

Can we distangle the relative effect of urbanization and artificial lighting on biodiversity?

Use of a national-scale acoustic monitoring database to test the effect of ALAN on bats.

C. Azam, I. Le Viol, J-F Julien & C. Kerbiriou

VIGIENATURE
Un réseau de citoyens qui fait avancer la science

ilede**France**

CESCO
Centre d'Écologie et des Sciences de la Conservation

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Introduction

Has the Earth's sixth mass extinction already arrived?

Anthony D. Barnosky[1,2,3], Nicholas Matzke[1], Susumu Tomiya[1,2,3], Guinevere O. U. Wogan[1,3], Brian Swartz[1,2], Tiago B. Quental[1,2]†, Charles Marshall[1,2], Jenny L. McGuire[1,2,3]†, Emily L. Lindsey[1,2], Kaitlin C. Maguire[1,2], Ben Mersey[1,4] & Elizabeth A. Ferrer[1,2]

Pollutions

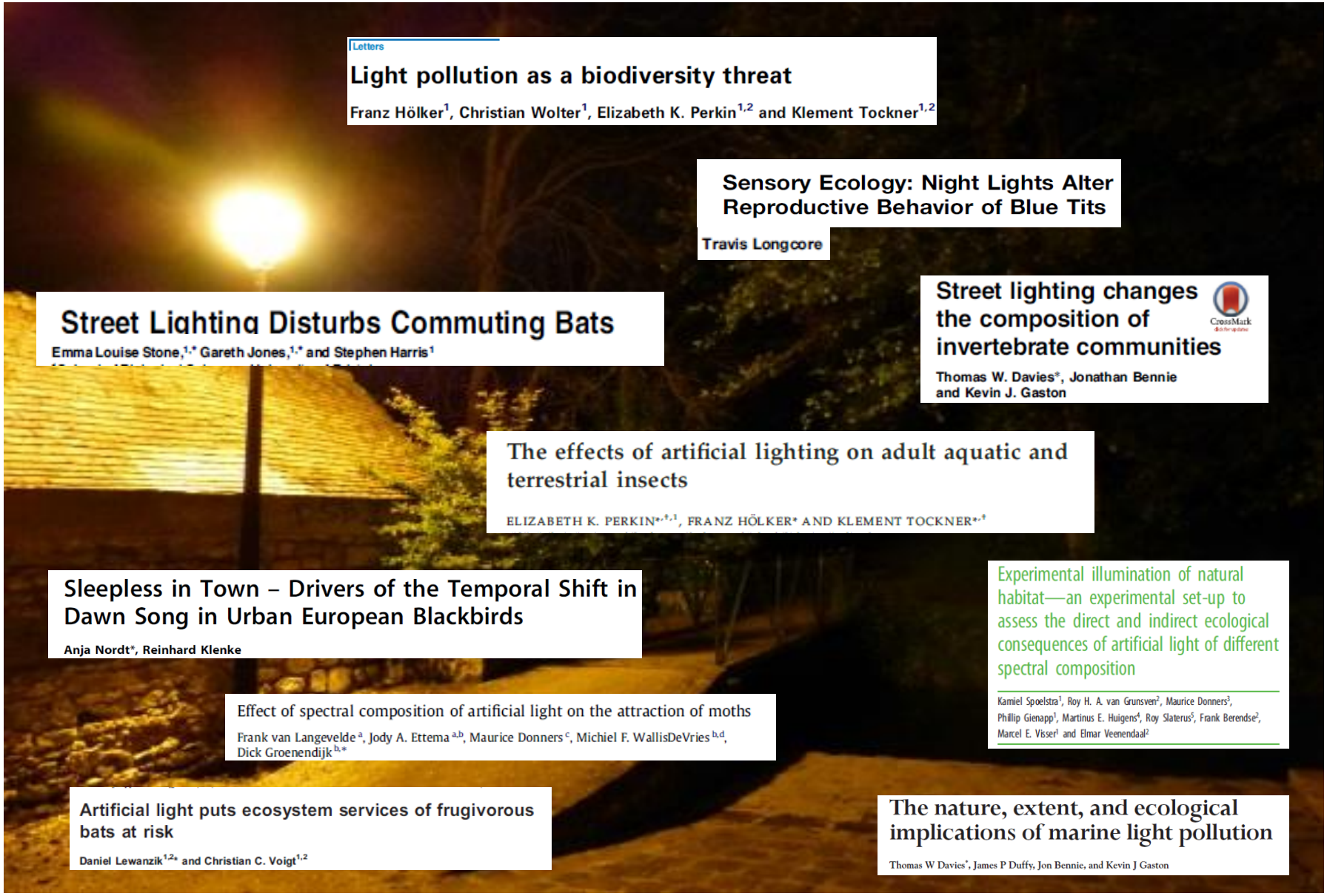
Habitat loss and fragmentation

Biodiversity

Climate Change

Ressource overexploitation

Introduction



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VS.

1) What is the relative effect of ALAN in regard to urbanization, and intensive agriculture on bats ?

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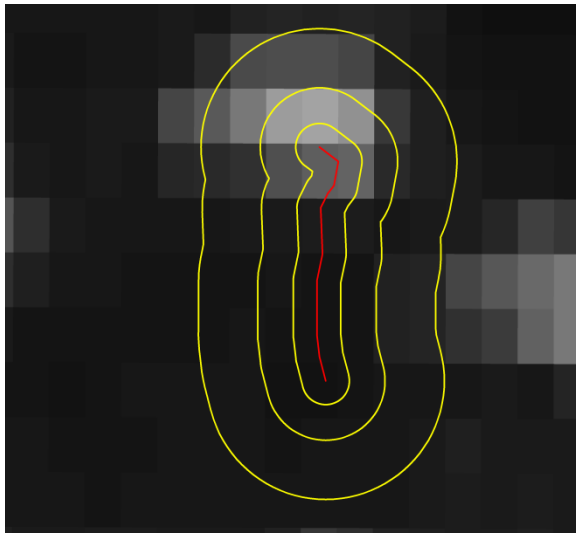

2) Multi-scale approach: Is there a scale of effect (local vs. landscape) to measure species response to ALAN?

To determine the **spatial extent** at which a given population can be affected by ALAN

