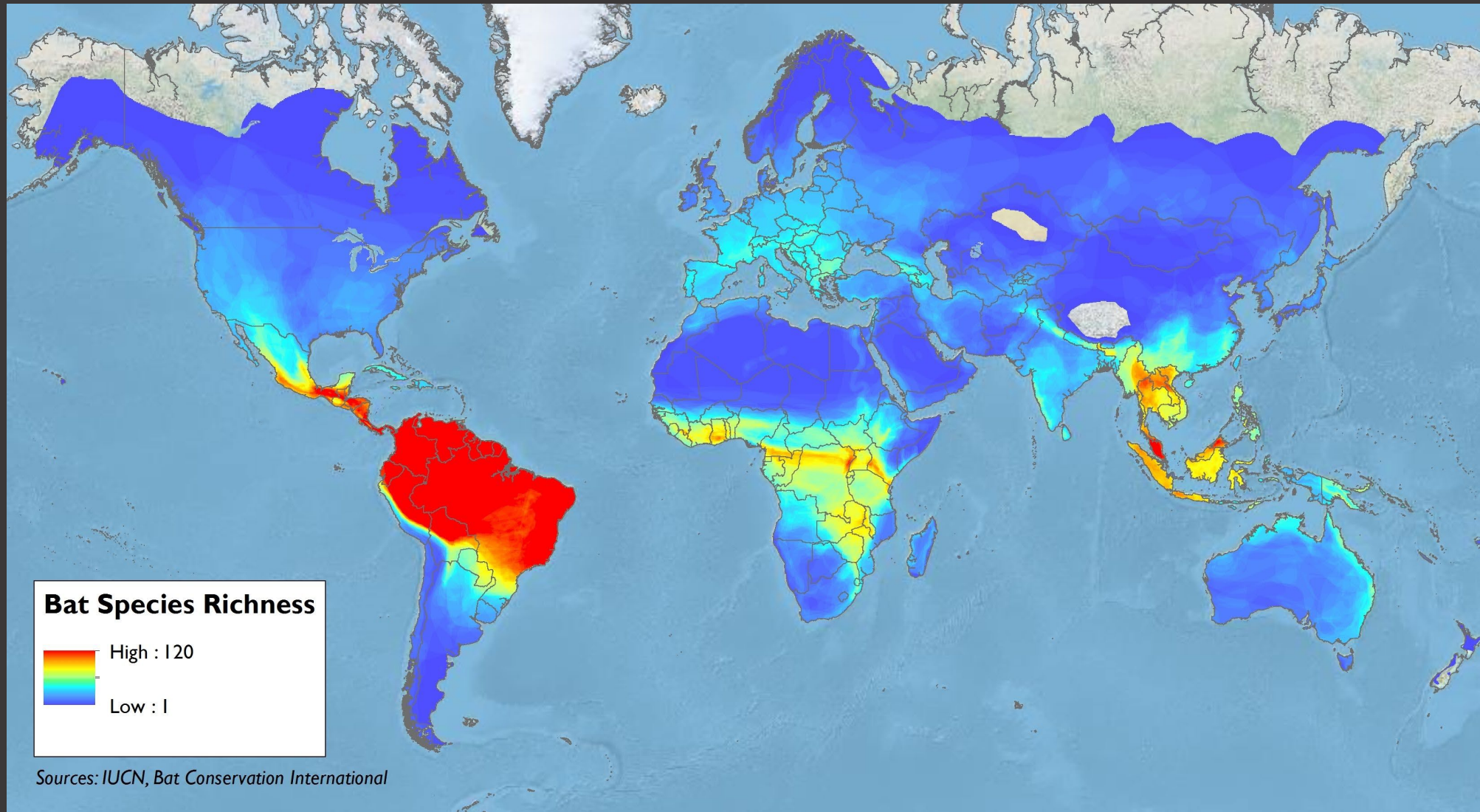


# Career



- R&D Bat expertise – Environmental impact assessment studies
- PhD thesis: Ecologie du déplacement et risques anthropiques de collision
- Post-doctoral researcher: artificial intelligence in bioacoustics
- Post-doctoral researcher: Bat migration routes in Europe

# Bat species richness



# Bat species richness

- > 1400 species worldwide
- 55 species in the Western palearctic
- France:
  - 4 families
  - 36 species





Charlotte Roemer

# Ecological niches

- Vertical distribution
- Adaptations
  - To clutter
  - To prey types
- Generalists and specialists



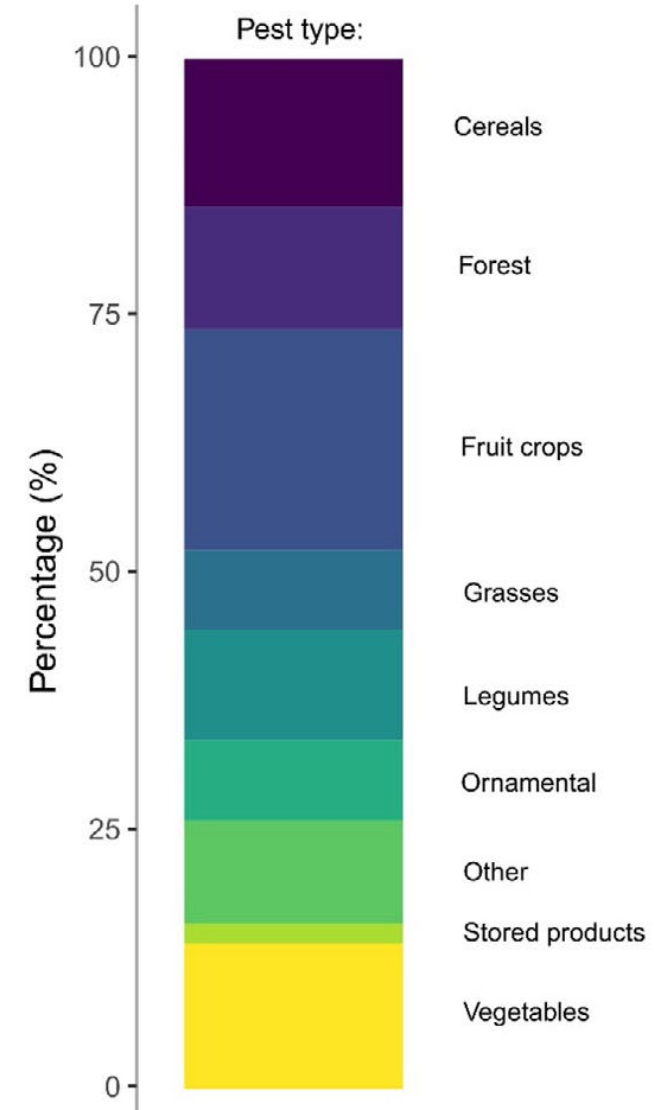
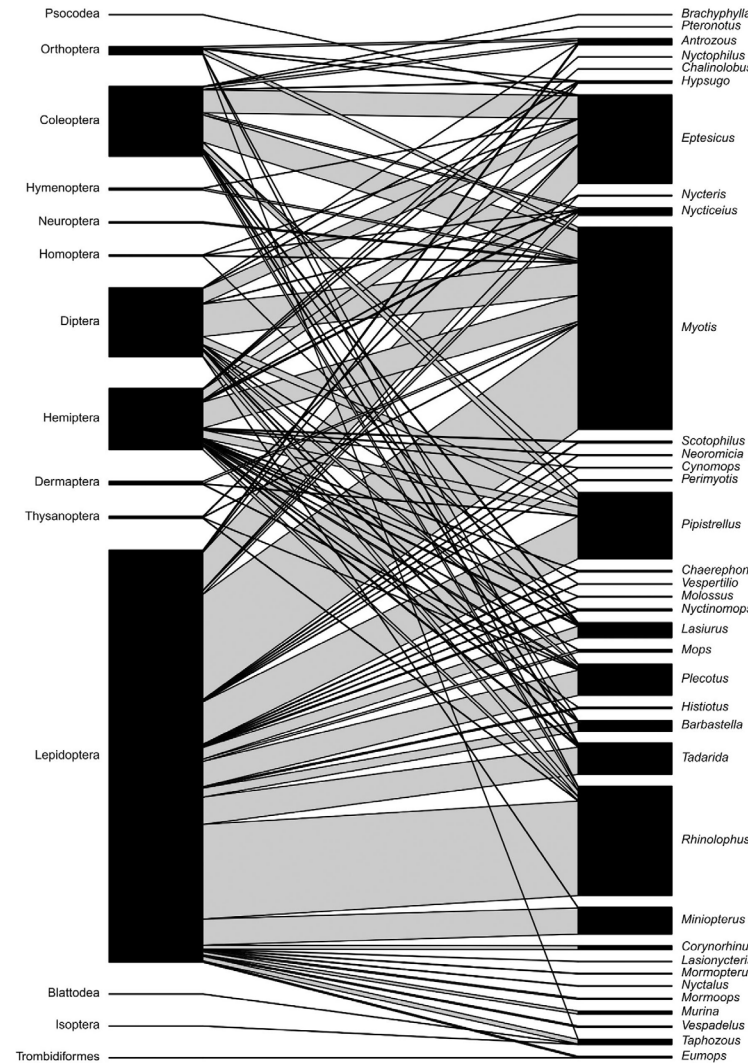


