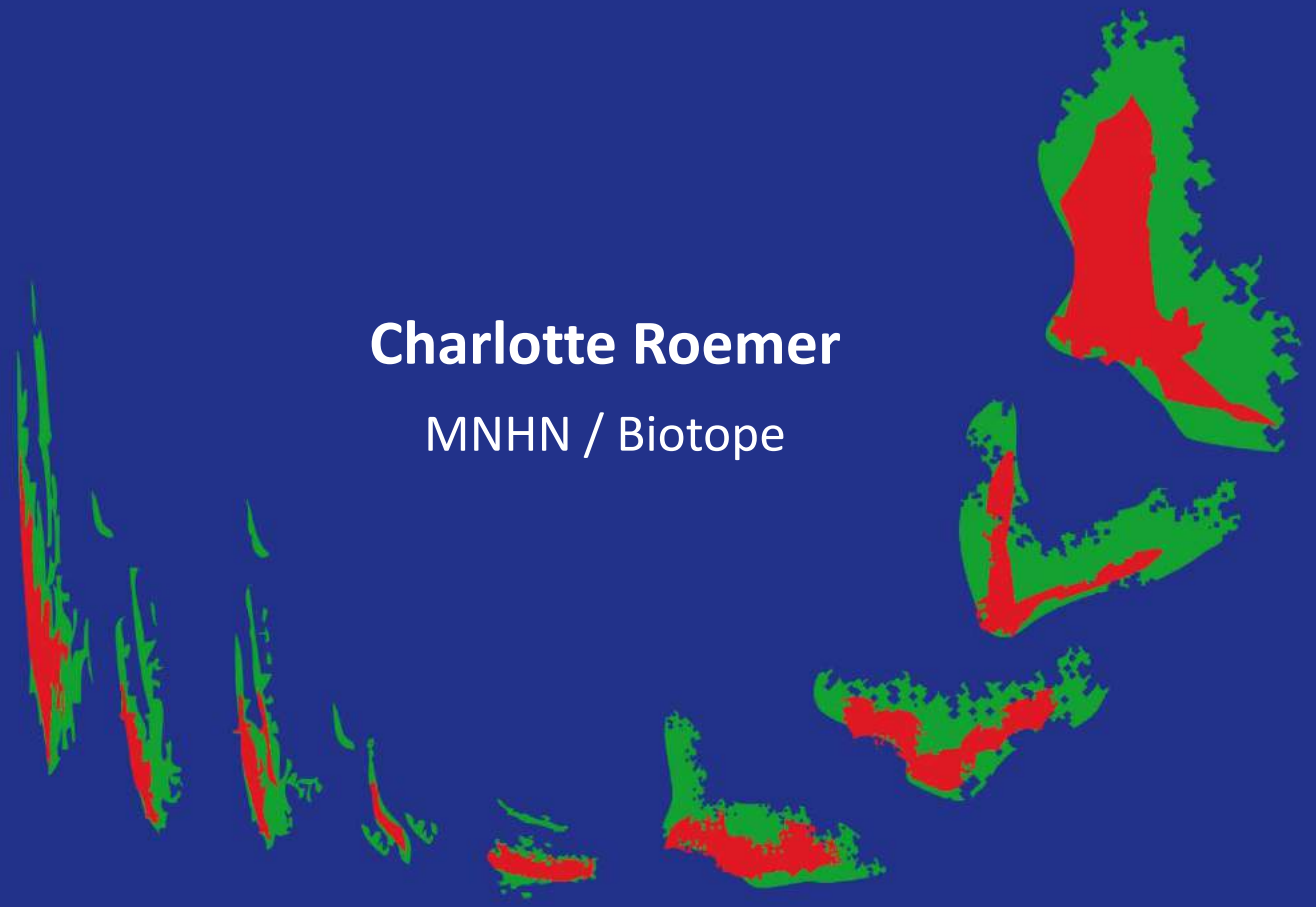
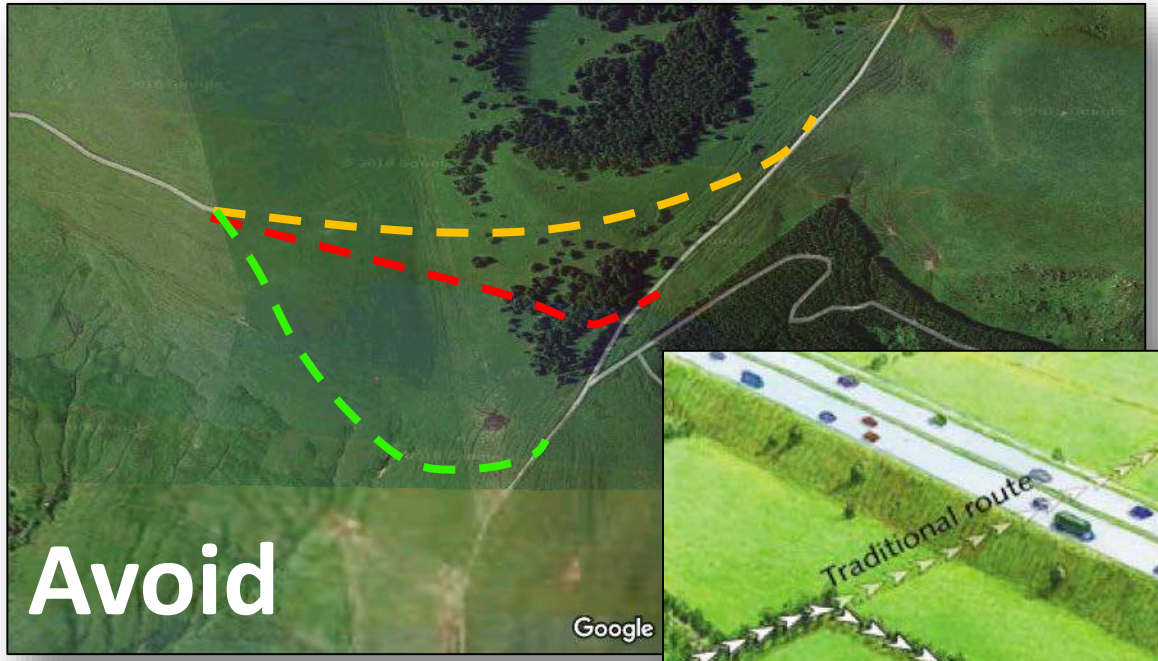
Bat collisions at secondary roads:
the importance of bat density and flight behaviour

Charlotte Roemer

MNHN / Biotope

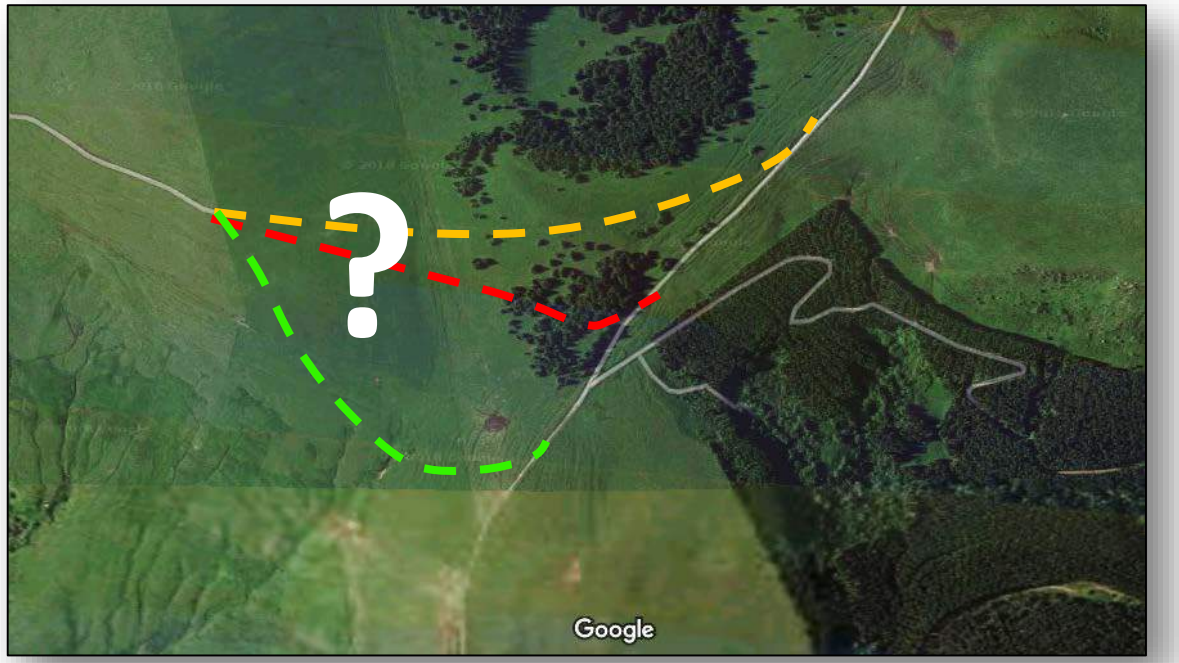


Environmental impact assessment studies



- **Mandatory** in Europe for roads and in some countries (France) for wind farms
- 3 steps after a field diagnosis