Introduction

- **Model species: 4 common species of bats**

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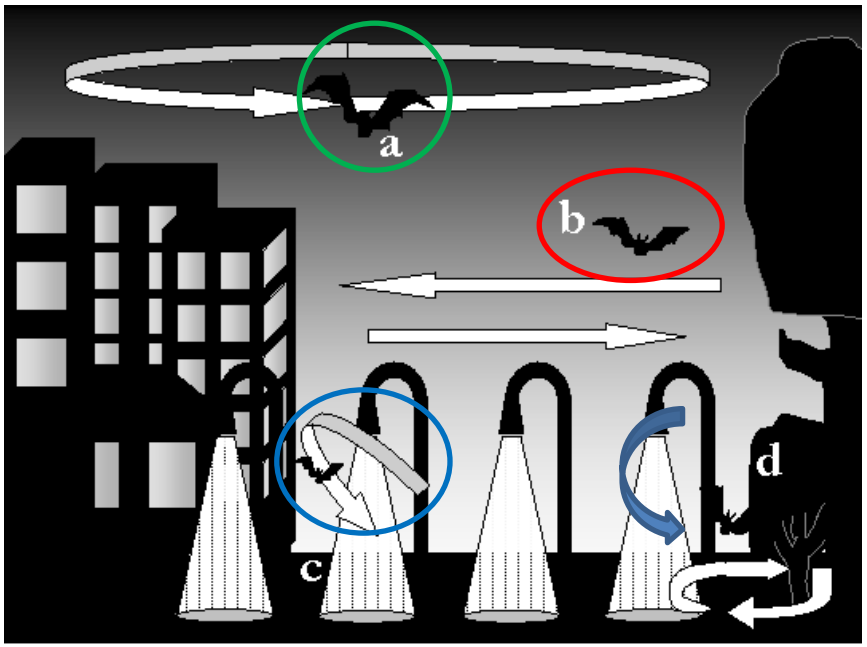
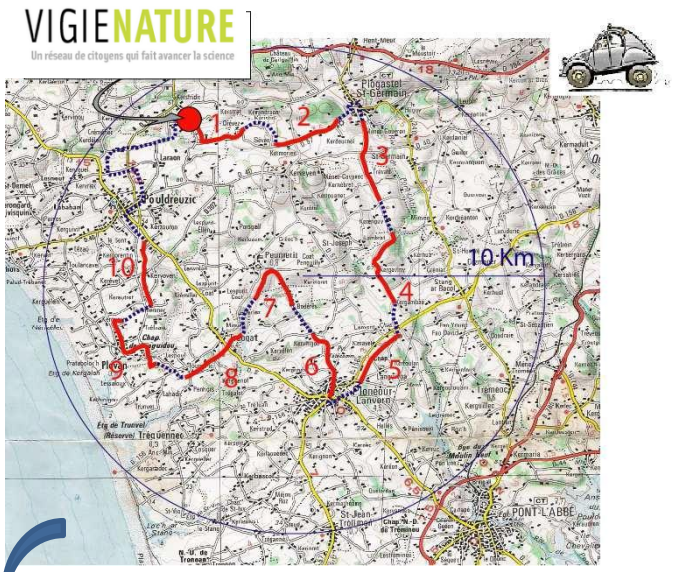
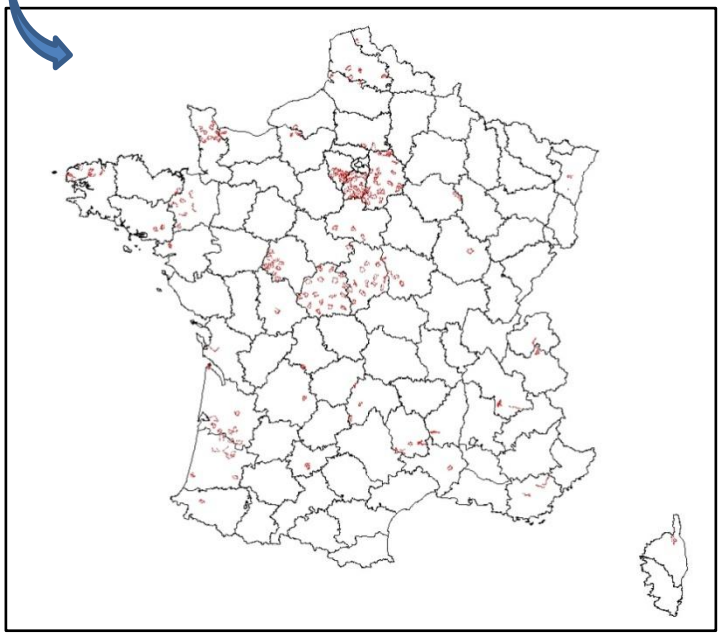


(Rydell 2006)

Increased foraging opportunities

Materials & Methods





Biological data

- **Car transects surveys**

1 circuit/night = 10 x 2 km transects

- **Constant acoustic recordings during transects**

Number of bat pass/species / transect

Standardized protocol
- ✓ Constant speed : 25 km/h
- ✓ Start30 minutes after sunset
- ✓ June/July
- ✓ T> 12°C, no wind, no rain

- From 2006 to 2013

398 circuits = 3996 transects

- **4 common species : 22 500 bat passes**

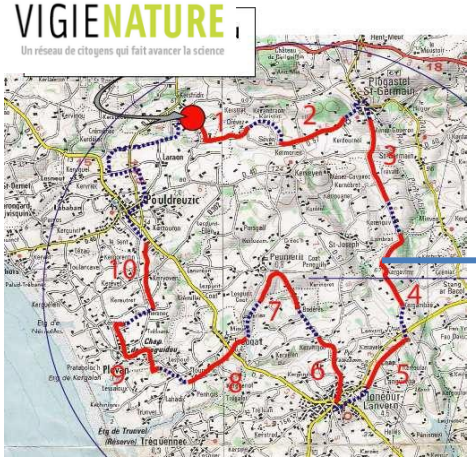
P. Pipistrellus
P. Kuhlii

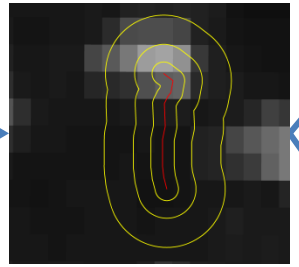
E. serotinus

N. leislerii

Materials & Methods

Environmental data



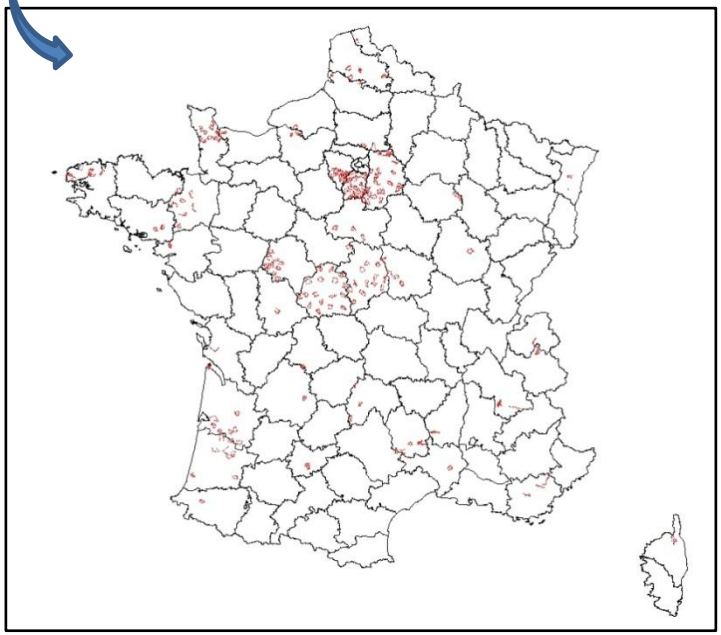


200 -500-1000 m
Buffers

VIIRS-DNB (2012)

- % of intensive agriculture
- % of impervious surface
- Average luminance

(nano-Watts/(cm2*sr)



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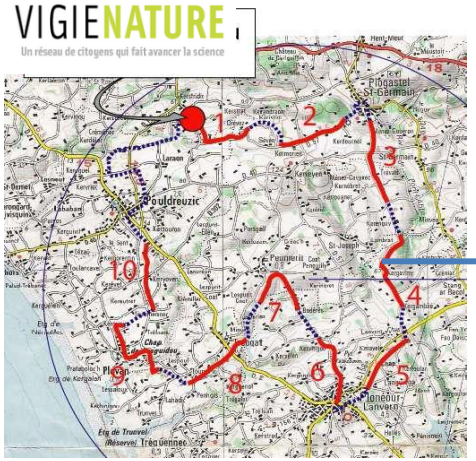