Matthieu Vaslin

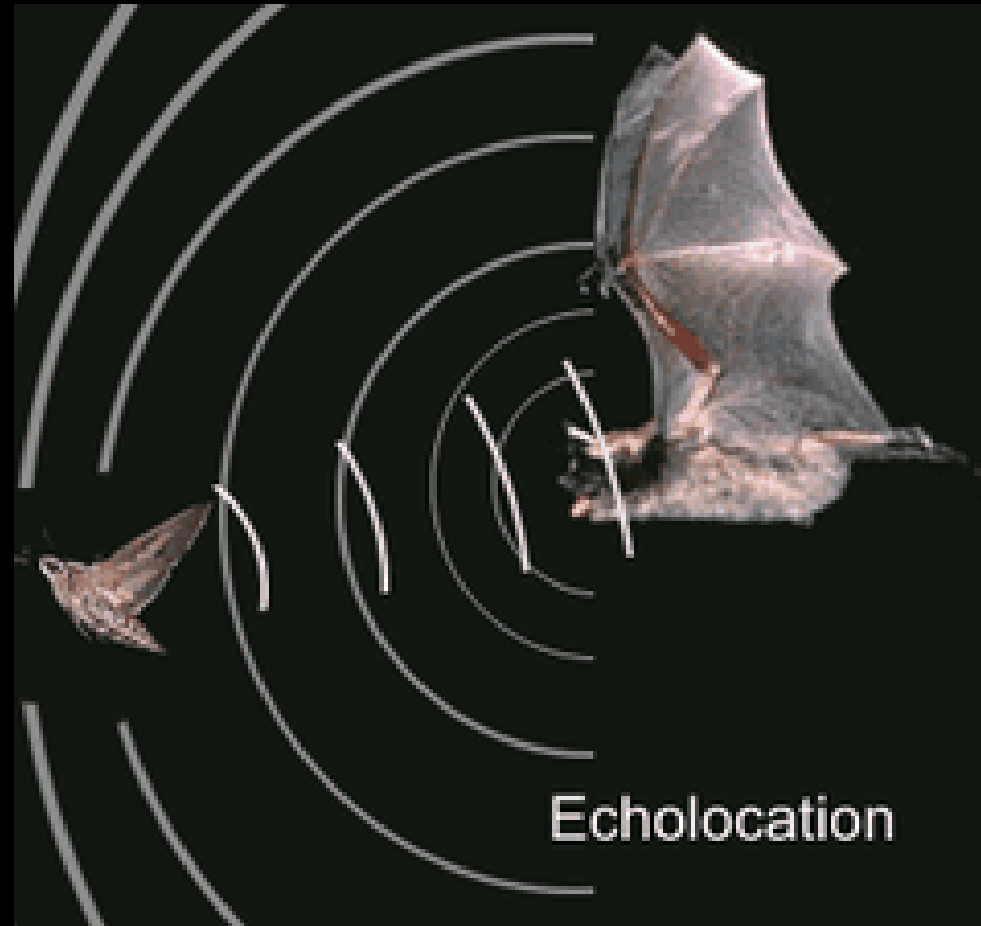
# Role as pest suppressors

## Worldwide:

- 81 bat species feed on 760 pest species of 14 different orders
- Essential for all types of crops







Echolocation

# Bioacoustics for the study of bats

- 1 call every 1-3 wingbeats (Holderied and von Helversen, 2003)

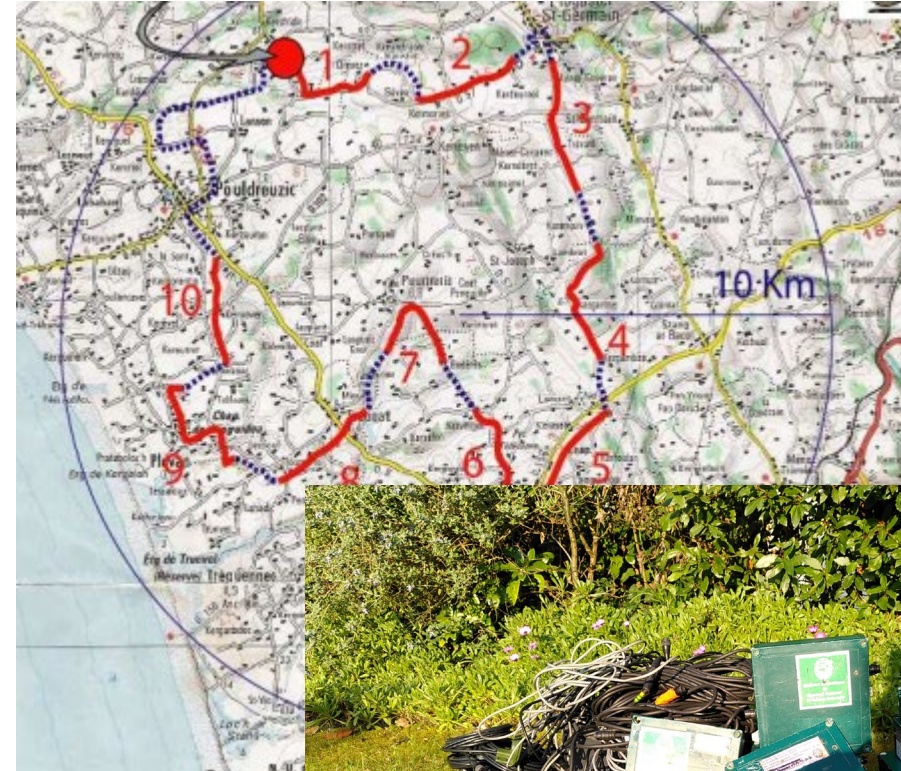
→ Very good detectability

- No individual monitoring
- “Activity“ or acoustic “Density“



# Bioacoustics for the study of bats

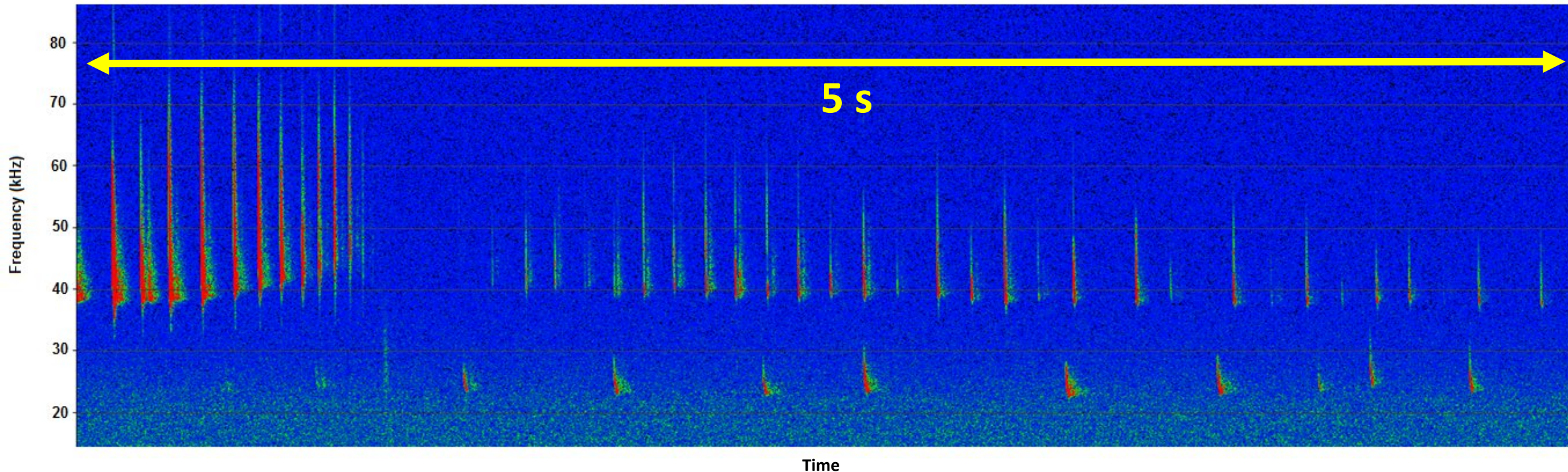
- **Transects**
  - Extends the spatial cover
  - Difficult inter-seasonal comparisons (varying night lengths)
- **Stationary recordings**
  - Spatio-temporal comparisons
  - Simultaneous recordings possible



# Metrics in bat bioacoustics

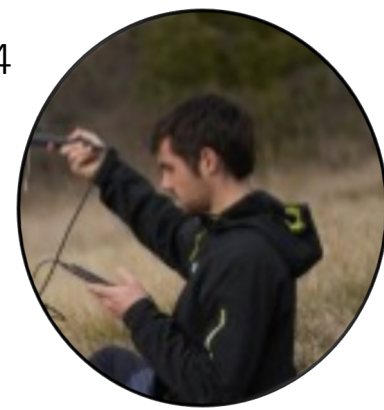
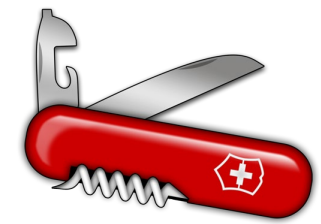


- Acoustic activity is a proxy of the density of individuals in the detection volume of the microphone
- How to count?
  - Bat pass =  $\geq 1$  call in a sequence of several seconds or minutes