Environmental impact assessment studies



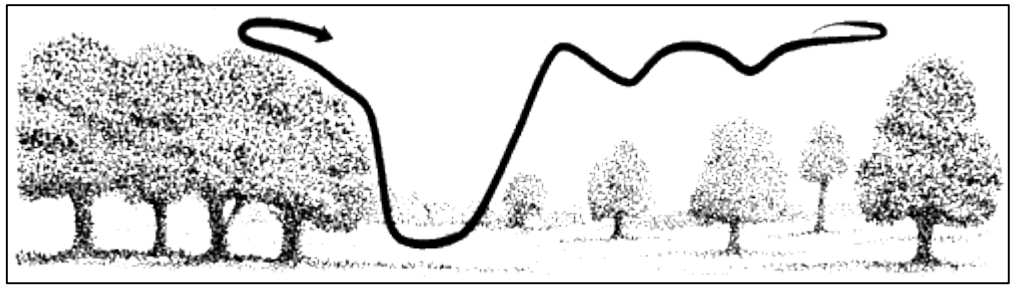
- **Avoid**: most efficient step, but often neglected (Bigard et al., 2017)

- Lack of empirical evidence

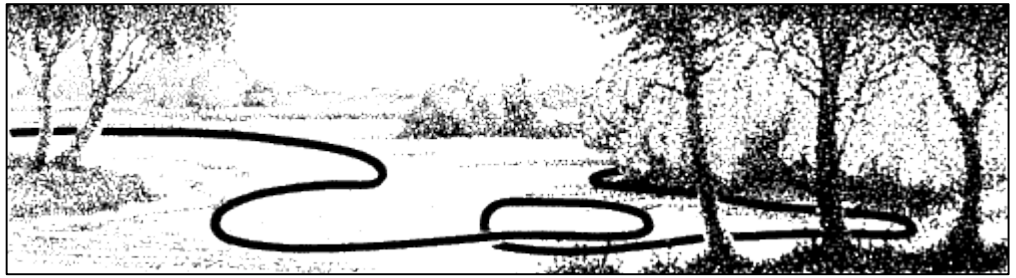
Bats: a unique sensory-motor system

- Bats use landscape structure for orientation and foraging

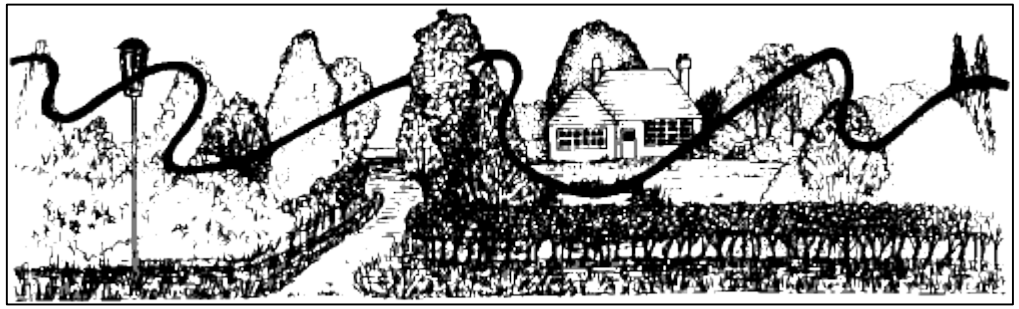
  → How does it influence intraspecific collision risks ?



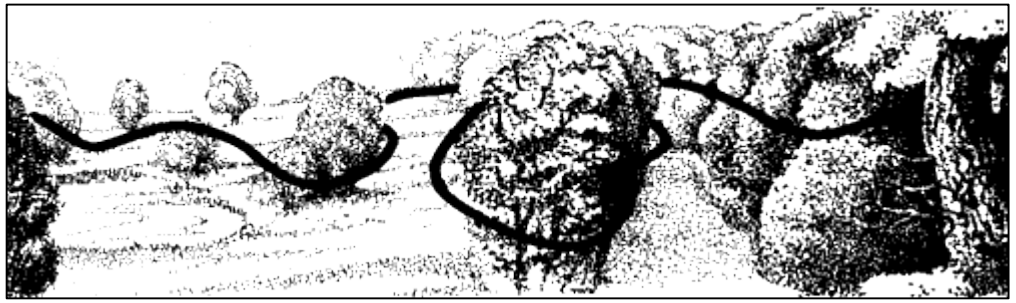
N. noctula



M. daubentonii



P. pipistrellus



M. mystacinus

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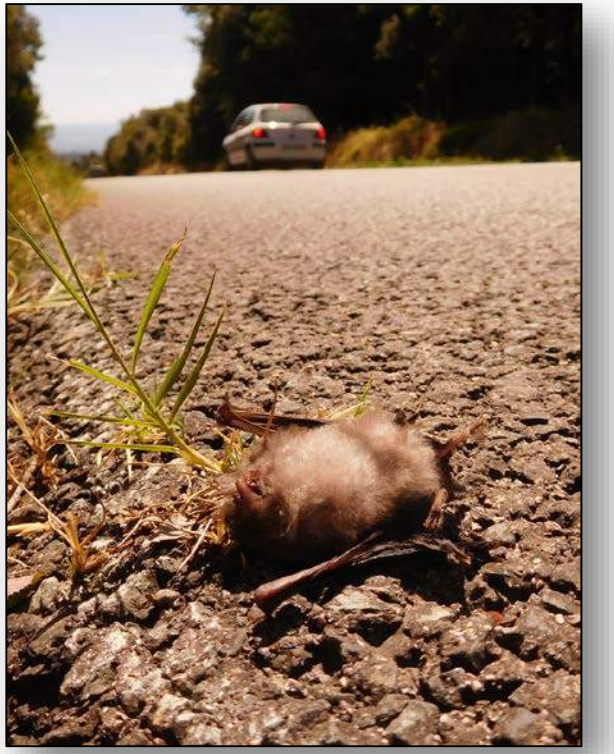
Influence of the environment on bat collisions

- Collisions ↗ in **late summer and autumn**
- **Good quality habitats** ↗ collisions

→ Scarce information at the species level

→ Role of vegetation orientation and density ?



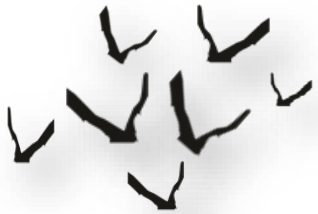
Fensome & Mathews 2016; Medinas et al. 2013; Gaisler et al. 2009; Lesiński et al. 2011

Conditioning events of collisions

Carcasses counts

Acoustic recordings

Collisions = Number of individuals present on site X Risky behaviour



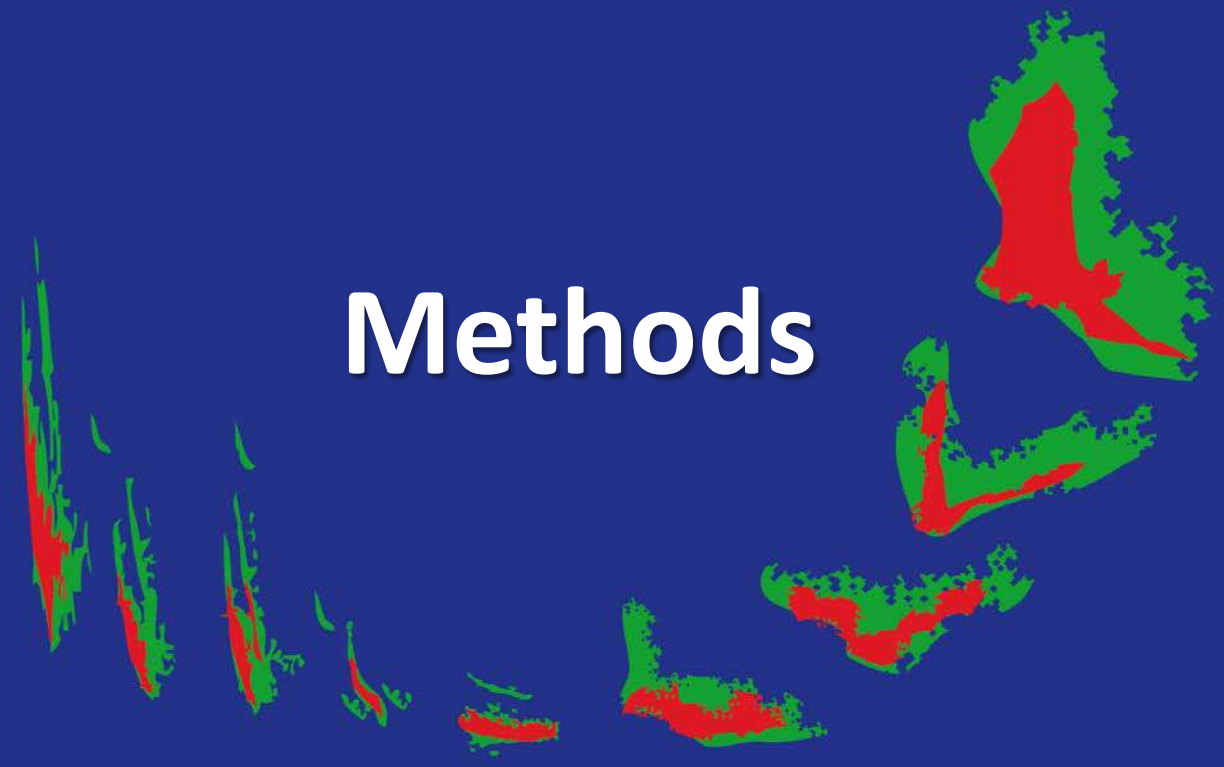
Advantages of bat acoustics over bat carcasses counts

- More data
  - More information at the species level
  - Higher statistical power
- Information on behaviour
  - Detailed understanding of collisions
  - Basis for siting of reduction measures