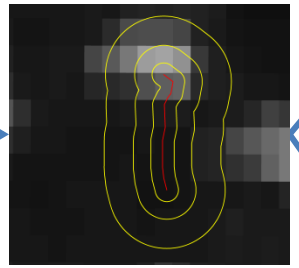

200 -500-1000 m Buffers

VIIRS-DNB (2012)

- % of intensive agriculture
- % of urban areas
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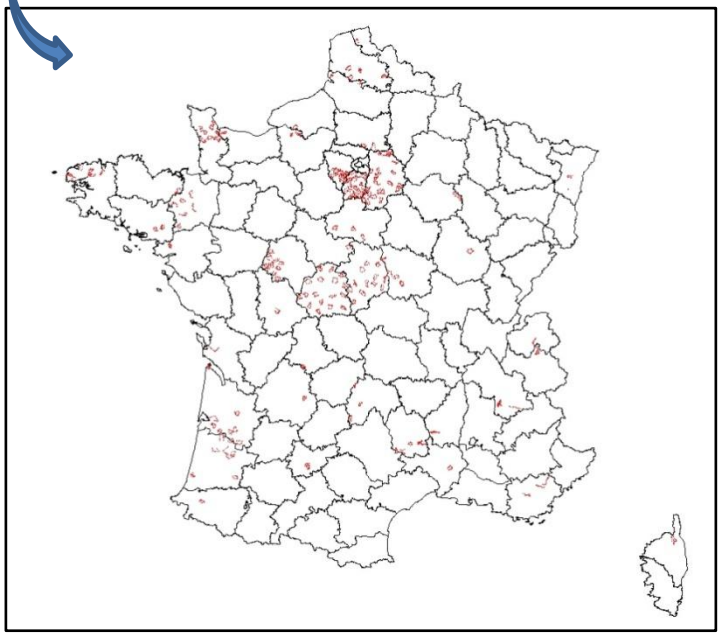
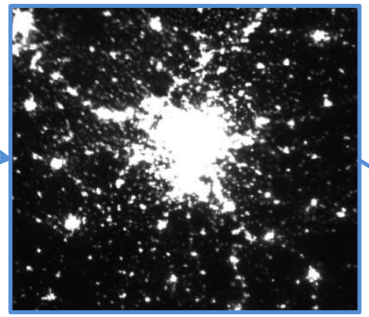


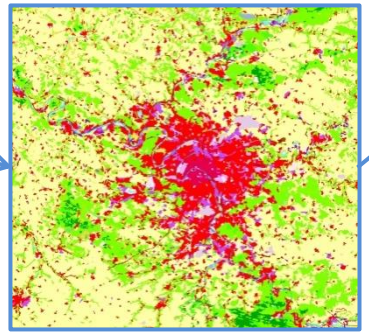
Table 1. Proportion of land cover type and luminance at the national scale and around the transects

Land cover	Continental France	Transects (200 m buffer)
% urban areas	5.2	14.4
% agriculture areas	28.1	32.5
% deciduous forests	19.9	18.6
Av luminance	3.2	2.2