# Metrics in bat bioacoustics

Robert 2024

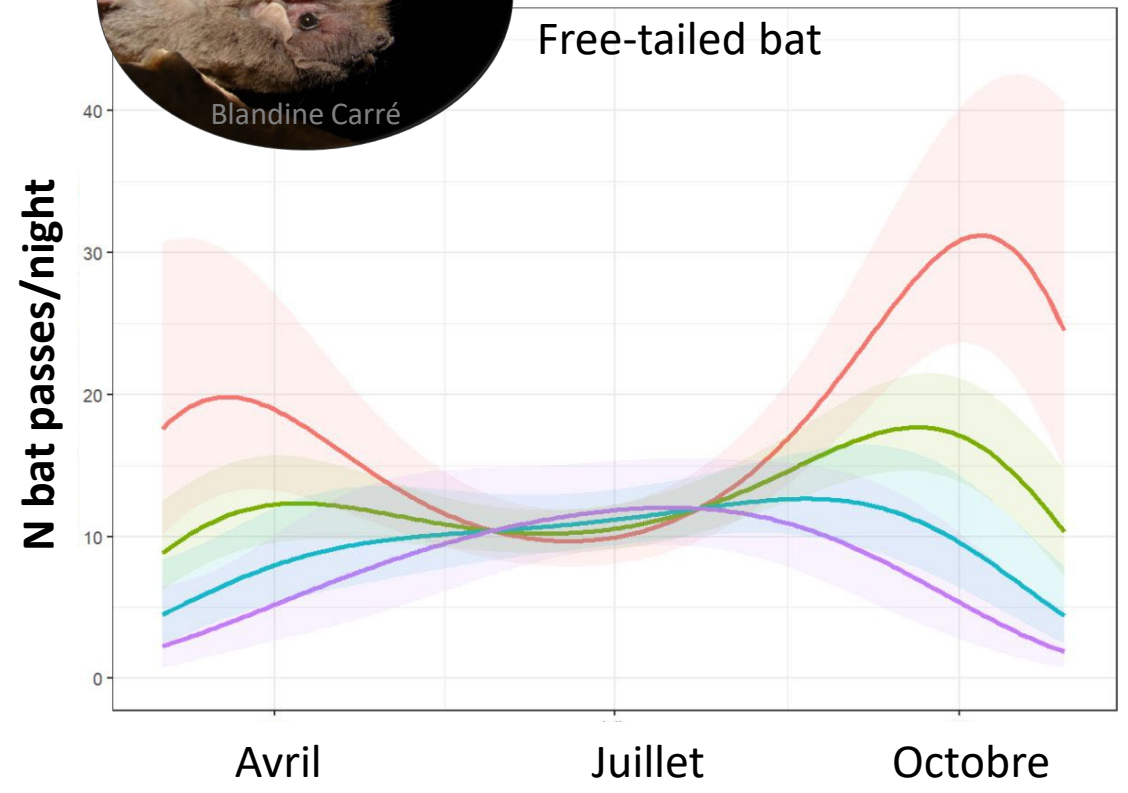


- From the species to the community

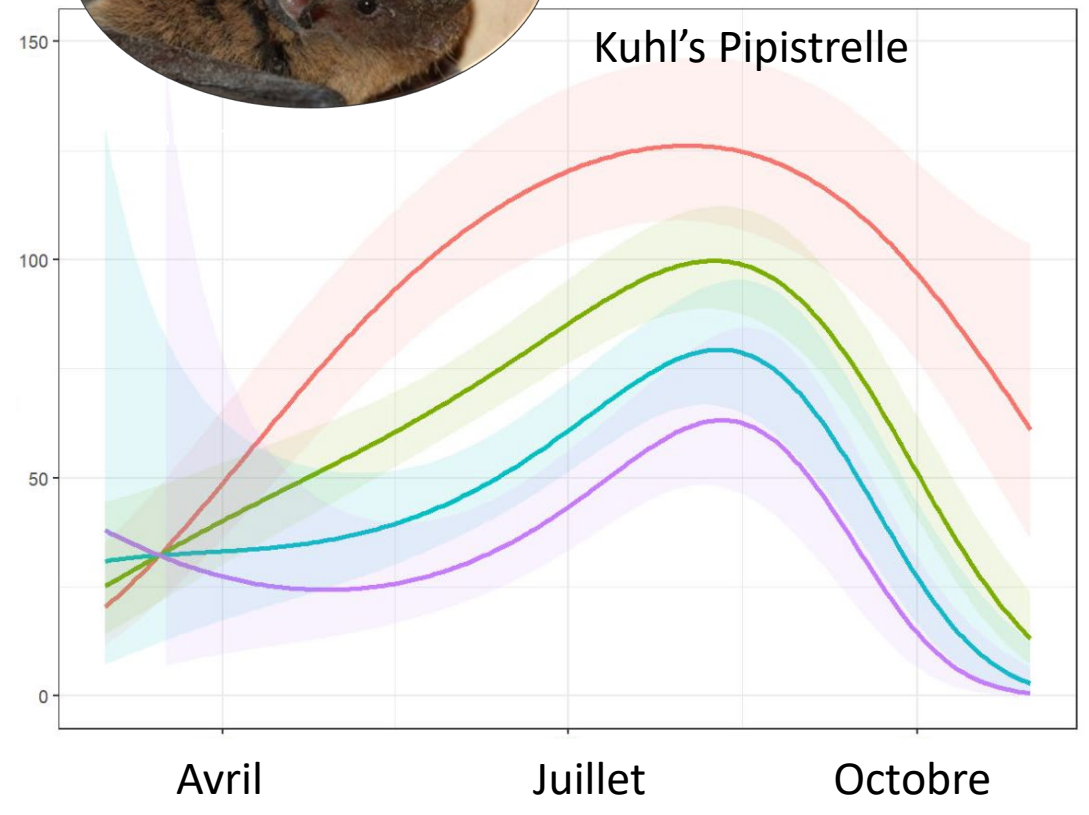


Free-tailed bat

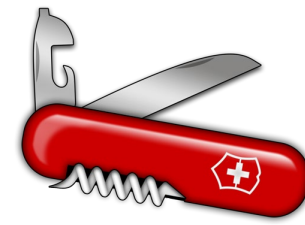
Blandine Carré



Kuhl's Pipistrelle



# Metrics in bat bioacoustics



- Quantification of the number of prey capture attempts...



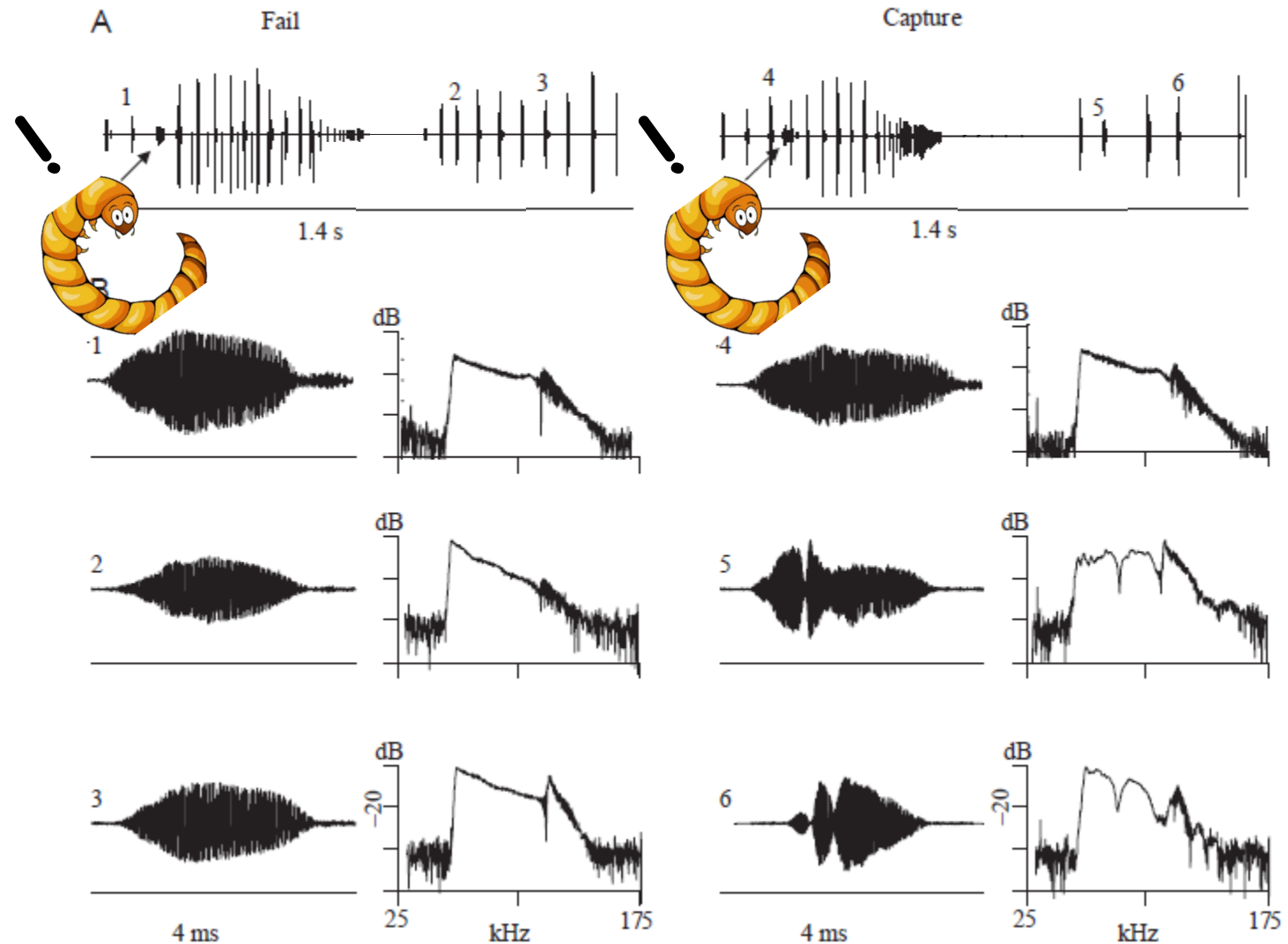
# Metrics in bat bioacoustics



Surlykke et al., 2003

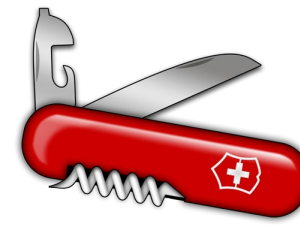
- Quantification of the number of prey capture attempts...
- ...and capture successes!

→ 75 % success rate in the prediction of the outcome of a capture attempt thanks to the notch criterion



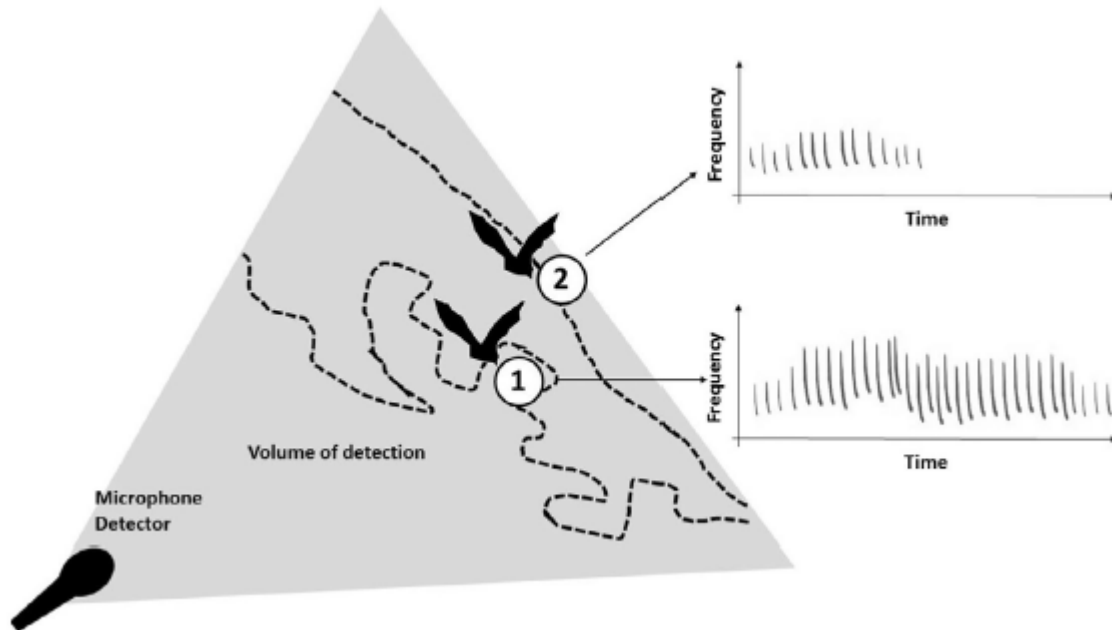


# Metrics in bat bioacoustics

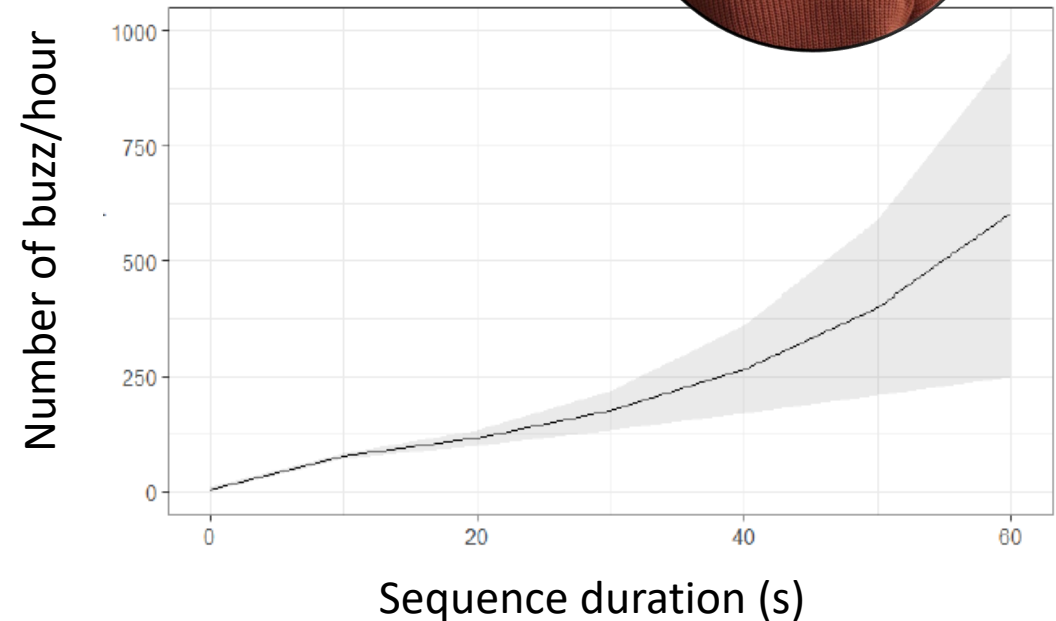


Chayrigues 2021

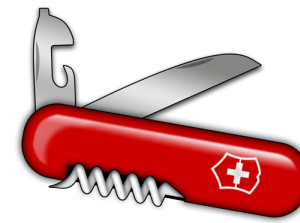
- Sequence duration:  
To classify foraging vs. commuting