Objectives

- Test effect of different landscapes on (1) **bat density** and (2) **flight behaviour**
- Infer **collision risks**
- Give recommendations for **road micro-siting/siting of mitigation measures**

Methods



Methods

- Disentangling the conditioning events of collisions:

PROXY

(1) Bat density ← number of bat passes/night

1 bat pass = acoustic contact of the species in a sequence of 5 sec (Barataud, 2015)

Methods

- Disentangling the conditioning events of collisions:

(2) Bat movement behaviour

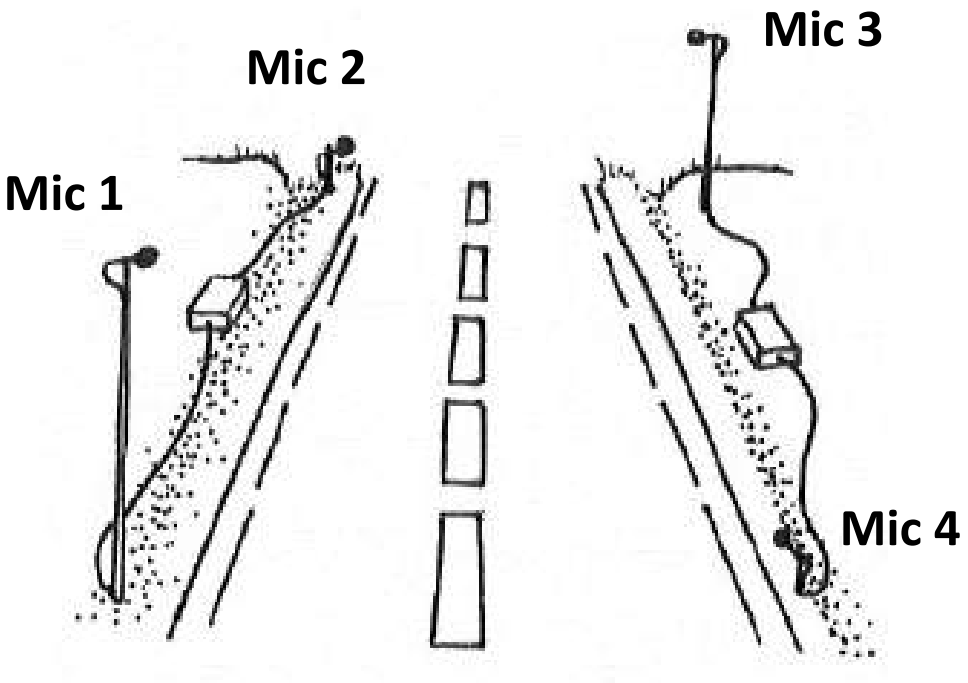
→ Proportion of flight trajectories in the zone at collision risk

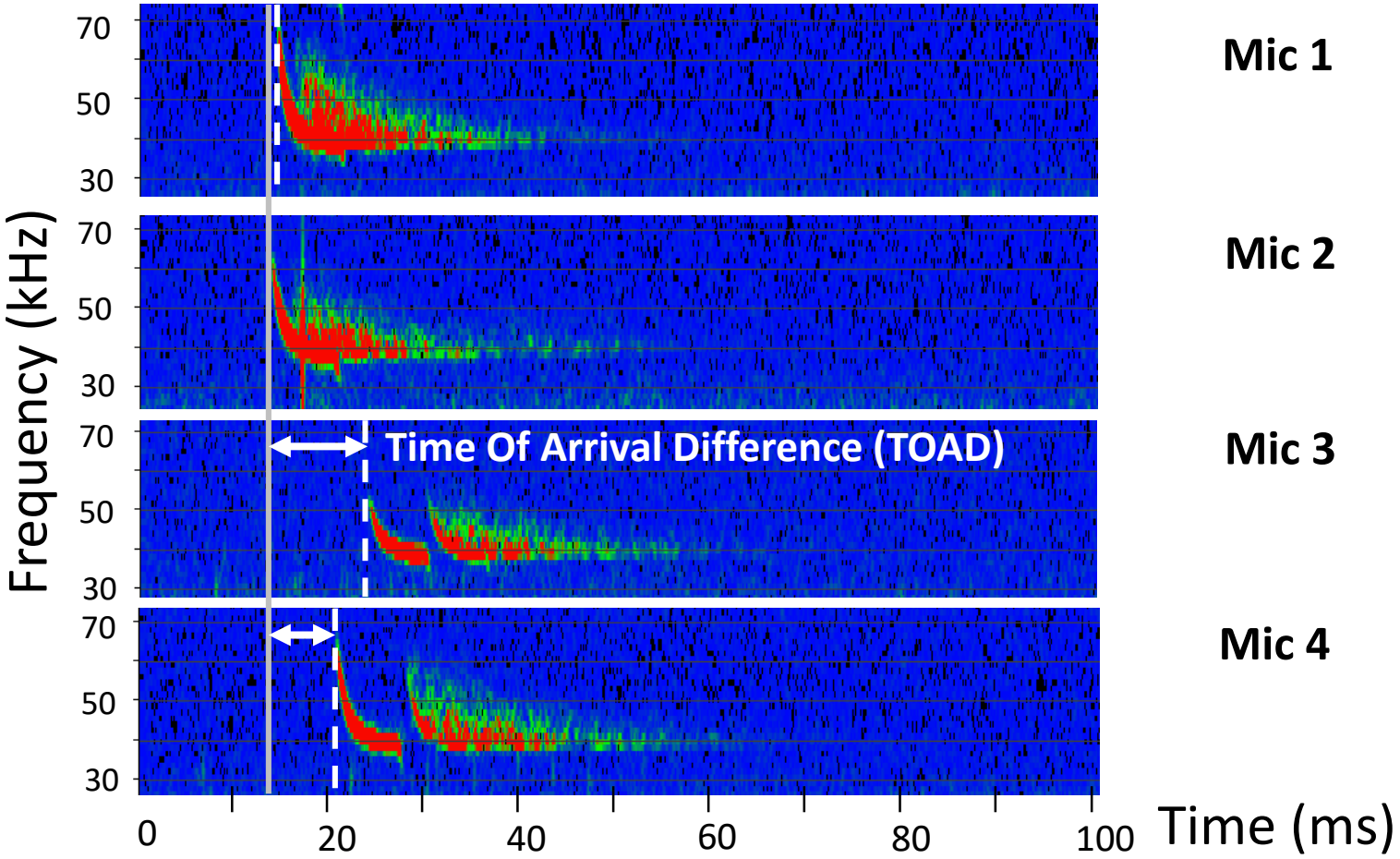
Collision risk

Safe

Methods: 3D acoustic flight path tracking

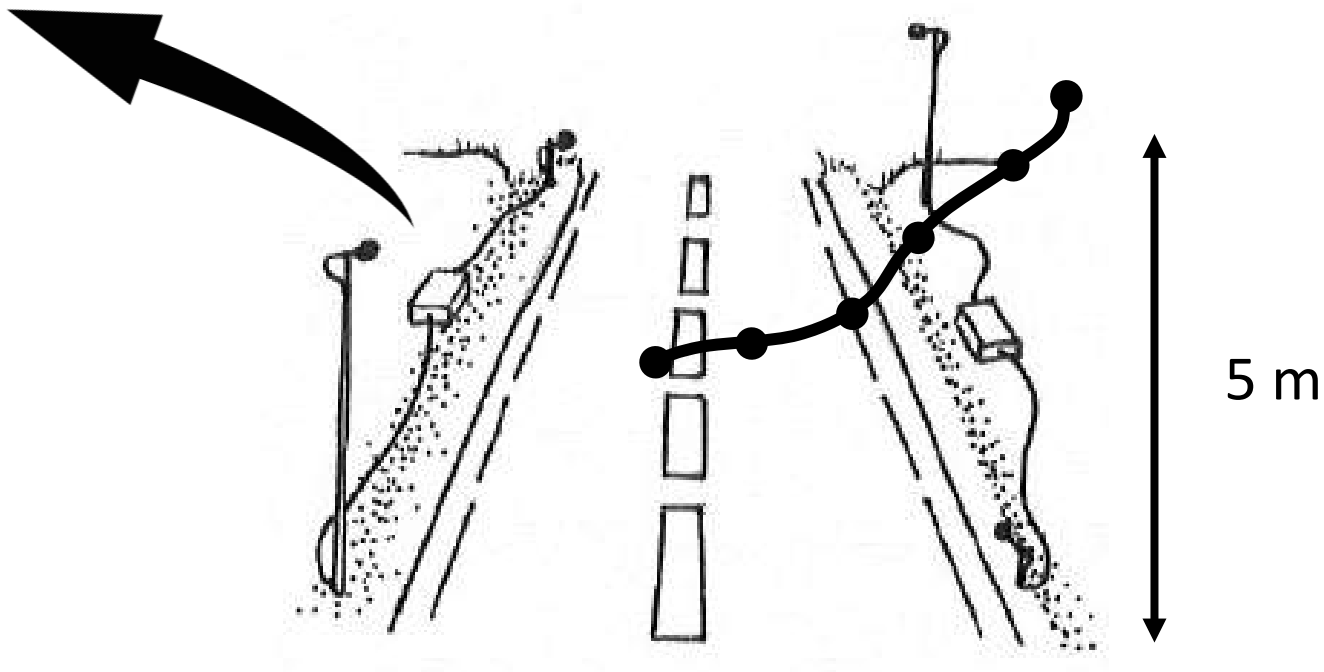
- Road collision risks studied on operational secondary roads
- Range of observation 10 m