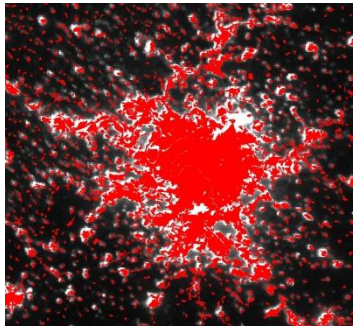
Materials and Methods



Paris by night

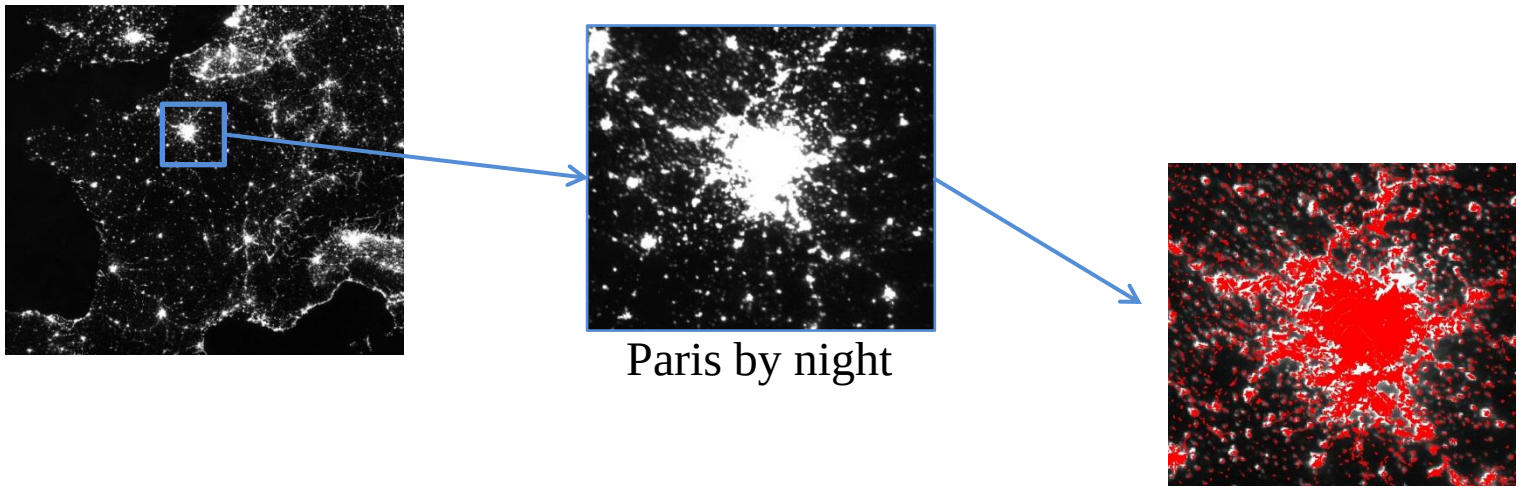


Paris conurbation



Overlap between urbanization and artificial lighting

Materials and Methods



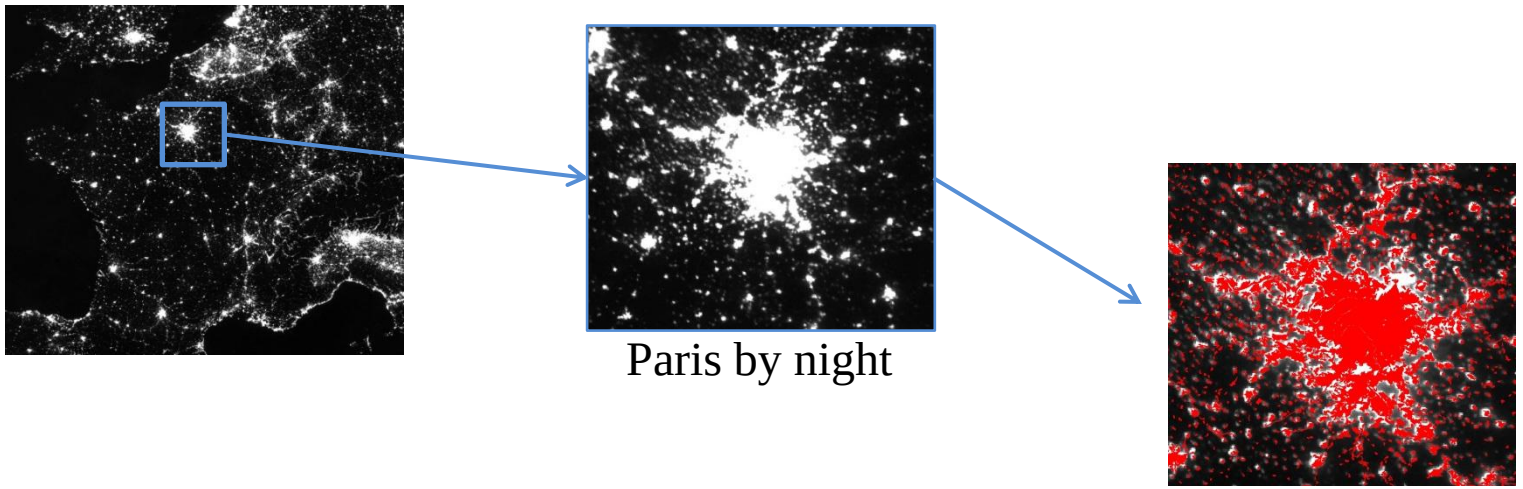
Paris by night

Overlap between urbanization and artificial lighting

- **Generalized Linear Mixed Models**
  - **Response variable:** Presence/absence of the species
  - **Fixed effects:** **Av. luminance OR % impervious surface + % agriculture** + meteorological covariables + date
  - **Random effect:** Circuit number

Ran models with all the combinations of predictors (Luminance **vs.** Impervious)

Materials and Methods



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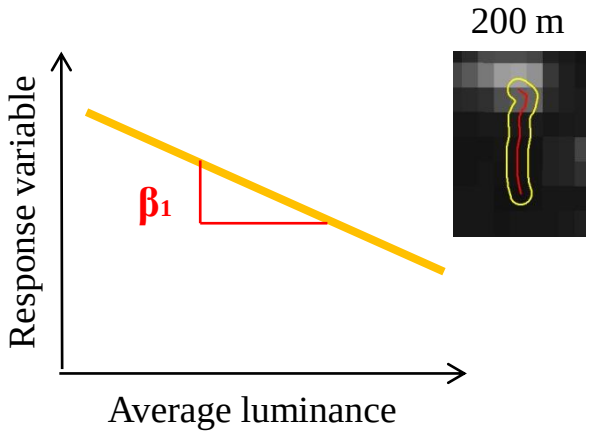
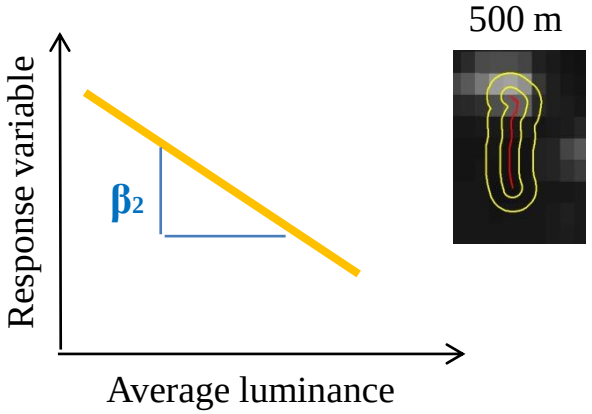
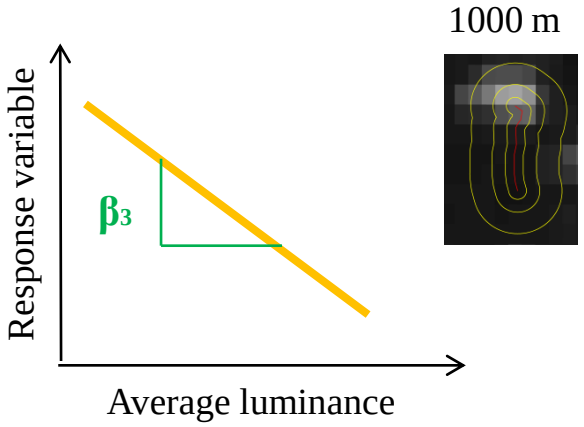
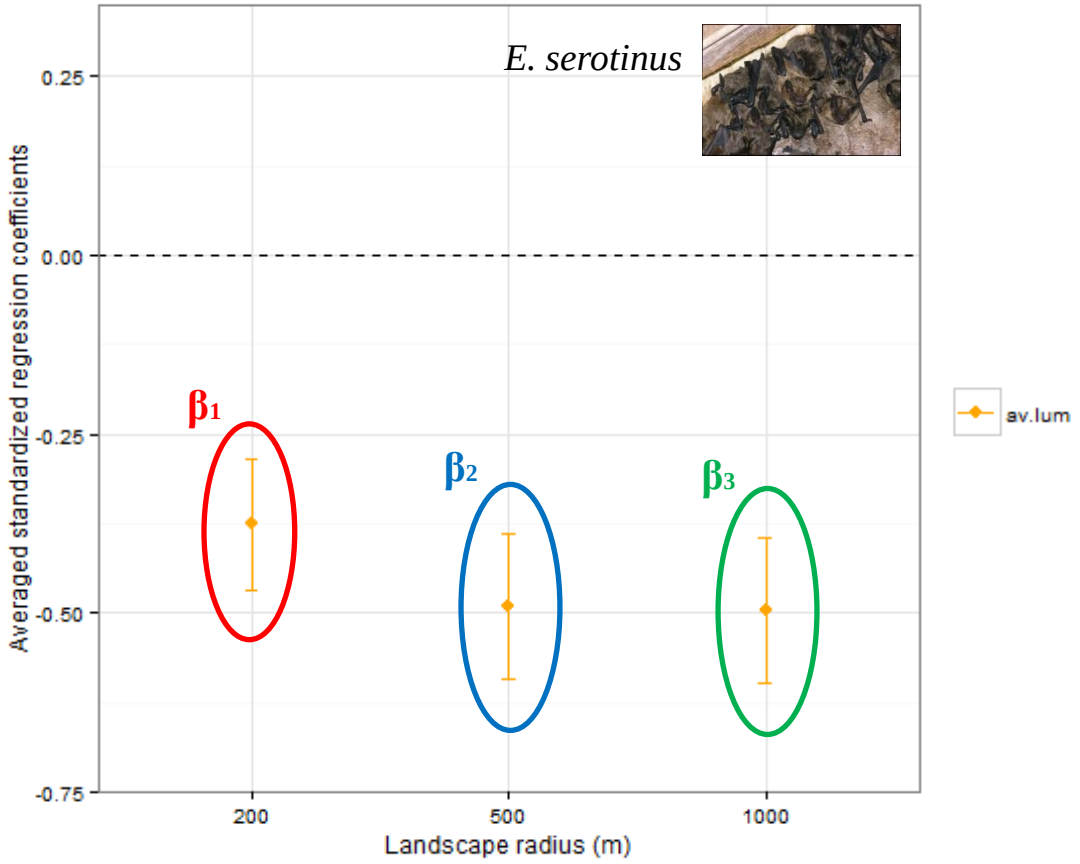
Multi-Model Averaging