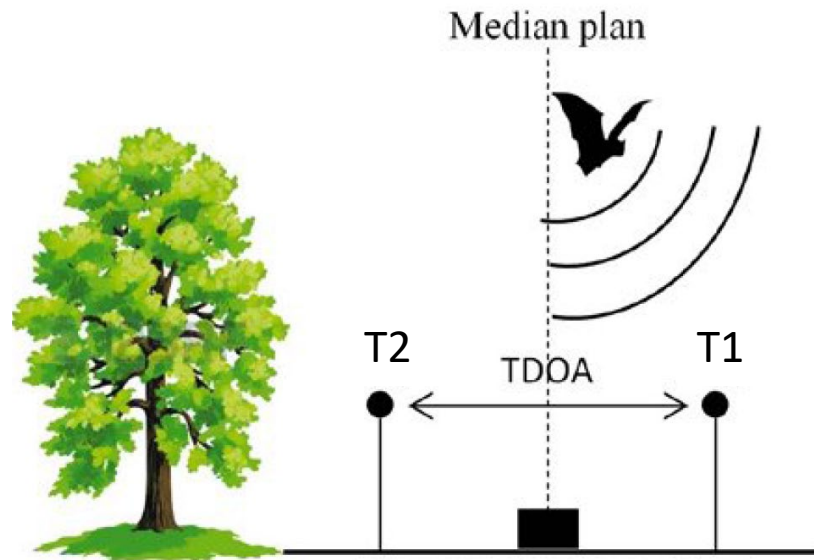
Kerbiriou et al., 2018



# Metrics in bat bioacoustics



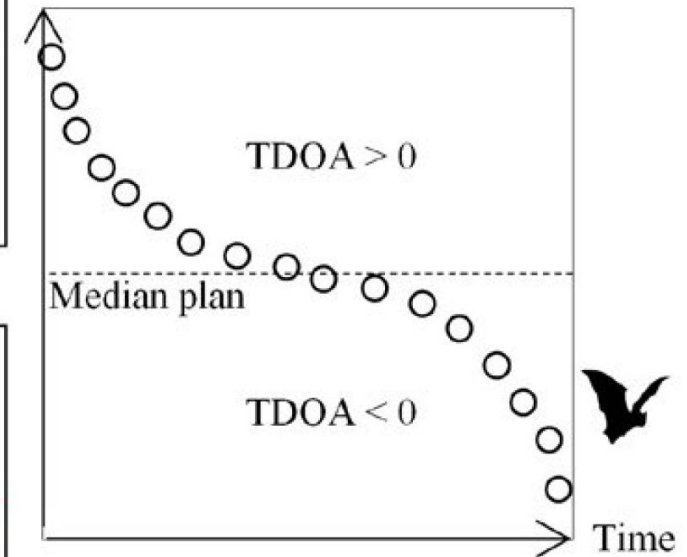
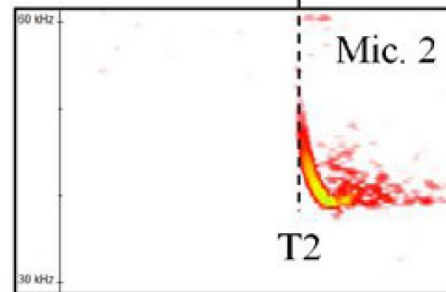
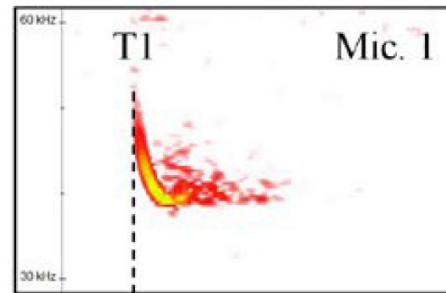
- Acoustic location