Methods: 3D acoustic flight path tracking

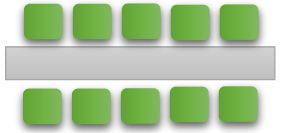
Proportion of flights in the zone at collision risk



Methods:
descriptive variables

- 6 different local landscapes
- Distance between road and tree foliage
- Vegetation height
- Road traffic
- Time of the year

Forest



Double parallel tree rows

Forest edge

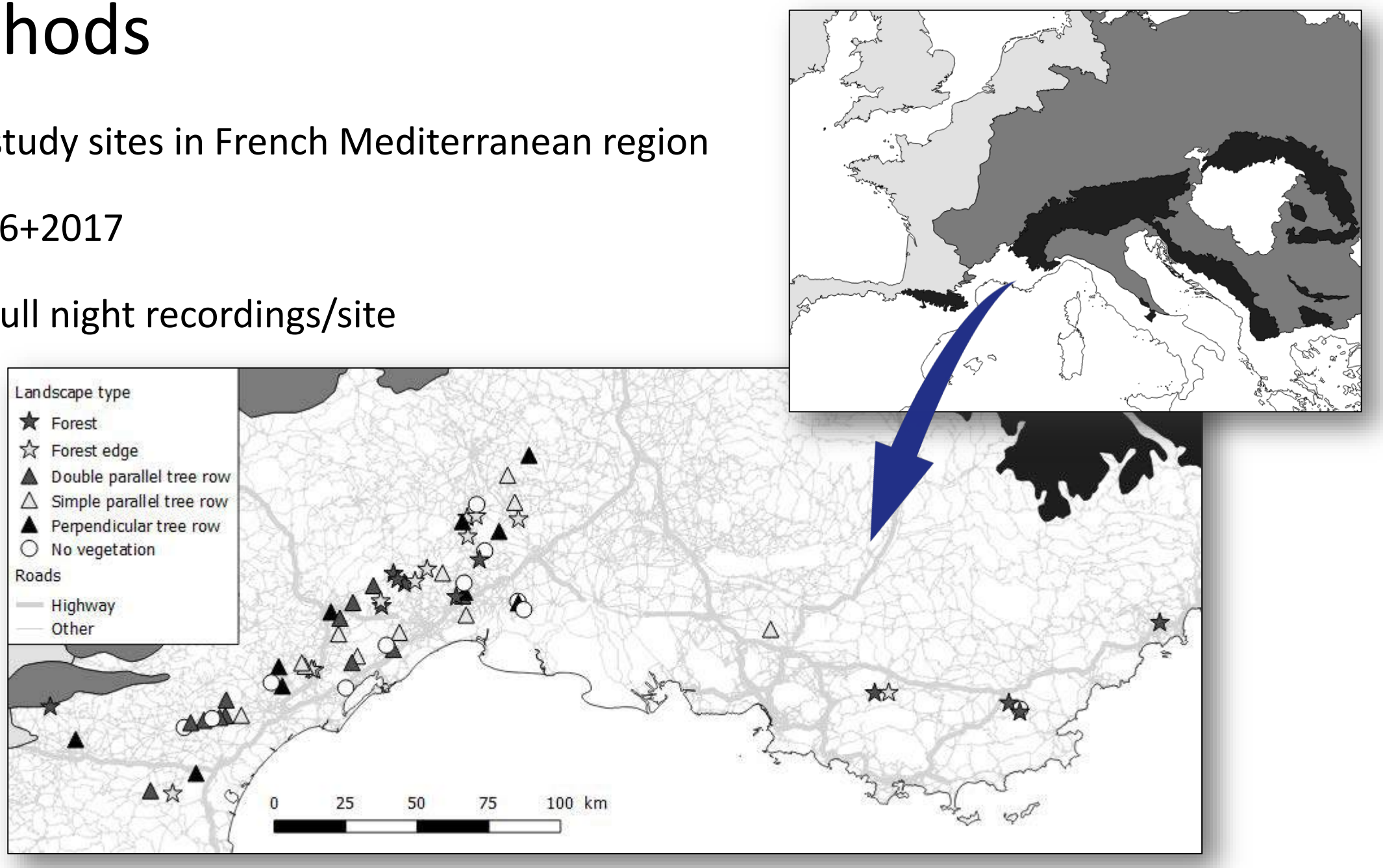
Simple parallel tree row

Perpendicular tree row

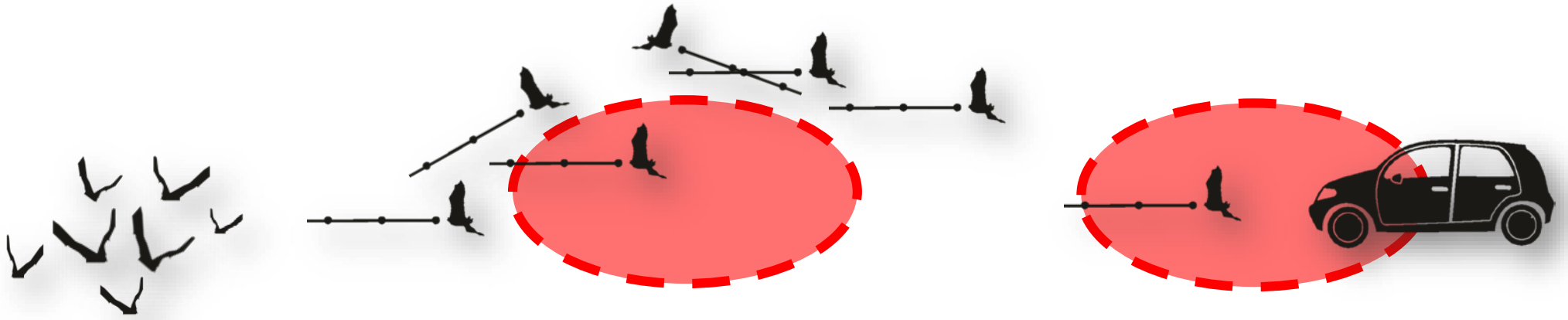
No tree

Methods

- 66 study sites in French Mediterranean region
- 2016+2017
- >2 full night recordings/site