Results

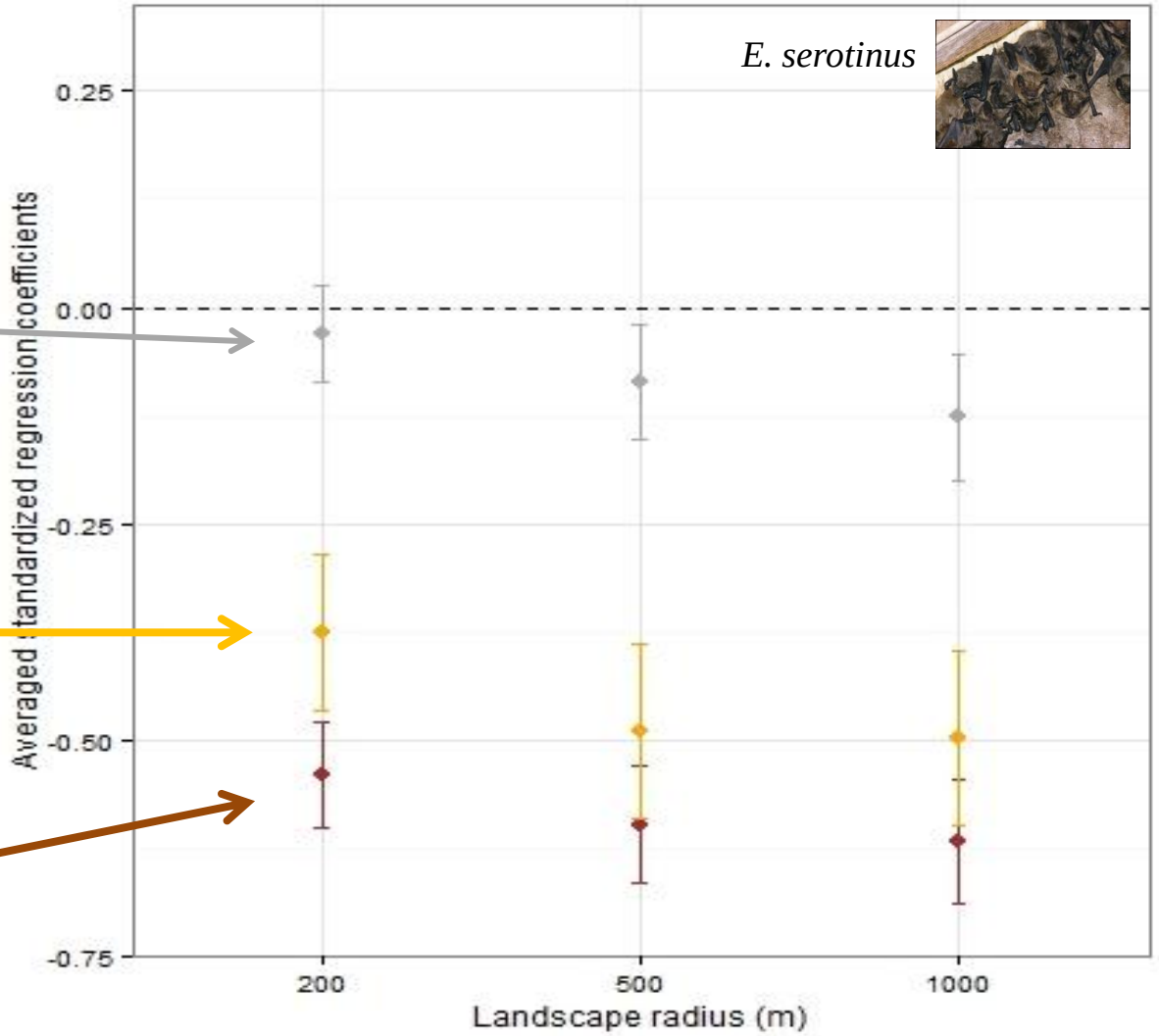

200 m
Response variable
β1
Average luminance


500 m
Response variable
β2
Average luminance


1000 m
Response variable
β3
Average luminance


E. serotinus
Averaged standardized regression coefficients
0.25
0.00
-0.25
-0.50
-0.75
β1
β2
β3
200
500
1000
Landscape radius (m)
av.lum