T1 = arrival time of the call on mic. 1

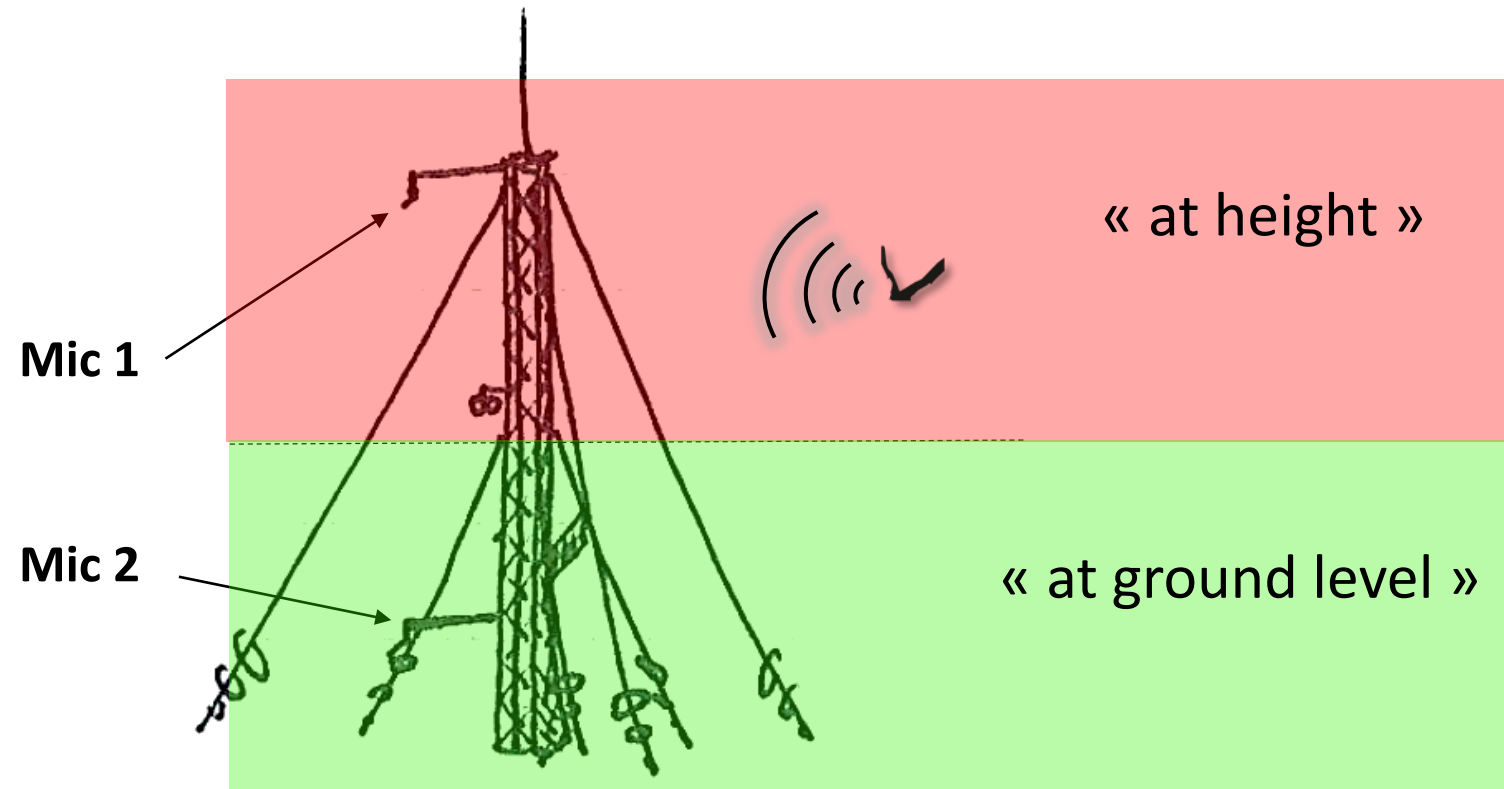
T2 = arrival time of the call on mic. 2

Time difference of arrival (TDOA) = T2-T1

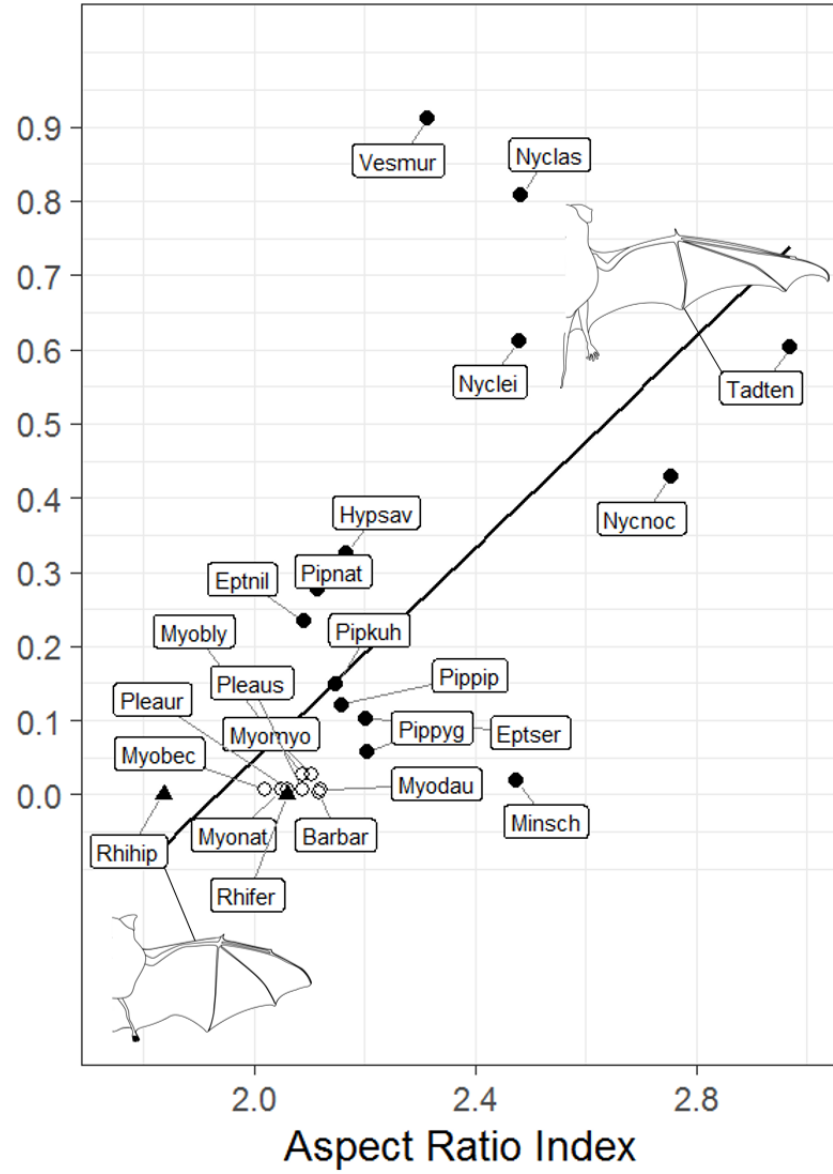
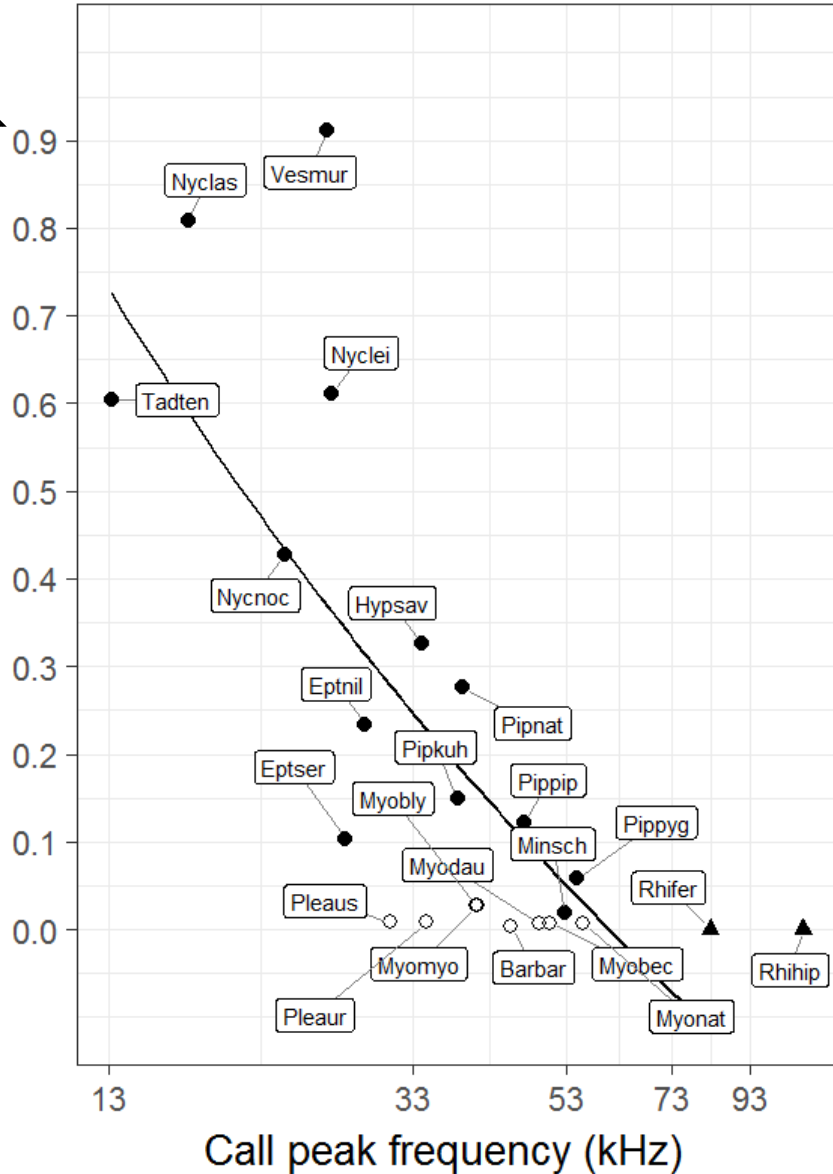
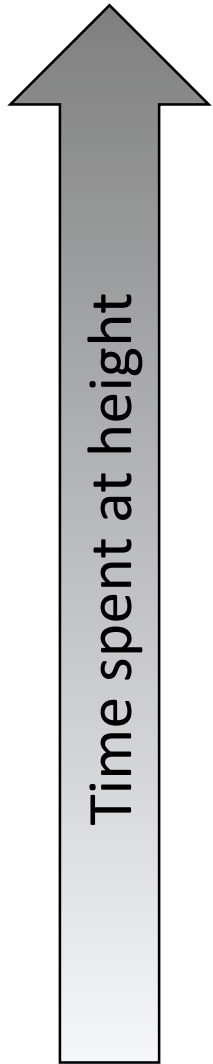