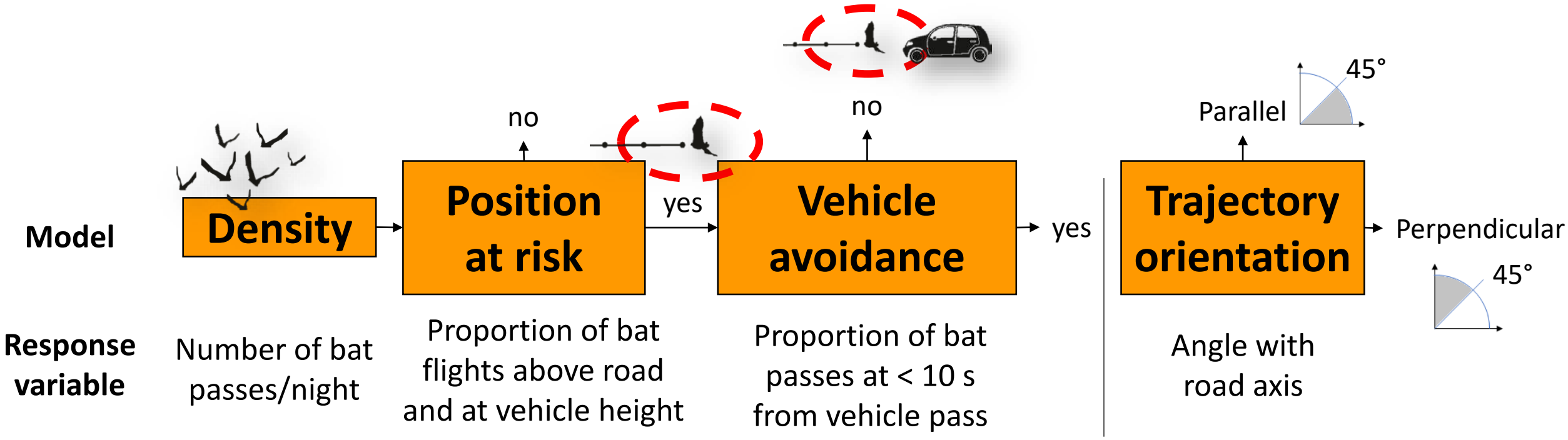


Methods

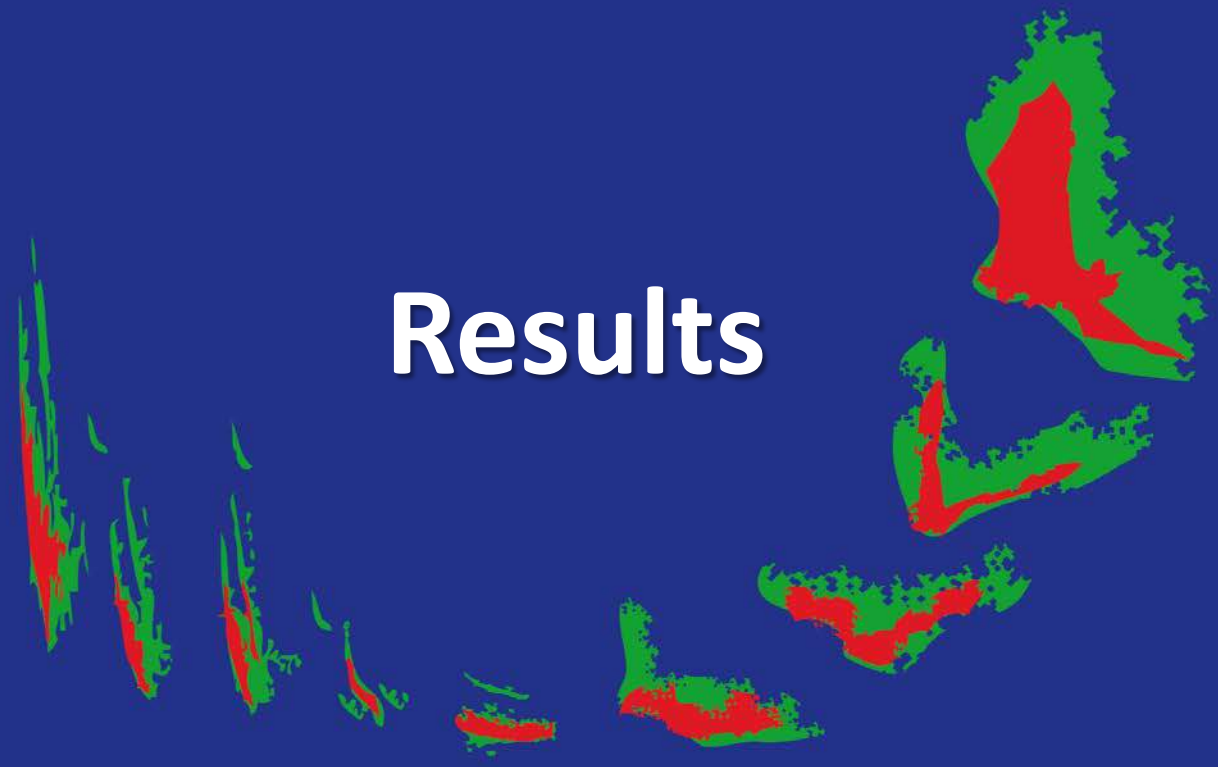


Collision risk = **Species density** **X** **Proportion of flights in the zone at risk** **X** **Proportion of flights in the zone at risk not avoiding vehicles**

Methods: Generalised linear mixed models



Results



Results

- **122,294 bat passes** recorded and identified
- **30,954 flight trajectories**
- Models for:
  - 9 species
  - 3 groups (*Pipistrellus kuhlii/nathusii*, *Plecotus* sp. and *Myotis blythii/myotis*)
  - 3 guilds:
    - **Short-range echolocators**: *Myotis*, *Plecotus*, *Barbastellus* and *Rhinolophus*
    - **Mid-range echolocators**: *Miniopterus*, *Pipistrellus* and *Hypsugo*
    - **Long-range echolocators**: *Eptesicus*, *Nyctalus* and *Tadarida*

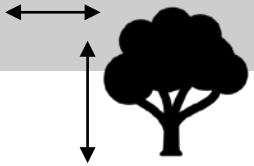
Results

Density → Position at risk → Vehicle avoidance | Trajectory orientation

Echolocation guild : **Short-range** | **Mid-range** | **Long-range**

M. daubentonii | *M. emarginatus* | *M. blythii/myotis* | *Plecotus sp.* | *M. schreibersii* | *P. kuhlii/nathusii* | *P. pipistrellus* | *P. pygmaeus* | *H. savii* | *E. serotinus* | *N. leisleri*

Distance to tree foliage



Tree height

↗ primary productivity = ↗ bat density ?