Results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%agri
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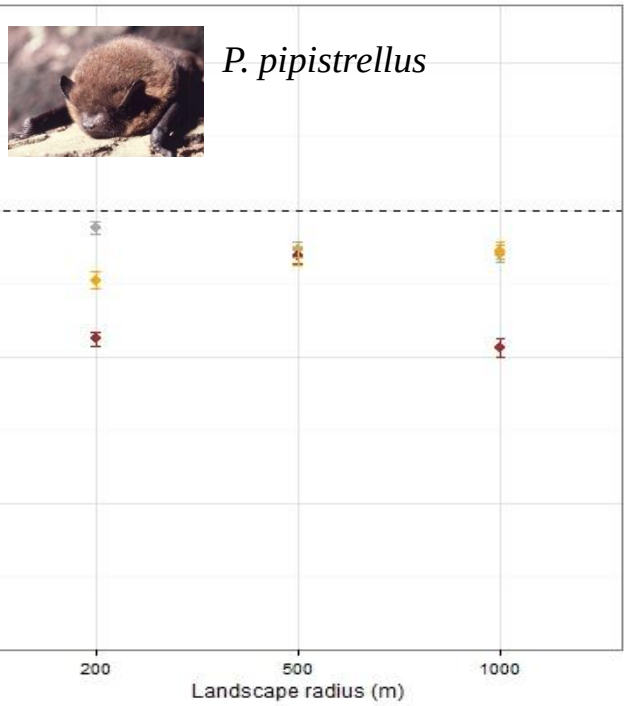
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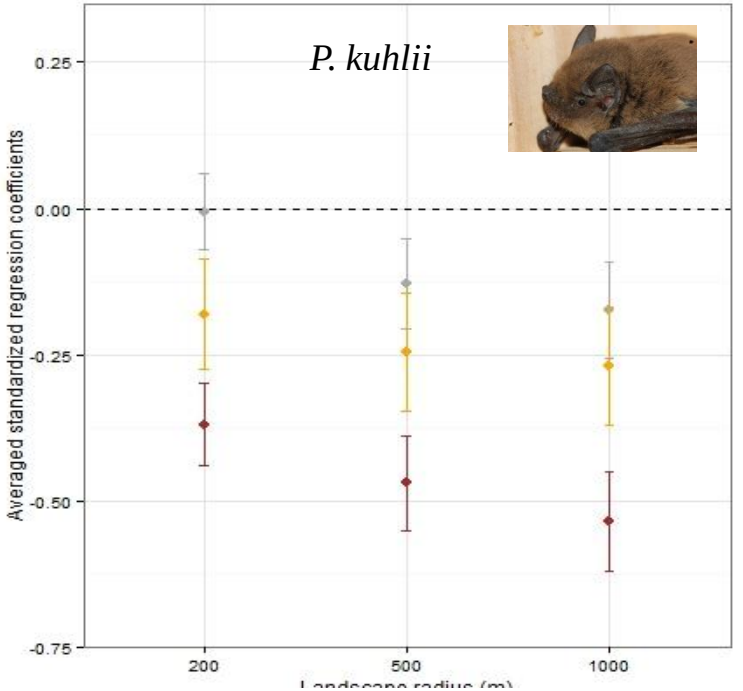
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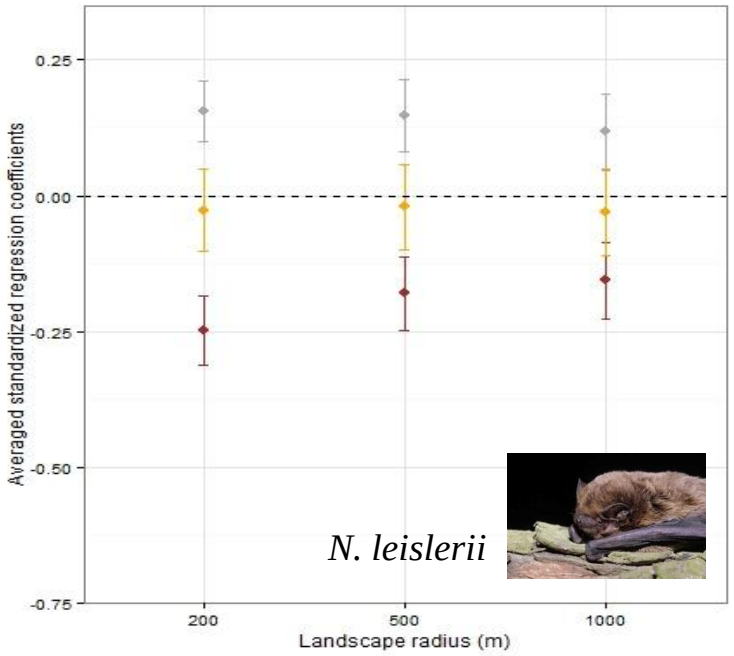
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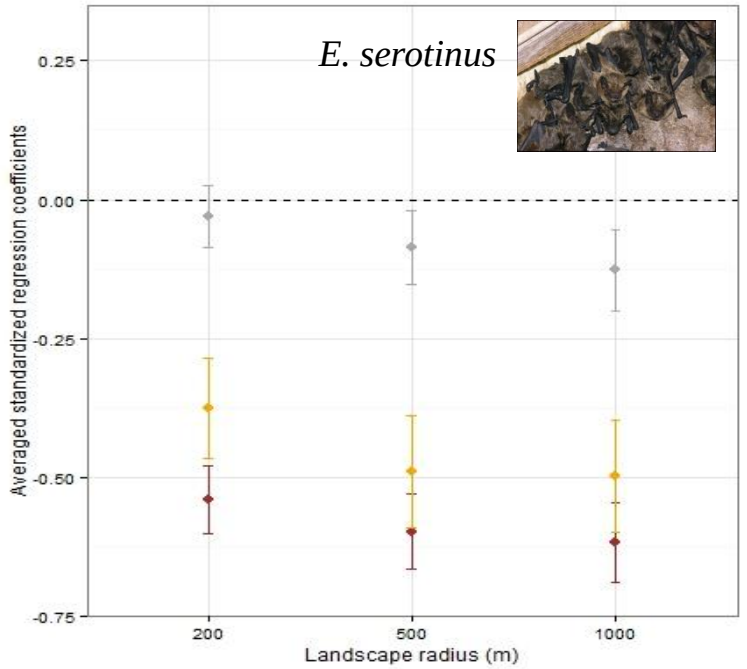
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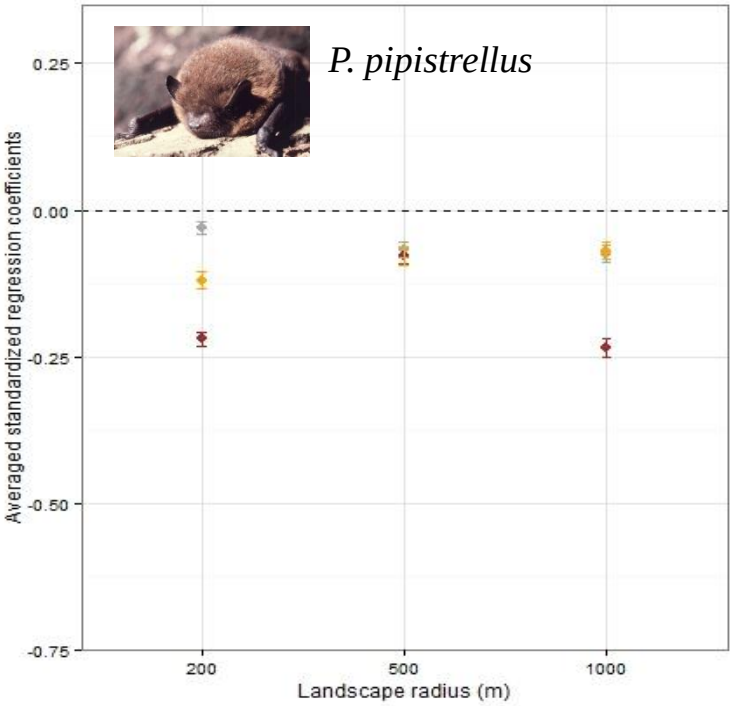

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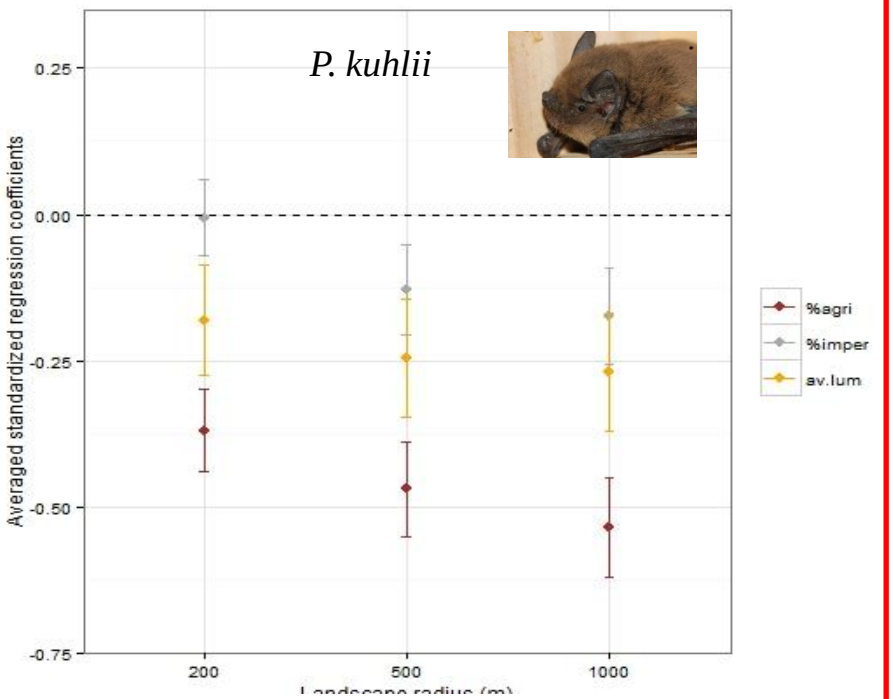