# Vertical ecological niches

- 1D positions
- 48 study sites (France and Belgium)
- 8435 nights

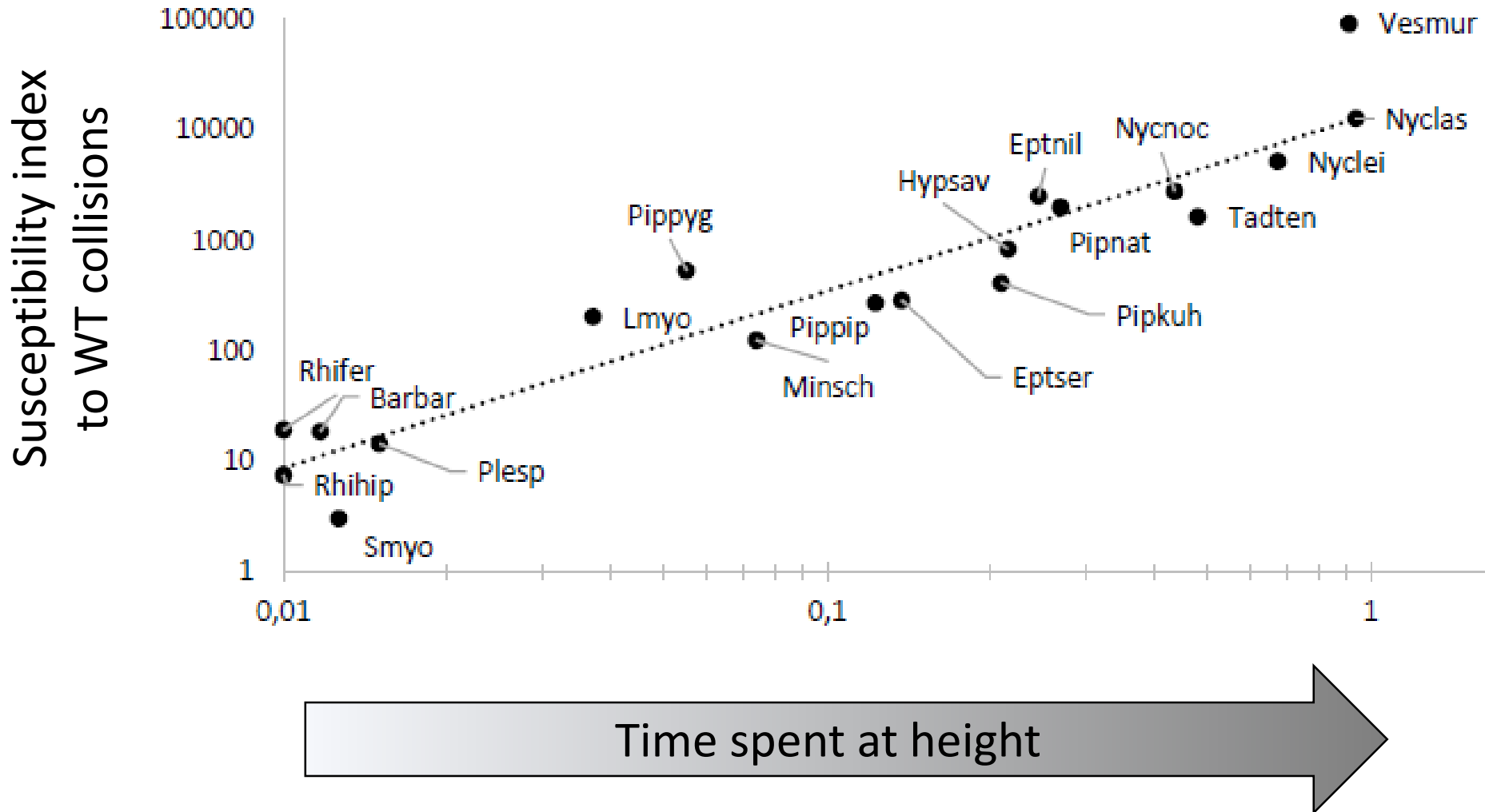


# Vertical ecological niches



Roemer et al. 2019,  
*The Journal of the Acoustical  
 Society of America*

# Vertical ecological niches

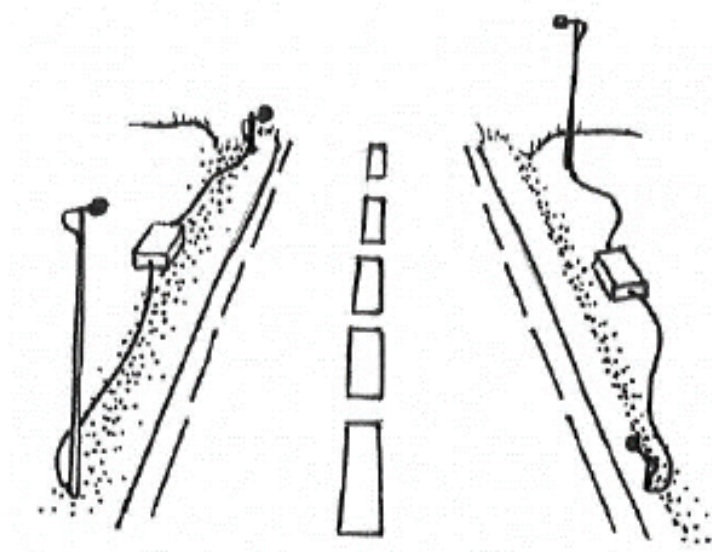


Roemer et al. 2017,  
*Biological Conservation*

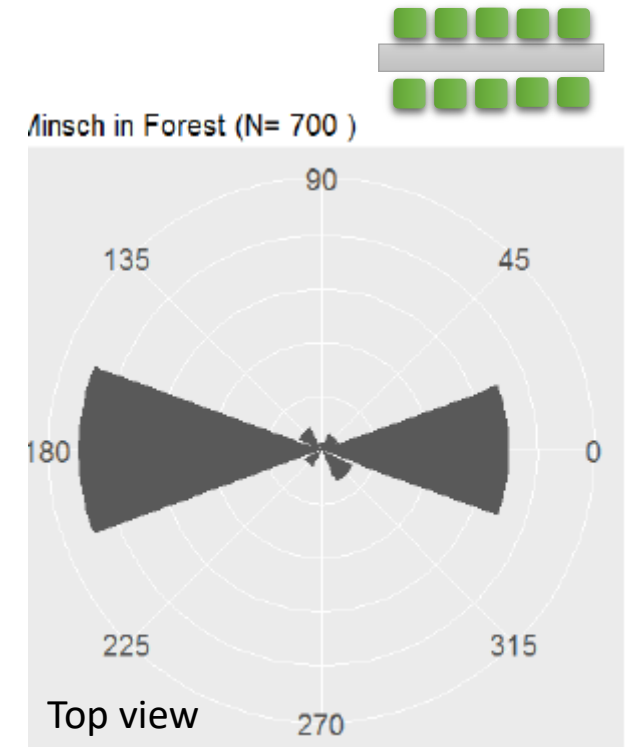
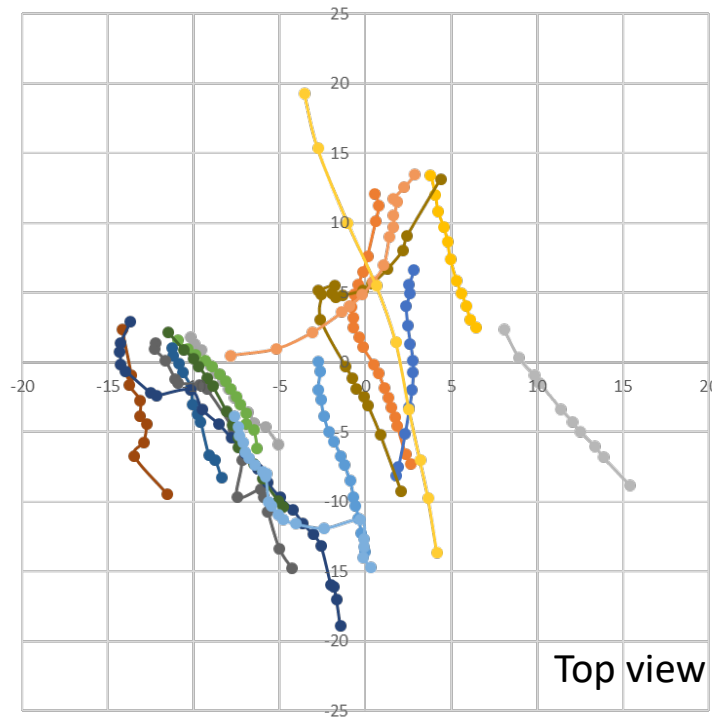
# Metrics in bat bioacoustics



- 3D flight path tracking

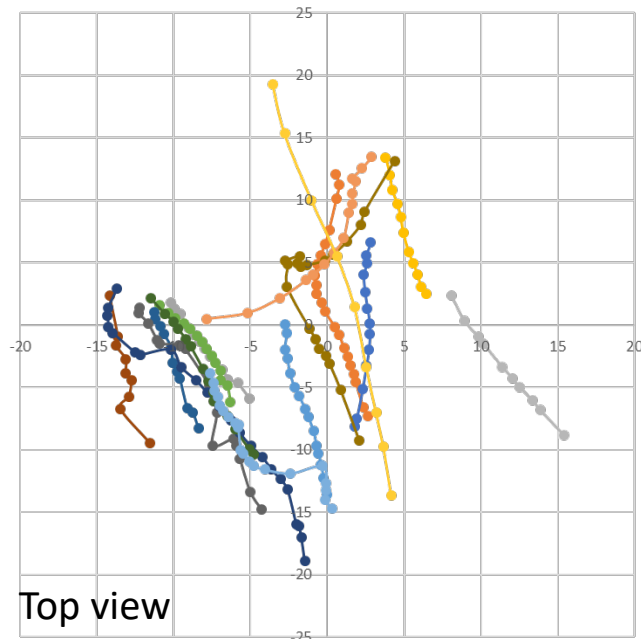


Roemer et al. 2020,  
*Peer Community in Ecology*



# Road ecology

- Road collision risks studied with 4 microphones
- 3D positions
- 66 secondary road locations (southern France)
- >120k bat passes and >30k trajectories



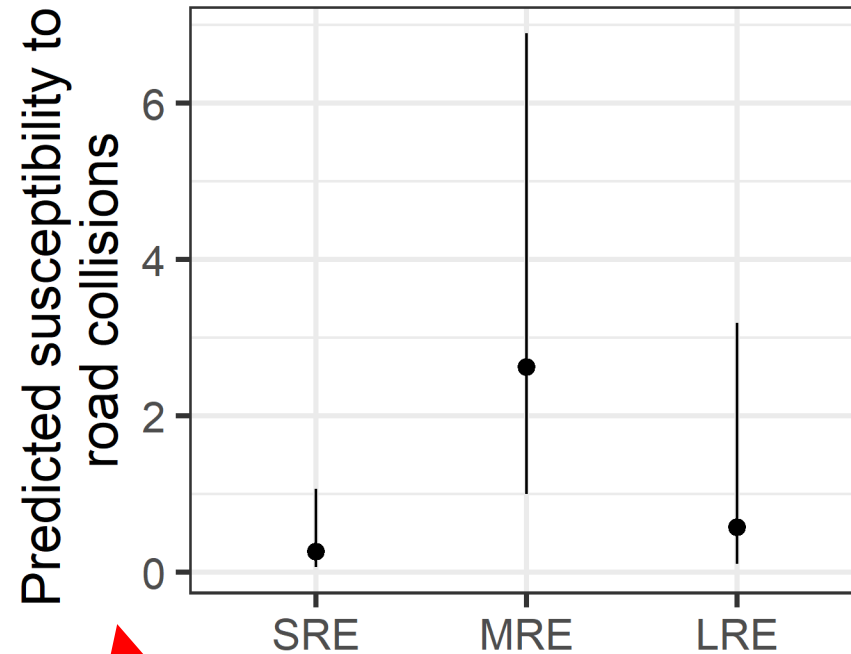
Collision risk



Safe



# Road ecology



SRE: Short-range echolocators  
MRE: Mid-range echolocators  
LRE: Long-range echolocators



To compare  
species susceptibility



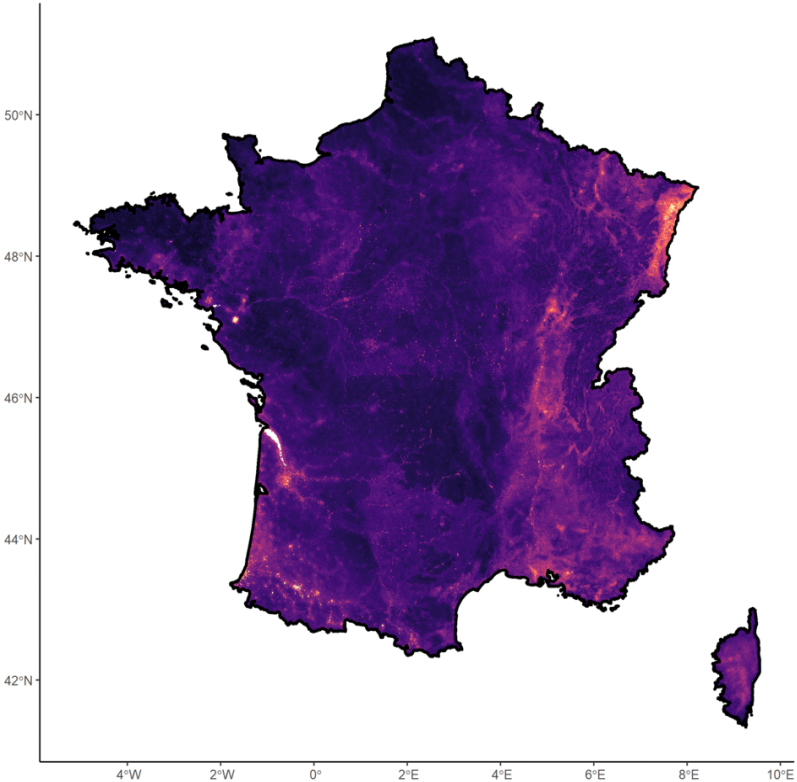
# At larger scales...

- Citizen sciences



Roemer et al. (in prep)

Nyctalus leisleri  
January  
Number of bat passes per night : Mean = 5.1, Max = 132.7