Traffic

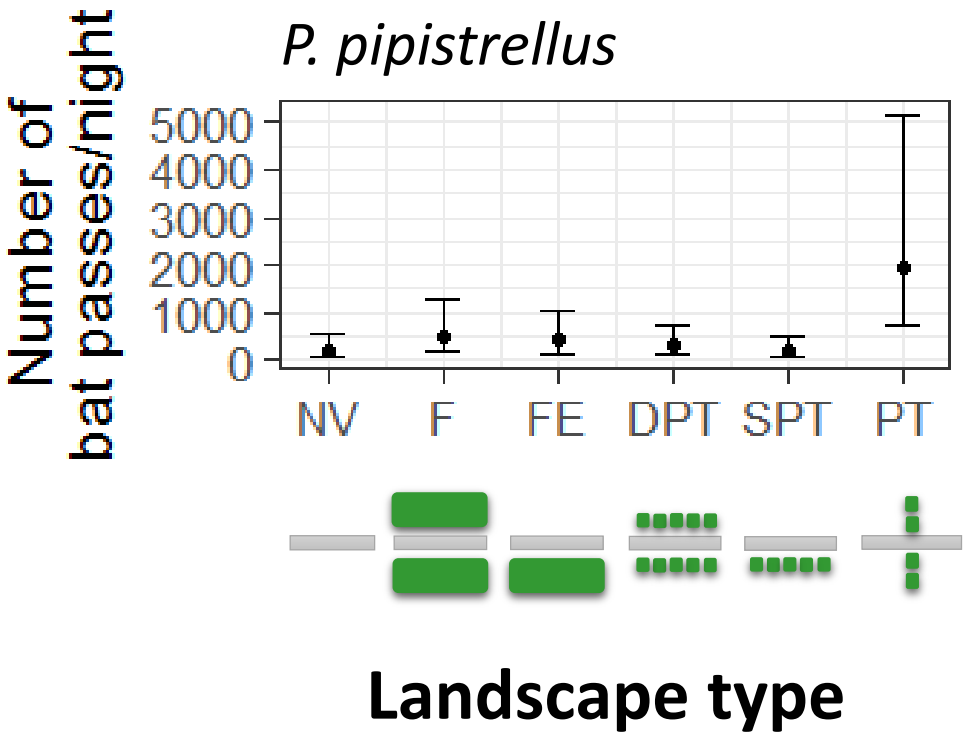
↘

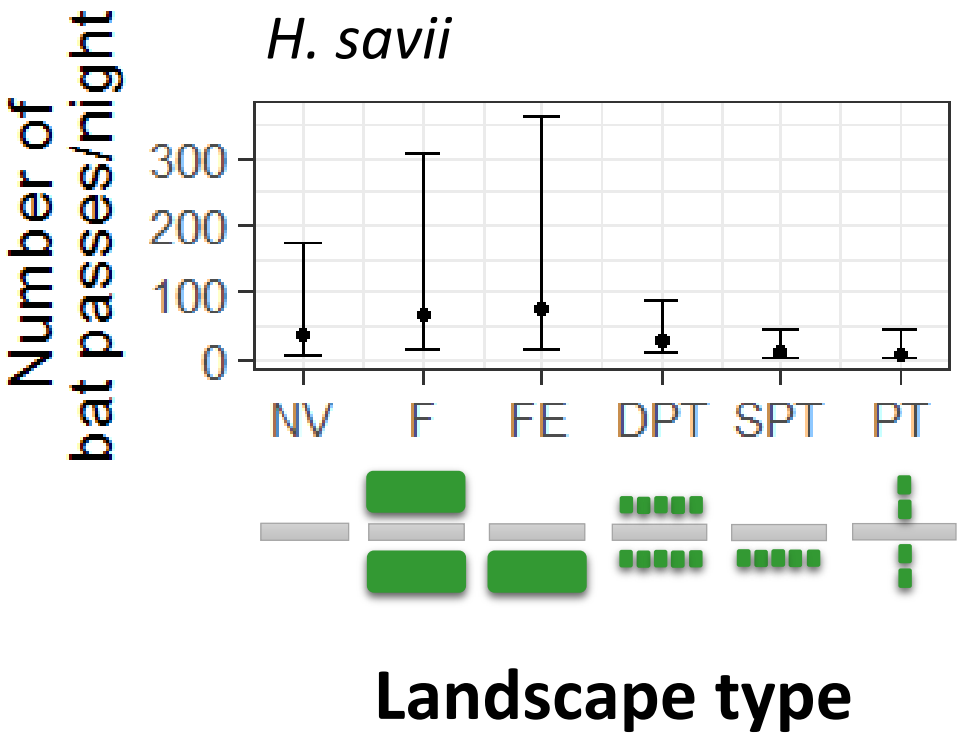
Landscape type

★ ★ ★ ★ ★

Results

Density → Position at risk → Vehicle avoidance | Trajectory orientation

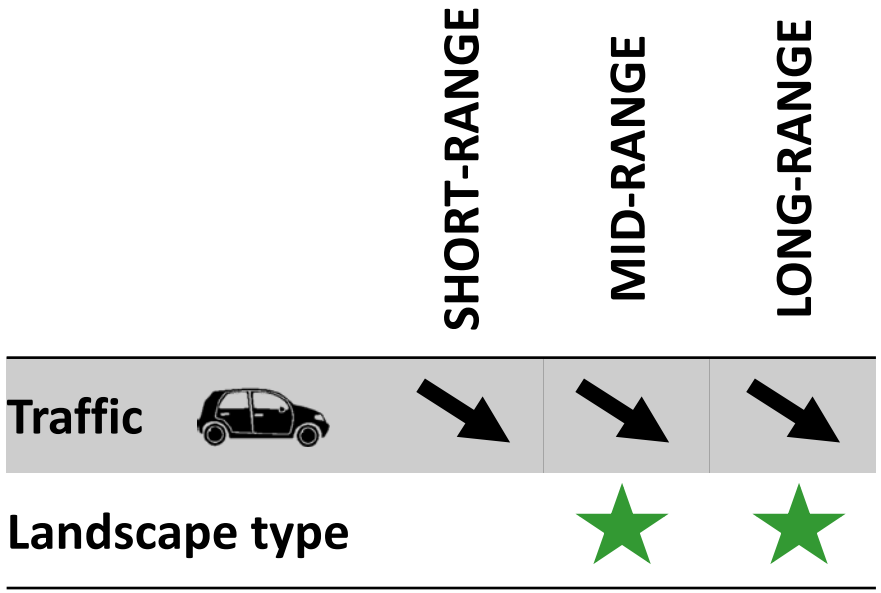




- **Responses varied according to species ecology (diet, roost opportunities…)**

Results

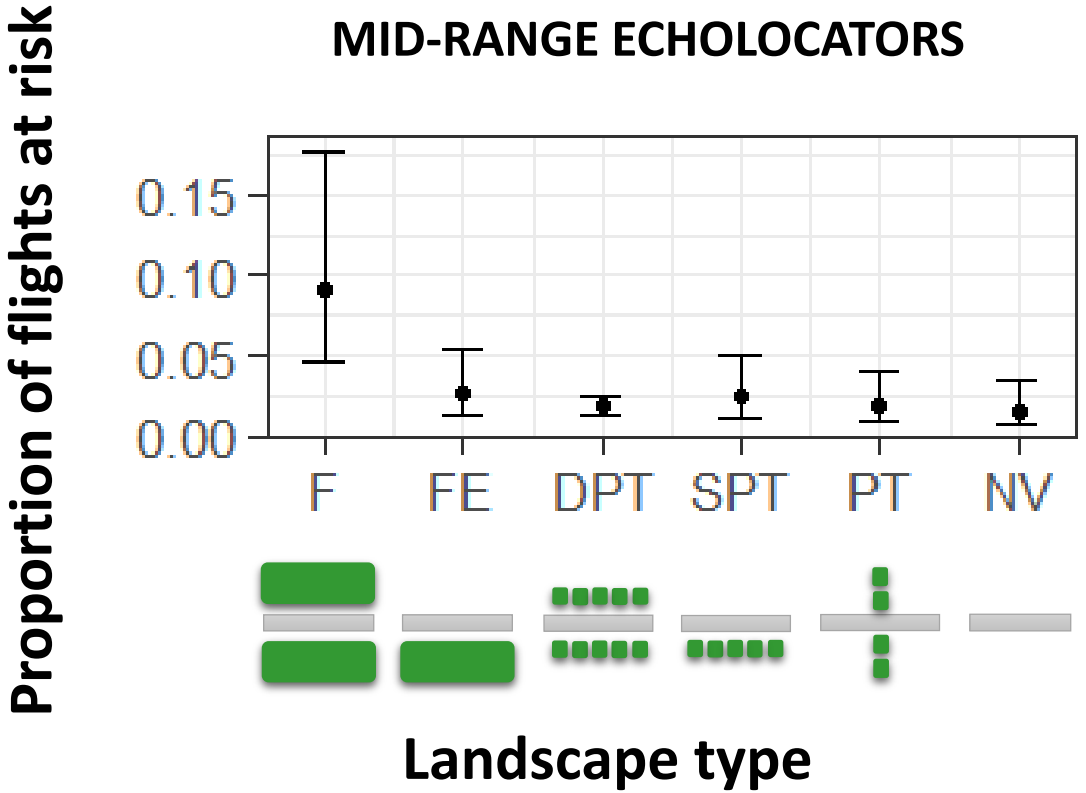
Density → **Position at risk** → Vehicle avoidance | Trajectory orientation



Bats avoid flying above the road with ↗ traffic

Results

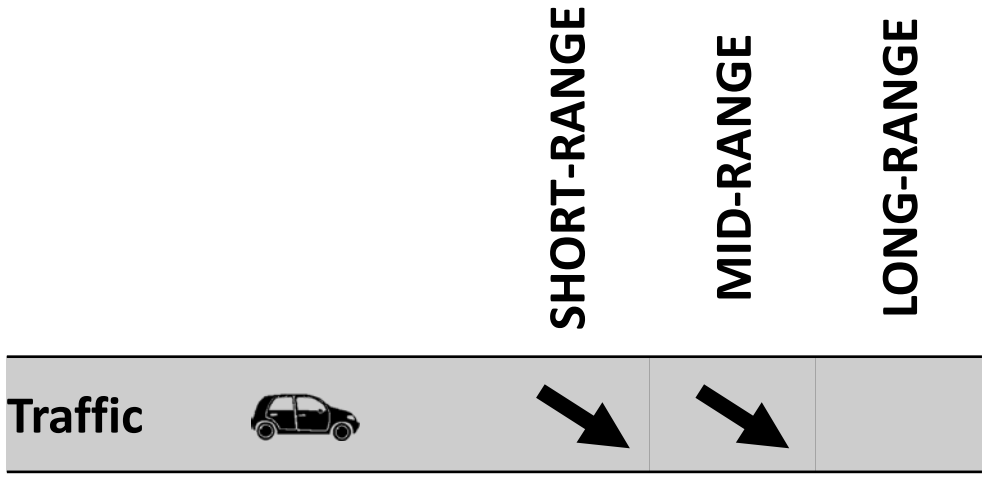
Density → **Position at risk** → Vehicle avoidance | Trajectory orientation

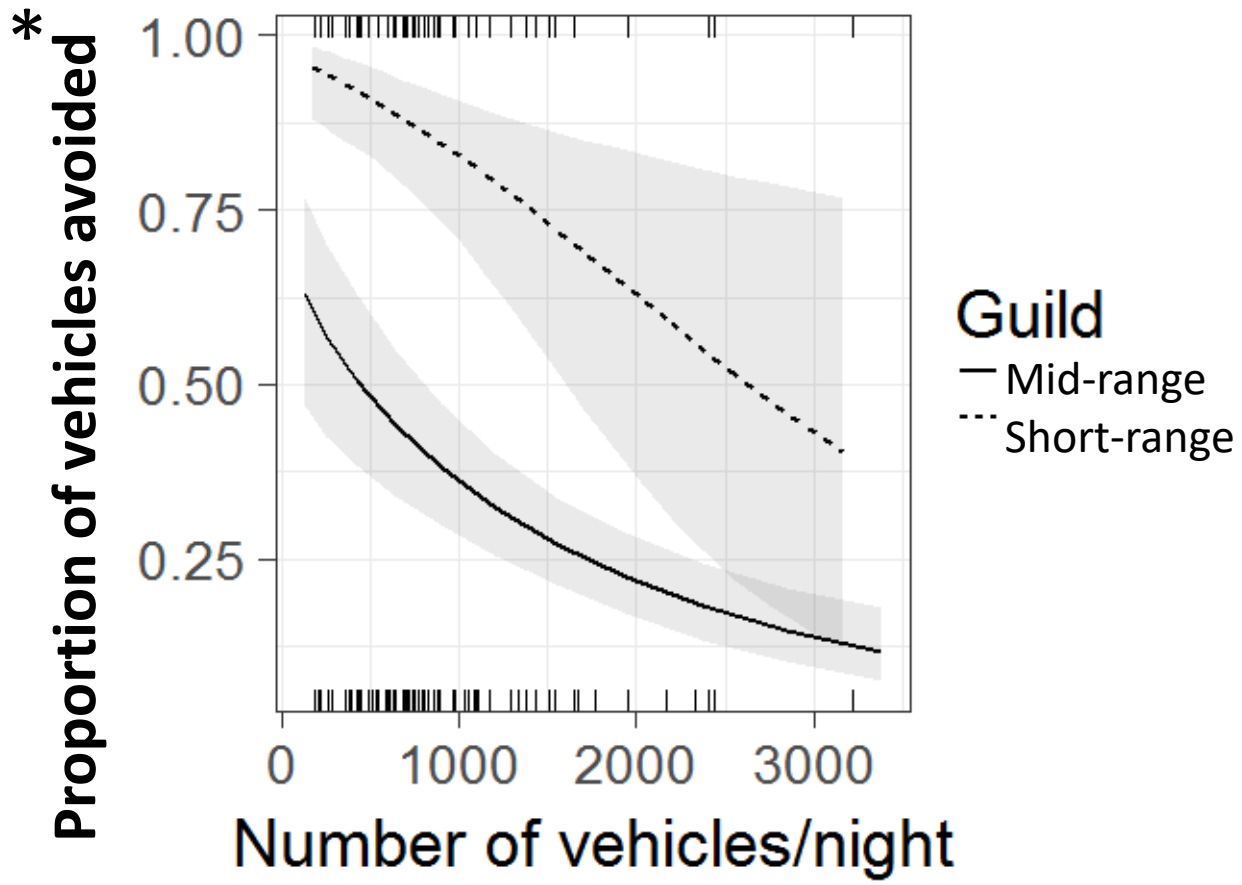


- **Similar response for all species: dense vegetation increases positions at risk**