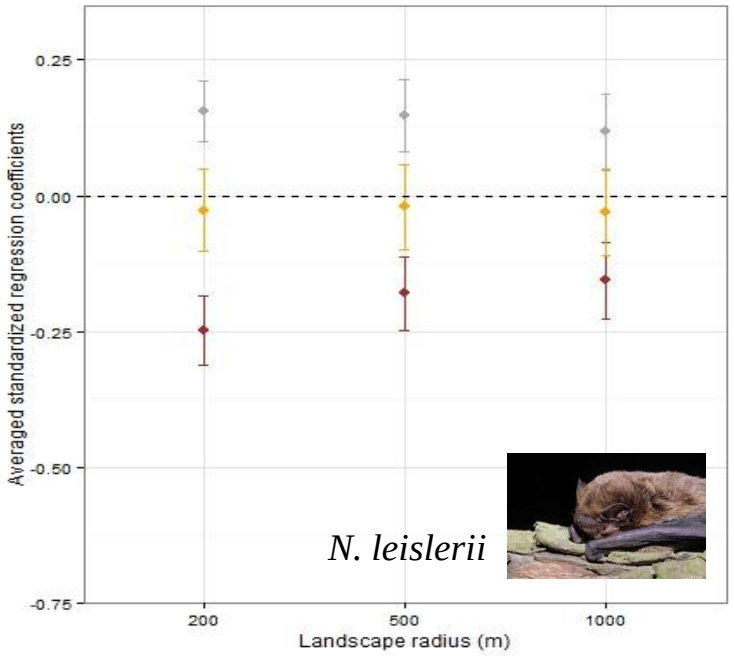

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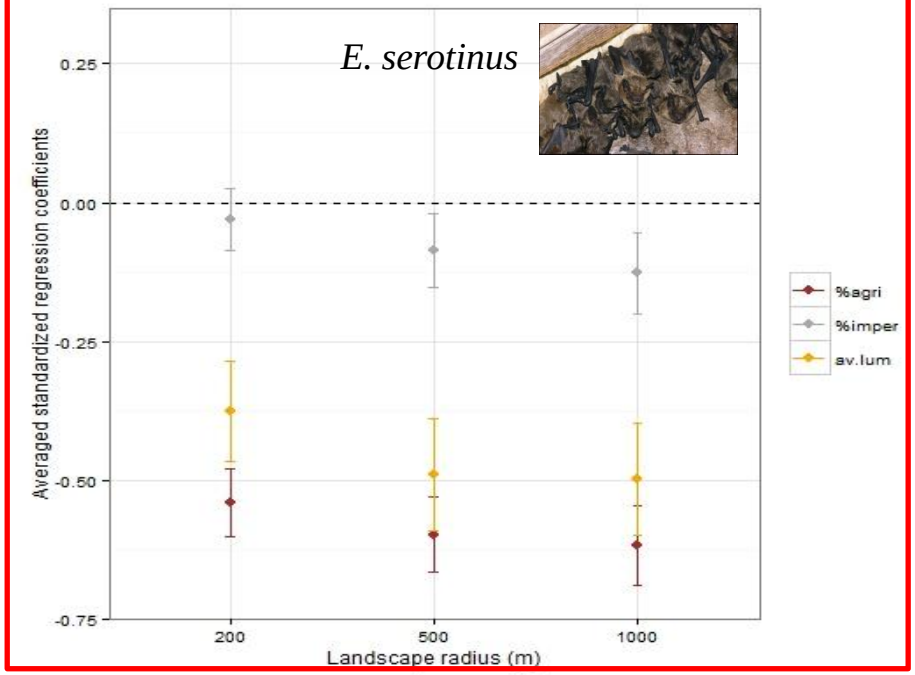

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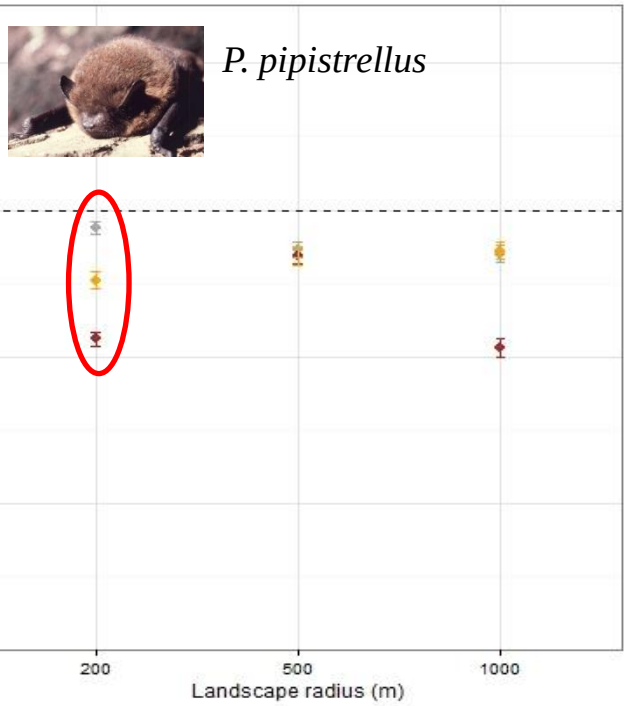
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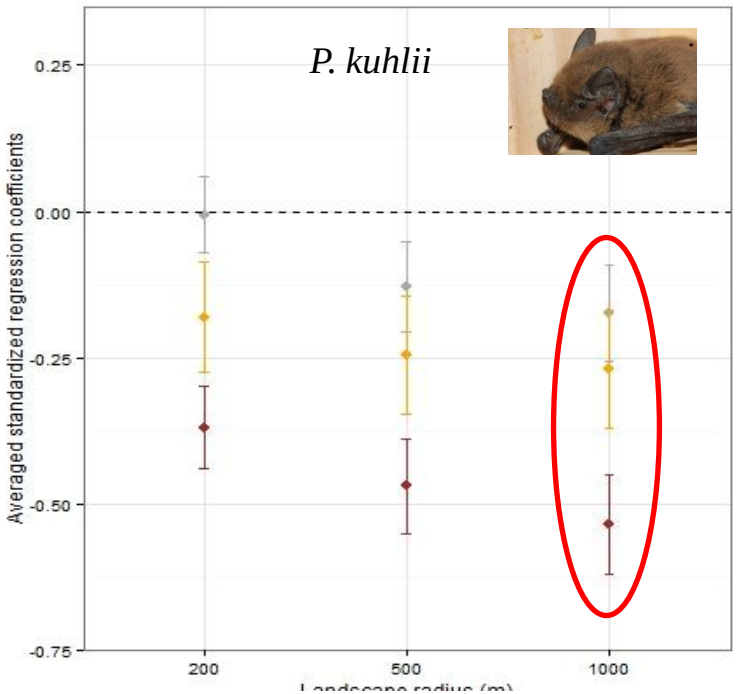
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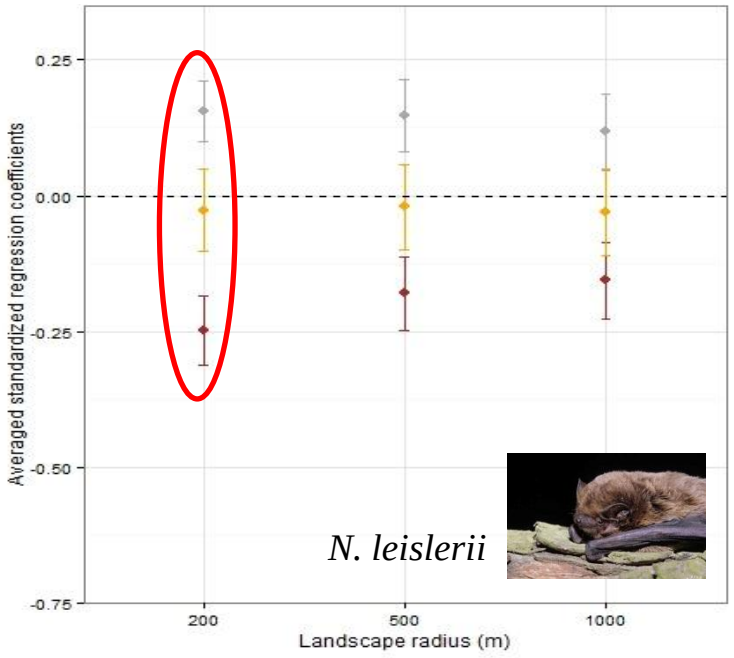
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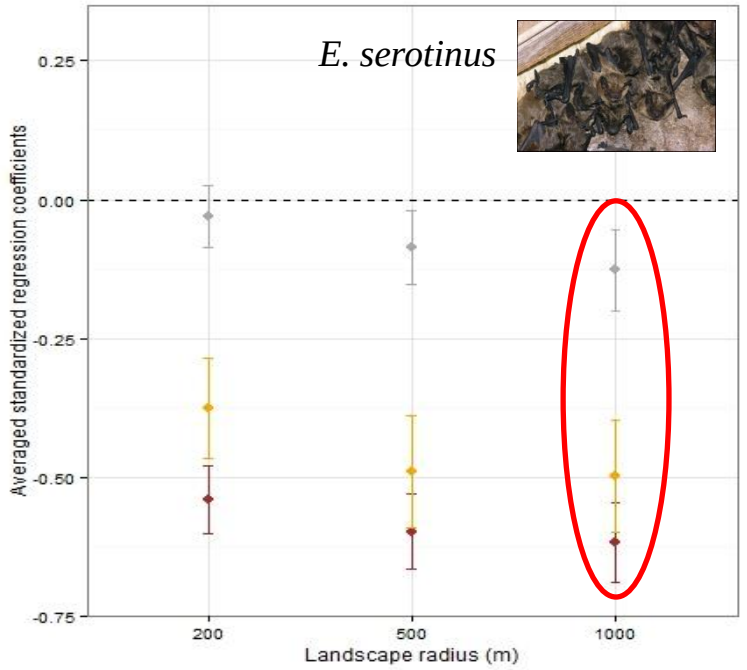
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Discussion