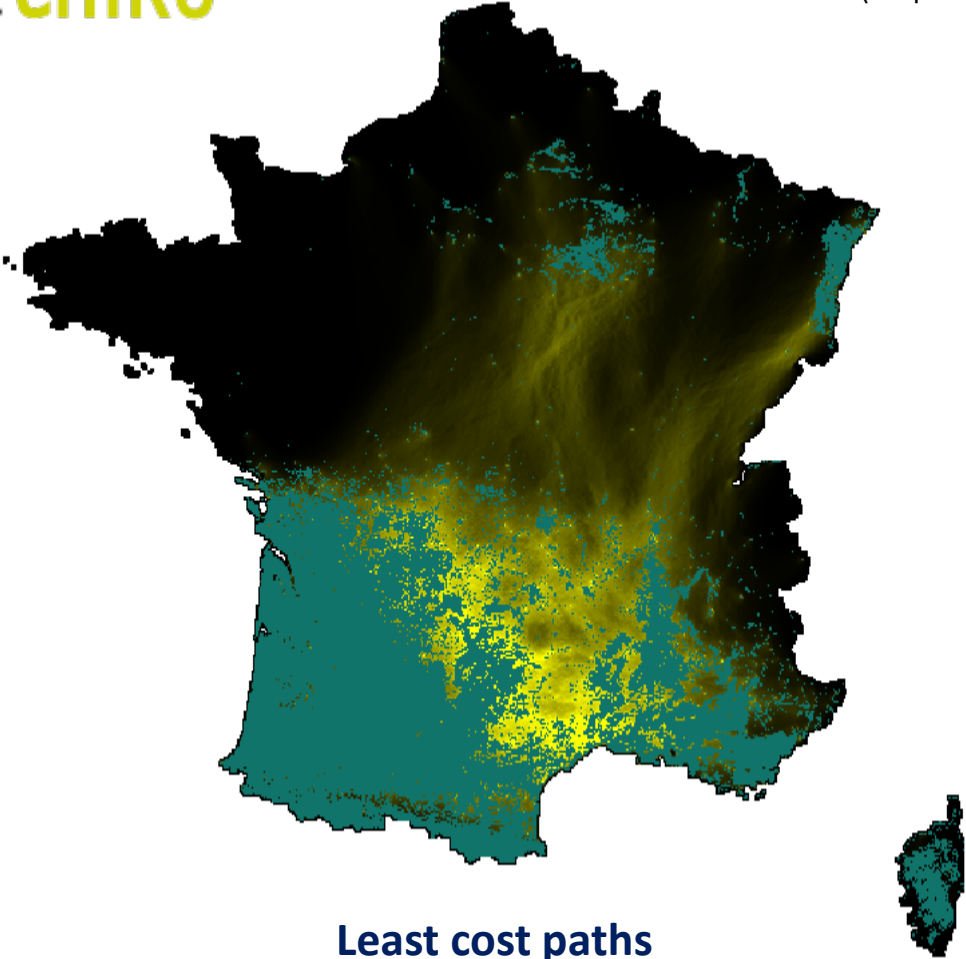


**N bat passes/night**



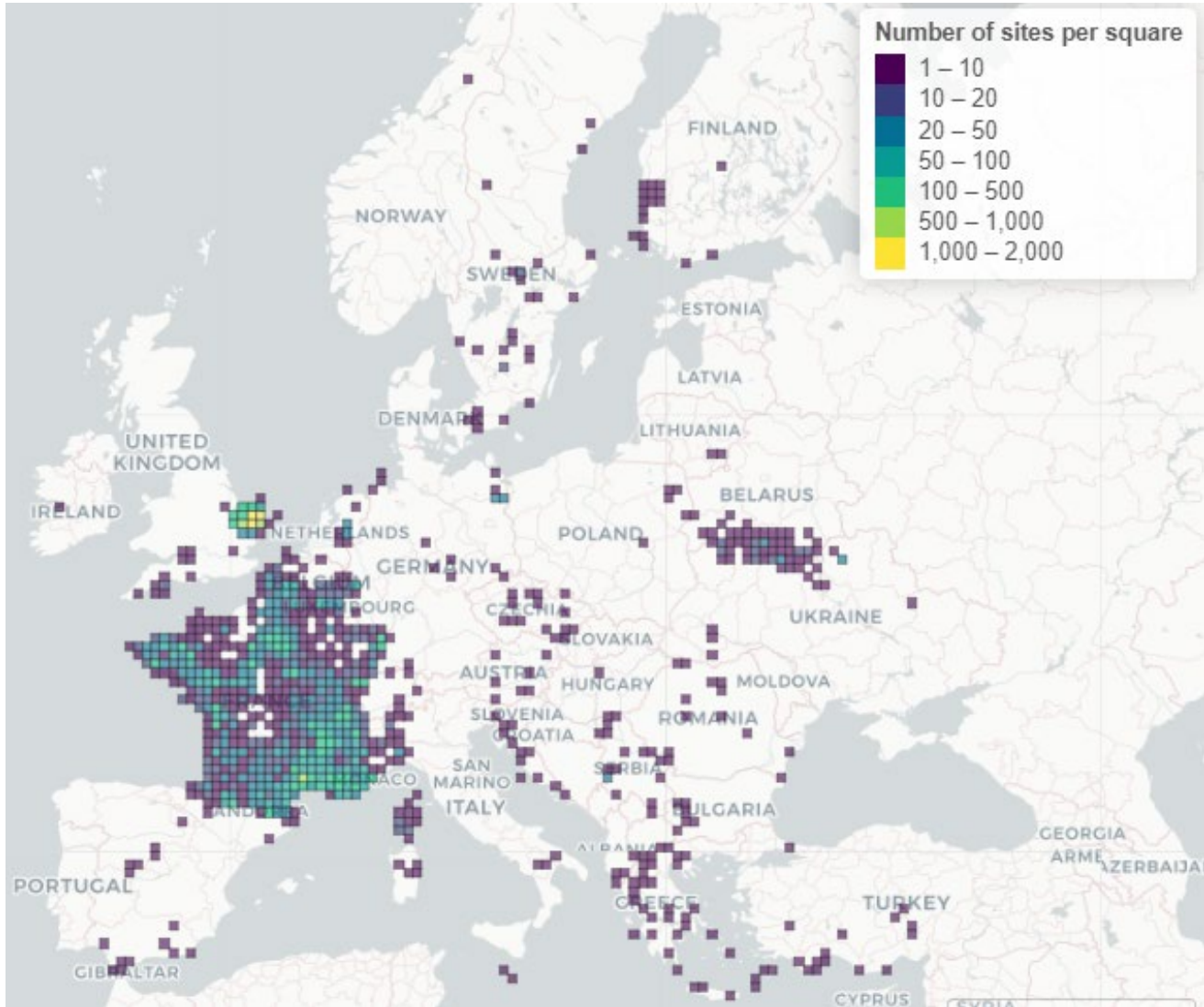
© Valéry Uldry

Leisler's bat



**Least cost paths  
between summer and winter**

# At larger scales...



- Bat migration routes in Europe

<https://bat-migration-europe.netlify.app/>

# At larger scales...

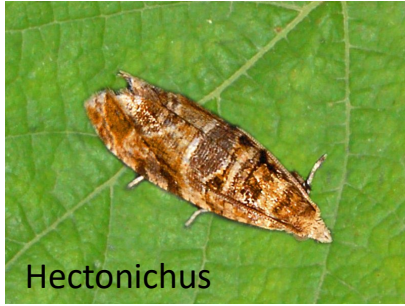
- Distribution and connectivity maps:
  - Sensitivity maps → spatial planning (wind and solar energy, roads, forestry, agriculture, urbanisation, ALAN...)
  - Priority areas for bat conservation → designation of N2000 areas
  - Research studies in ecology and evolution



# Applications for the study of bat $\leftrightarrow$ insects interactions



Ilia Ustyantsev



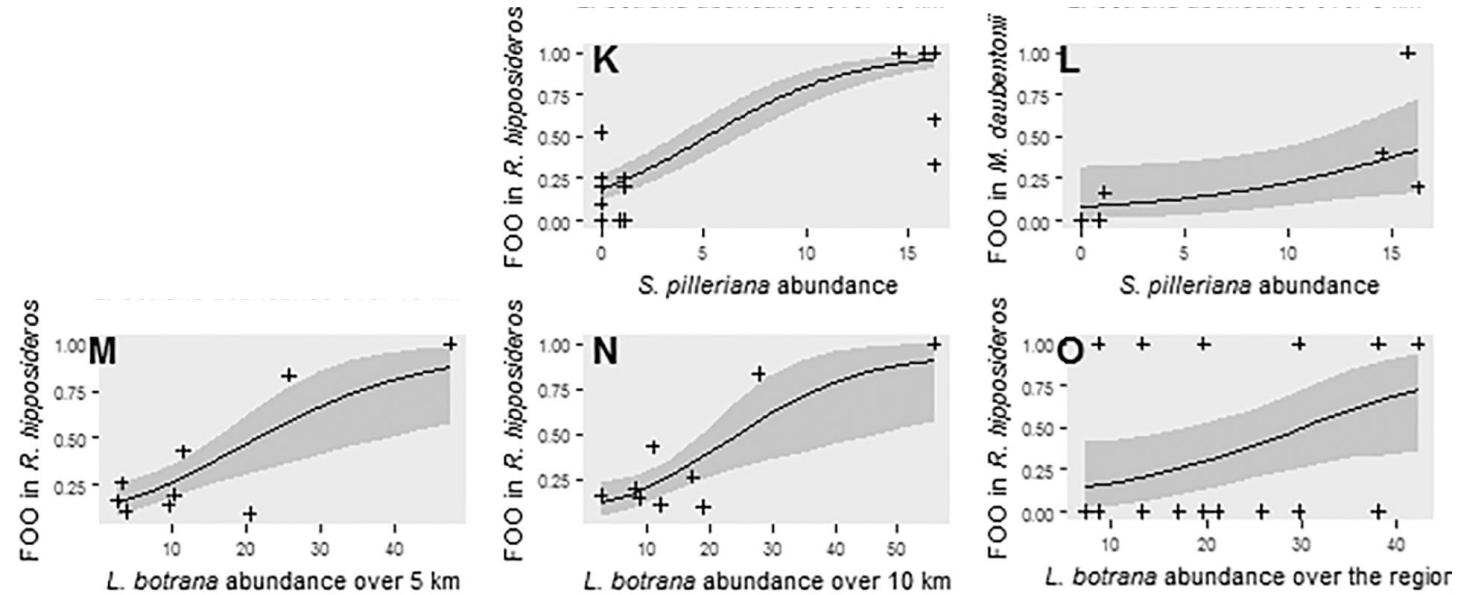
Hectonichus

*Sparganothis pilleriana*

*Lobesia botrana*

- Pest consumption can be demonstrated only qualitatively and in a few species (need to access the guano)

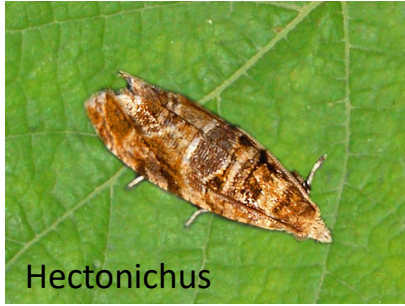
(all responses are significant)