Results

Density → Position at risk → **Vehicle avoidance** | Trajectory orientation

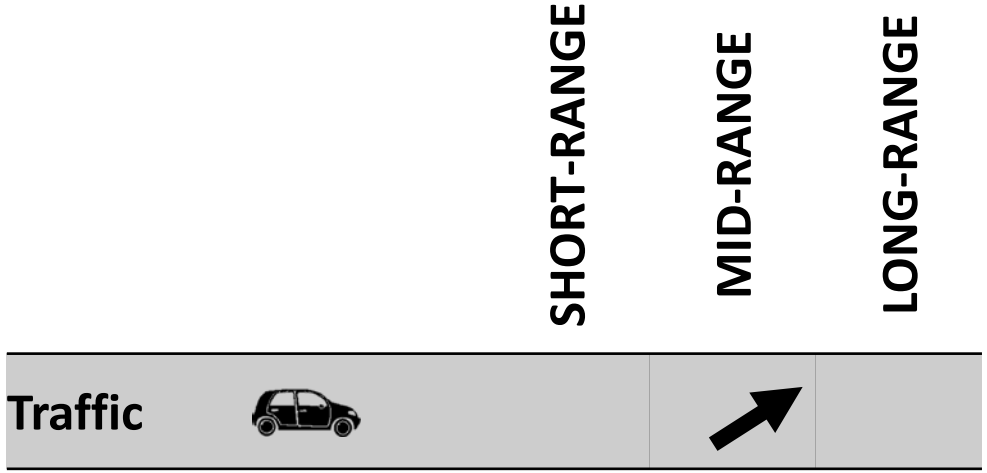


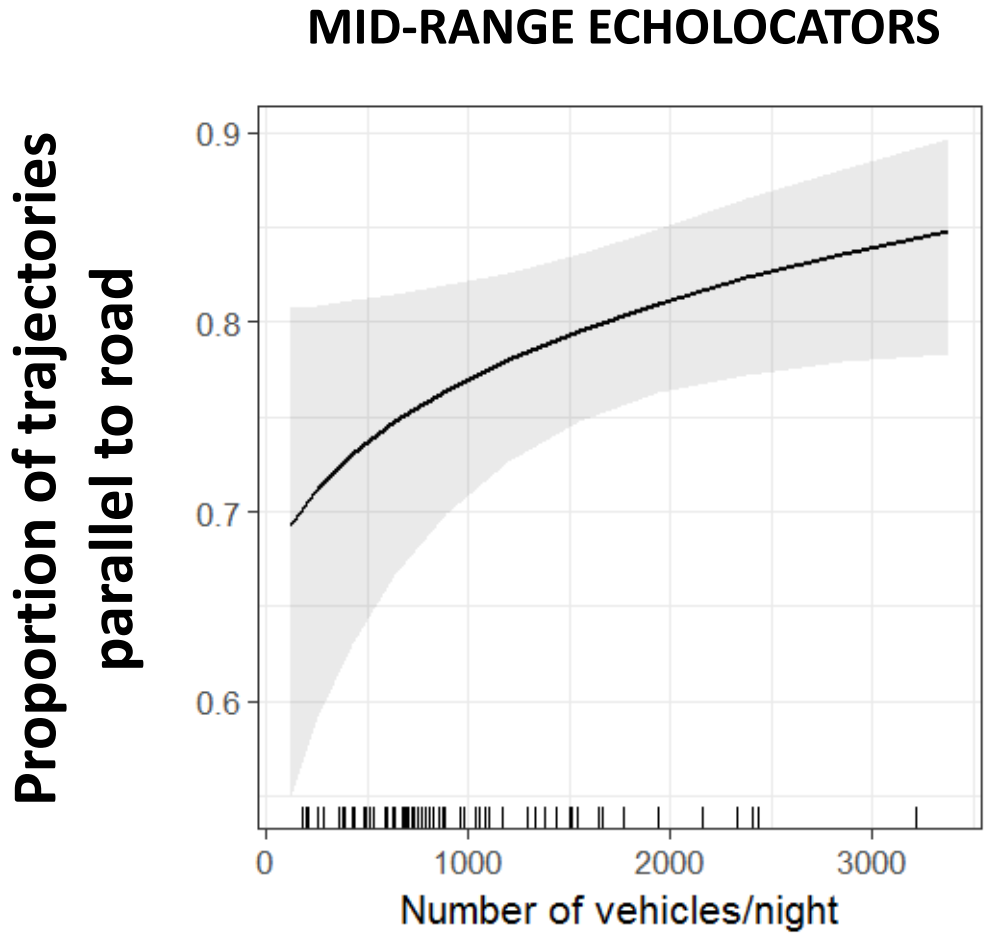


* bat presence < 10 s before or after vehicle pass

Results

Density → Position at risk → Vehicle avoidance | **Trajectory orientation**



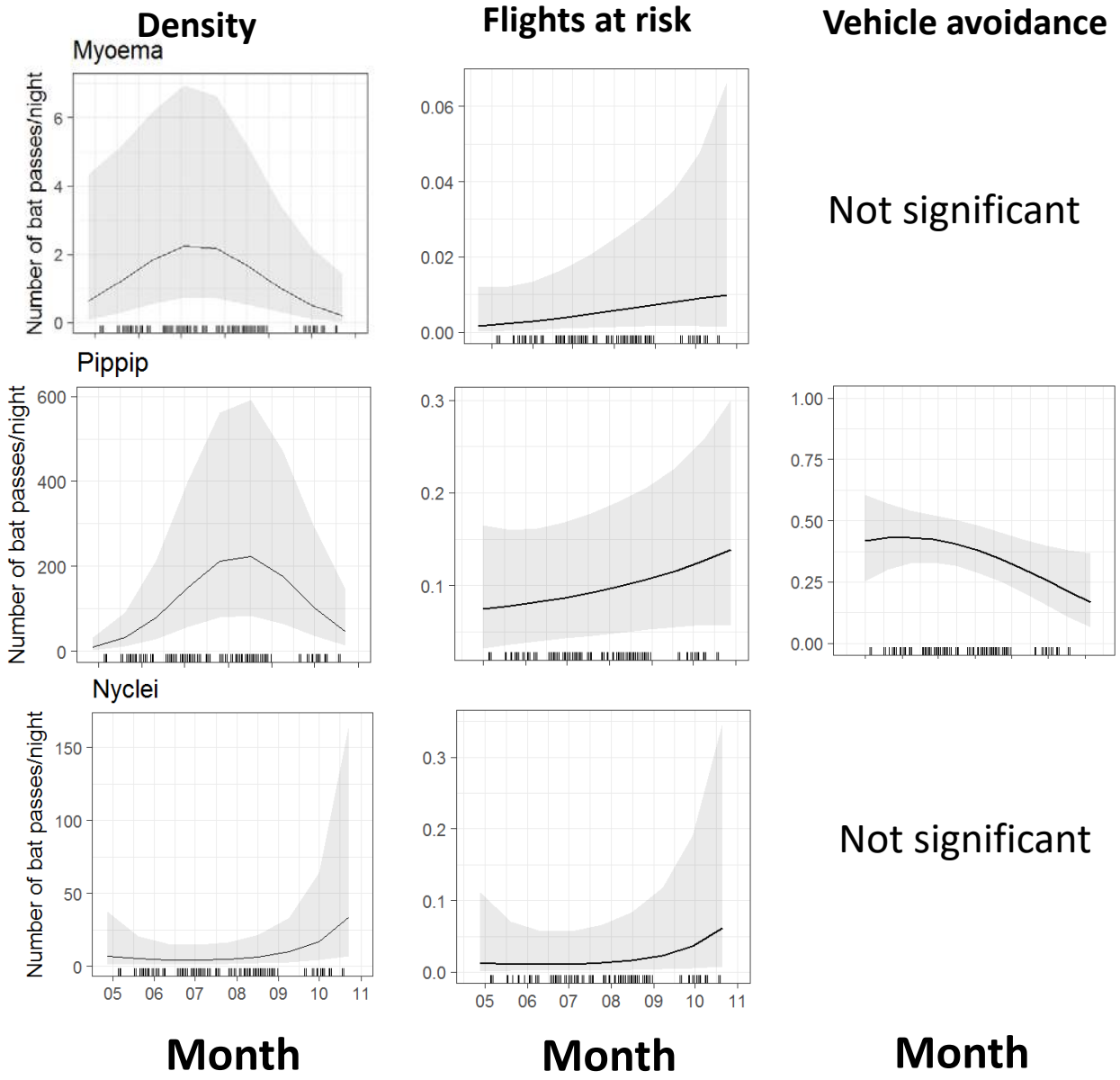


Results: effect of time of the year

Short-range echolocators (SRE)

Mid-range echolocators (MRE)

Long-range echolocators (LRE)



Not significant

Not significant

Discussion

Recommendations to avoid road collisions

- **Bat density** ↘ with distance to tree foliage

  → **Site roads away from trees** 👍

  → Small trees = low primary productivity = low bat density ?

  = low roost opportunities = low bat density ?