- ALAN have a significant negative effect on 3 species of bats at almost all spatial scales
- The strength of each species response depended of the spatial scale considered

➡ Evidence of landscape-scale effects of ALAN on bats

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- ALAN have a significant negative effect on 3 species of bats at almost all spatial scales
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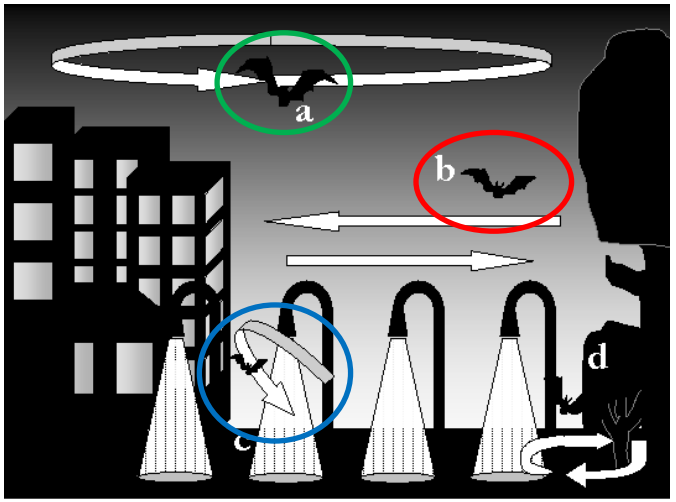
➡ Evidence of landscape-scale effects of ALAN on bats

- Large scale negative effect on "light-attracted species"

Rapid declines of common, widespread British moths provide evidence of an insect biodiversity crisis

Kelvin F. Conrad[a,*], *Martin S. Warren*[b], *Richard Fox*[b], *Mark S. Parsons*[a], *Ian P. Woiwod*[a]

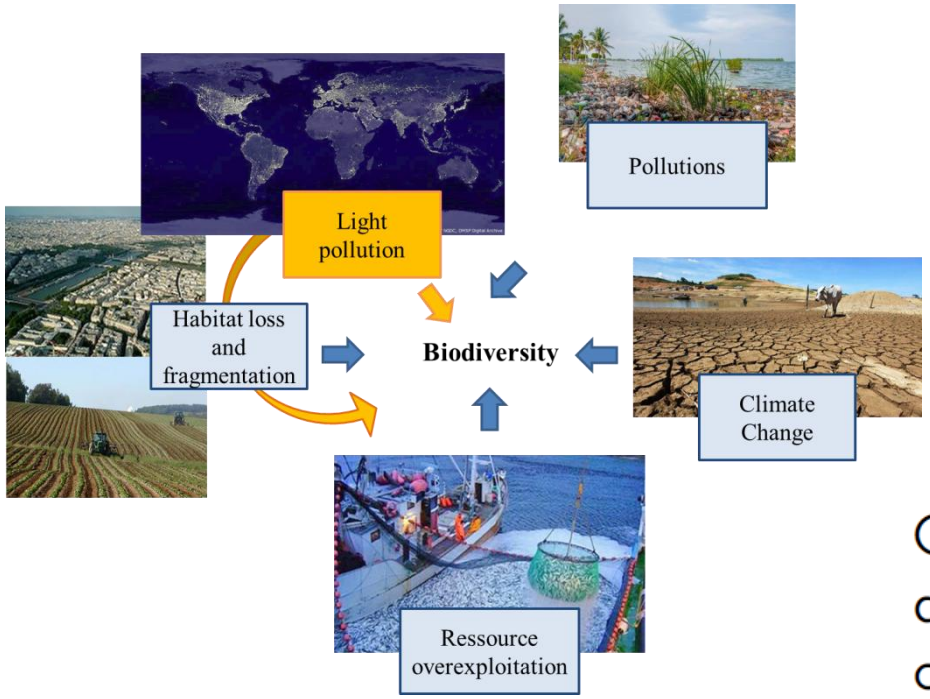
[a]Rothamsted Research, Plant and Invertebrate Ecology, West Common, Harpenden, Hertfordshire AL5 2JQ, UK
[b]Butterfly Conservation, Manor Yard, East Lulworth, Wareham, Dorset BH20 5QP, UK



(Rydell 2006)

➕ Downs *et al.* 2003; Hale *et al*. 2015

Discussion



Contrasting trends in light pollution across Europe based on satellite observed night time lights

Jonathan Bennie, Thomas W. Davies, James P. Duffy, Richard Inger & Kevin J. Gaston

- **Opportunities exist to reduce light pollution!**
  - dimming lighting
  - lighting spectrum
  - part-night lighting
  - dark sky reserve
  - etc.

Any questions?

CESCO
Centre d'Écologie et des Sciences de la Conservation

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Nathalie De Lacoste
Arthur Vernet

cazam@mnhn.fr