# Applications for the study of bat $\leftrightarrow$ insects interactions



Ilia Ustyantsev

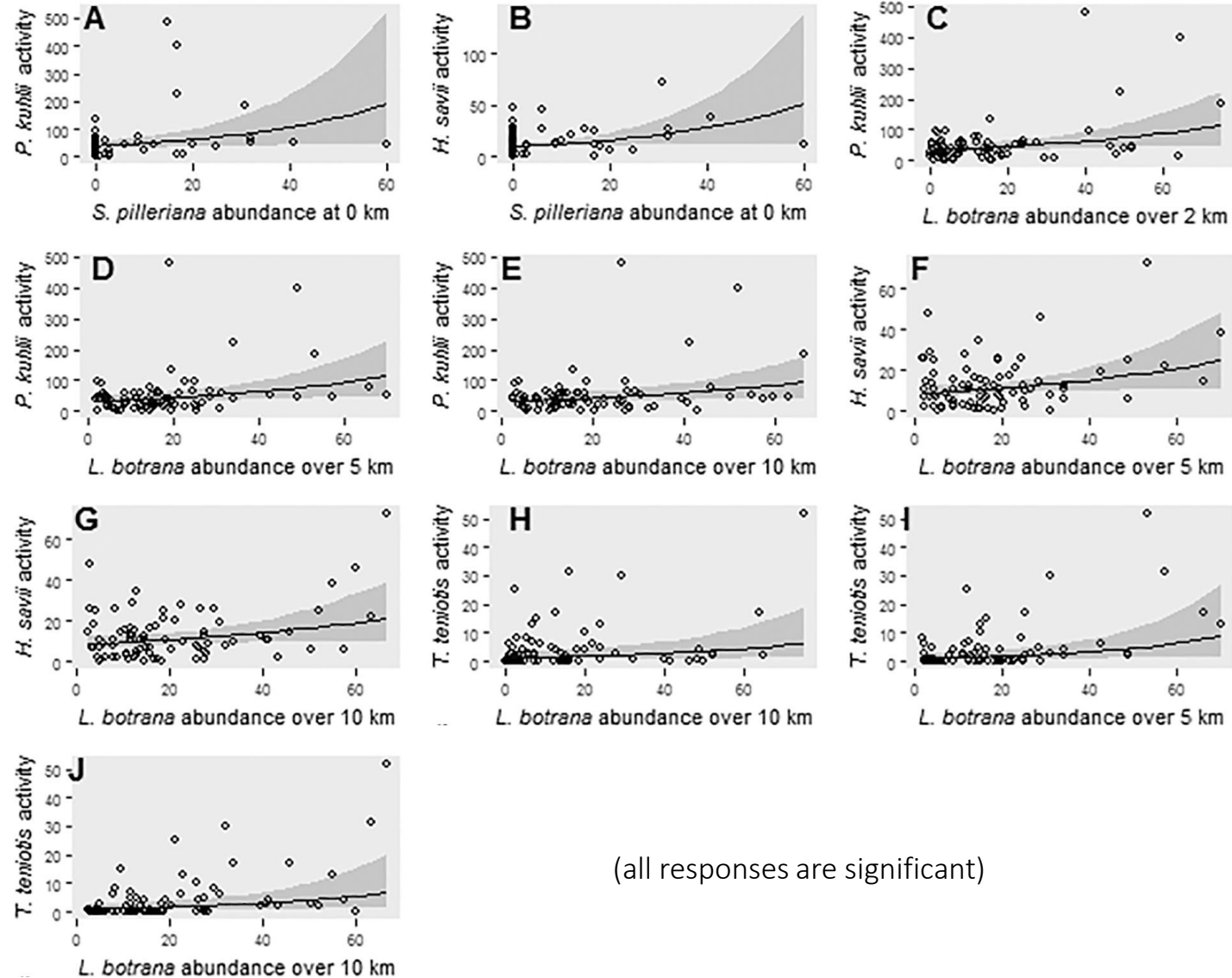


Hectonichus

*Sparganothis pilleriana*

*Lobesia botrana*

- Acoustics is a complementary method with other constraints
- Bats of different niches respond to pest abundance at different scales  $\rightarrow$  synergetic action

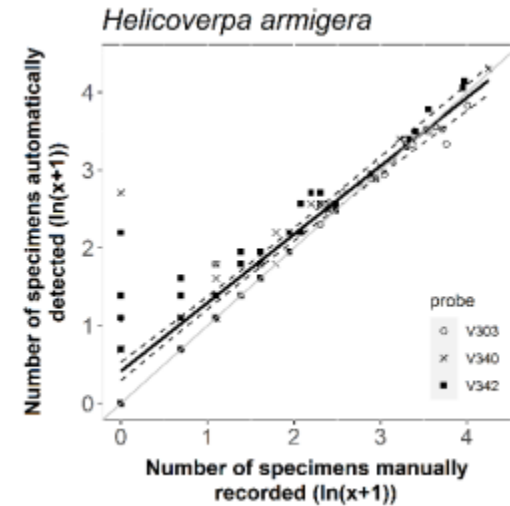
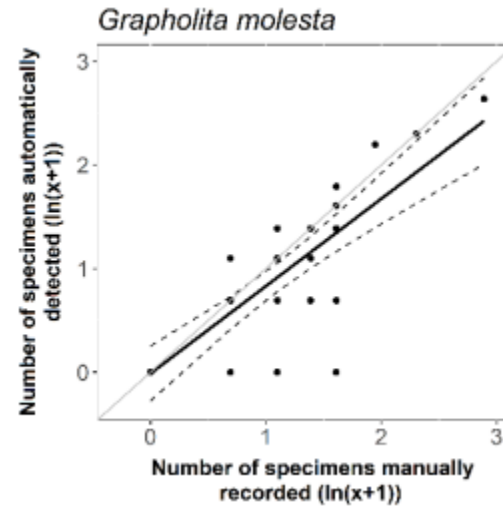
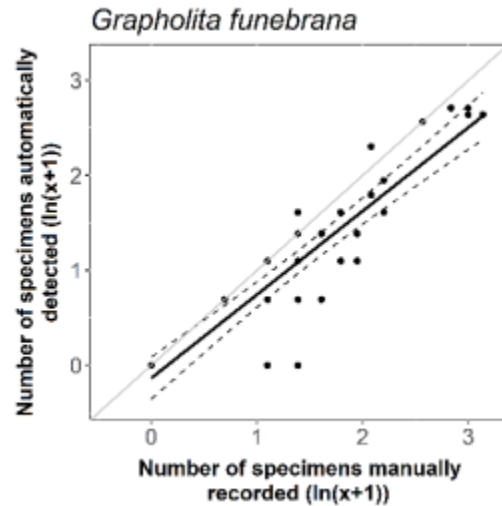
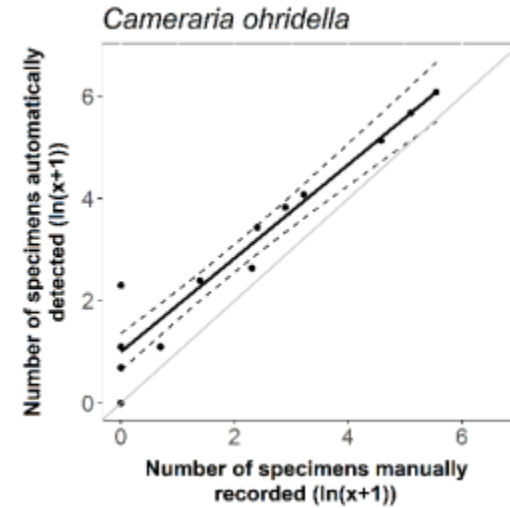
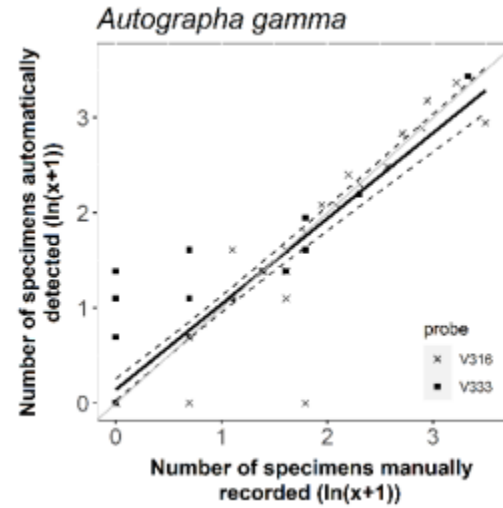
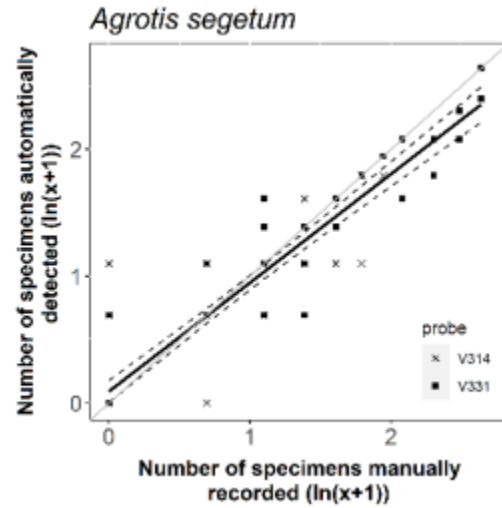
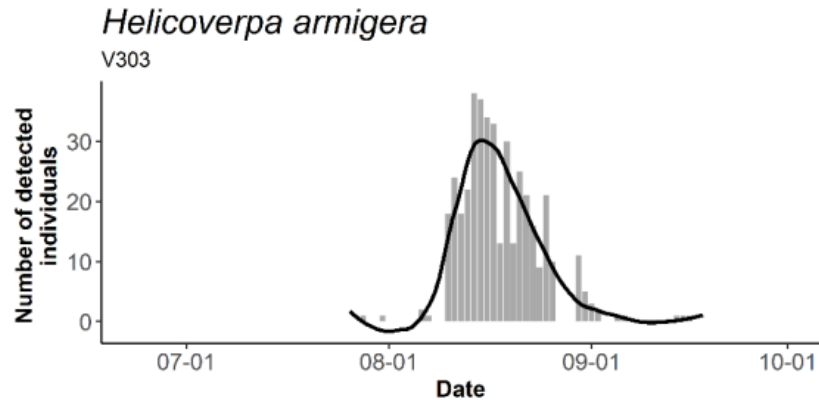


(all responses are significant)

# Passive tools, artificial intelligence and big data



# Passive tools, artificial intelligence and big data



# Passive tools, artificial intelligence and big data

OBSERVATOIRE  
AGRICOLE *de la*  
BIODIVERSITÉ

L'OAB ▼

LES PROTOCOLES ▼

AGRICULTURE ET BIODIVERSITÉ

LE RÉSEAU ▼

LES ACTUALITÉS



NOUVELLE OBSERVATION

CONNEXION

INSCRIPTION

LES OUTILS



L'Observatoire Agricole de la Biodiversité est avant tout un réseau de personnes : les agriculteurs et les animateurs ! De nombreux partenaires sont impliqués autant au niveau national qu'au niveau local.



# Passive tools, artificial intelligence and big data

- Possible large scale studies:
  - Energy flows
  - Role of the structure of predator communities in the suppression of pest
  - Effect of the decline of prey and predators on the trophic interactions
  - Seasonal dynamics of communities
  - ...





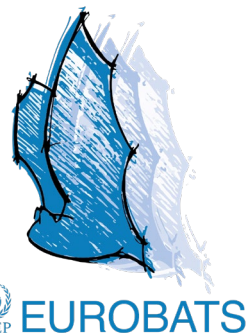
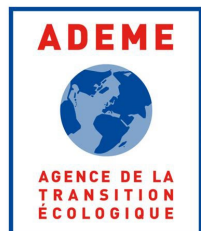
# VIGIECHIRO



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Thanks to my colleagues and collaborators

Thanks to the funders



**TEAM CHIRO**

Thank you for your attention!