Distance to foliage = +2

Distance to foliage = - 3

Recommendations to avoid road collisions

- **Bat position at risk** ↗ when vegetation was dense

  → **Avoid dense vegetation** 👍

  → Tree rows = safer use of the “Edge effect”

Recommendations to reduce road collisions

- If roads sited in risky areas, test reduction measures, such as:
  - Vehicle speed reduction
  - (Cutting down trees to create a gap)

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association nationale recherche technologie

Thanks to my great supervisors:

Aurélie Coulon

Yves Bas

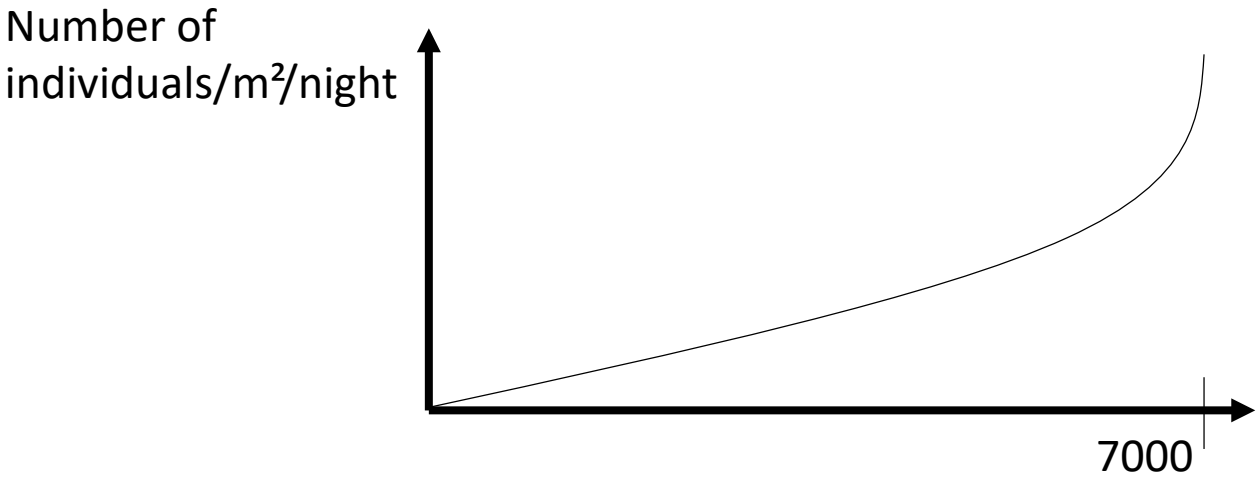
Many thanks to the people who helped me during fieldwork, in particular Bruno Sanchez.

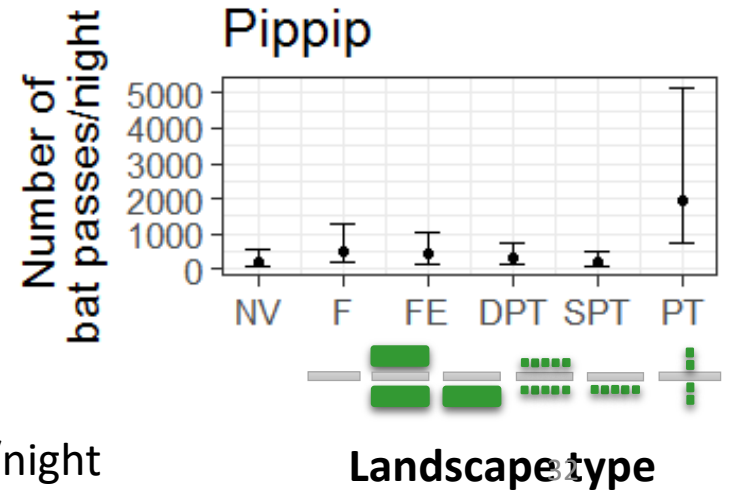
Merci!

Contact: croemer@biotope.fr

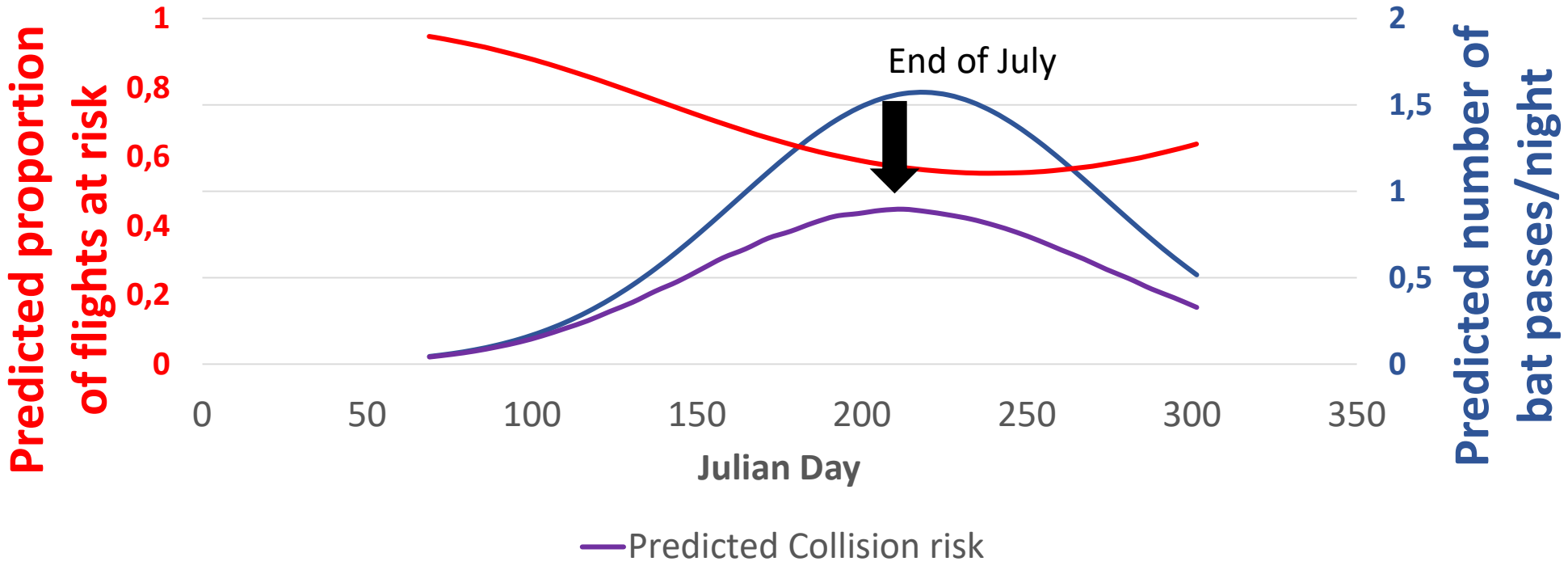
Bat density

- Density = number of individuals / m²
- Our hypotheses:
  - Number of bat passes in a constant volume (i.e. microphone detection range) is proportional to density
  - Relation is not totally linear
  - But the majority of our sites did not have a very high activity



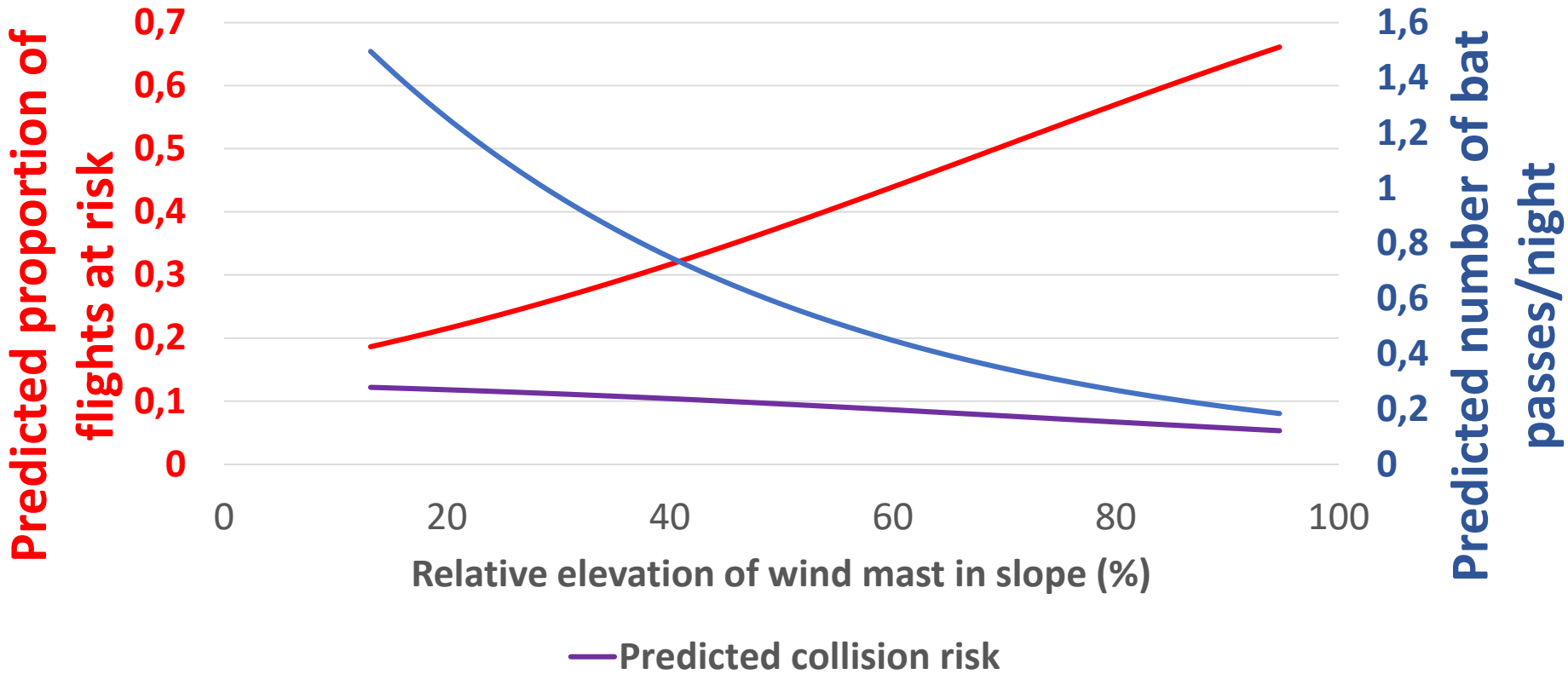


Conditional events of collisions



- Effect of the time of the year (*Nyctalus leisleri*)

Conditional events of collisions



- Effect of relative elevation of the wind mast (*Pipistrellus nathusii*)