



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



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îledeFrance



CESCO

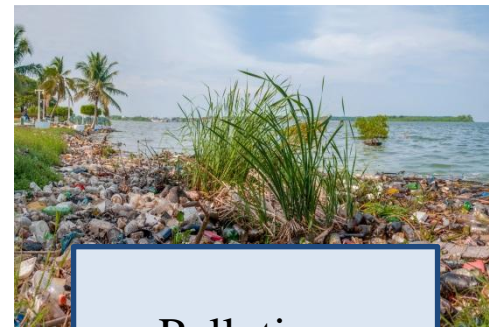
Centre d'Écologie et des
Sciences de la Conservation

Contact: cazam@mnhn.fr

Introduction

Has the Earth's sixth mass extinction already arrived?

Anthony D. Barnosky^{1,2,3}, Nicholas Matzke¹, Susumu Tomiya^{1,2,3}, Guinevere O. U. Wogan^{1,3}, Brian Swartz^{1,2}, Tiago B. Quental^{1,2,4}, Charles Marshall^{1,2}, Jenny L. McGuire^{1,2,3,5}, Emily L. Lindsey^{1,2}, Kaitlin C. Maguire^{1,2}, Ben Mersey^{1,4} & Elizabeth A. Ferrer^{1,2}



Pollutions



Climate Change

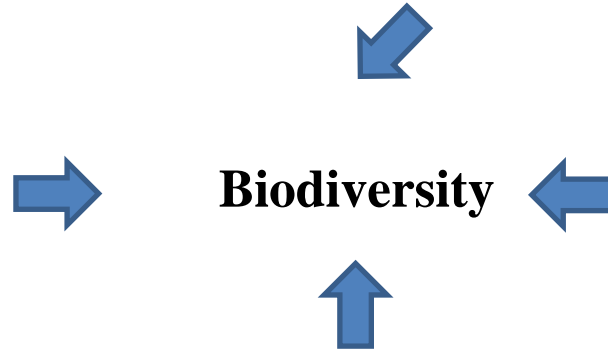


Ressource overexploitation

Habitat loss and fragmentation



Biodiversity



Introduction

Letters

Light pollution as a biodiversity threat

Franz Hölker¹, Christian Wolter¹, Elizabeth K. Perkin^{1,2} and Klement Tockner^{1,2}

Sensory Ecology: Night Lights Alter Reproductive Behavior of Blue Tits

Travis Longcore

Street Lighting Disturbs Commuting Bats

Emma Louise Stone,^{1,*} Gareth Jones,^{1,*} and Stephen Harris¹

Street lighting changes the composition of invertebrate communities



Thomas W. Davies*, Jonathan Bennie and Kevin J. Gaston

The effects of artificial lighting on adult aquatic and terrestrial insects

ELIZABETH K. PERKIN^{*,1}, FRANZ HÖLKER* AND KLEMENT TOCKNER^{*,2}

Sleepless in Town – Drivers of the Temporal Shift in Dawn Song in Urban European Blackbirds

Anja Nordt*, Reinhard Klenke

Experimental illumination of natural habitat—an experimental set-up to assess the direct and indirect ecological consequences of artificial light of different spectral composition

Kamiel Spoelstra¹, Roy H. A. van Grunsven², Maurice Donners³, Phillip Gienapp¹, Martinus E. Huigens⁴, Roy Slaterus⁵, Frank Berendse², Marcel E. Visser¹ and Elmar Veenendaal²

Effect of spectral composition of artificial light on the attraction of moths

Frank van Langevelde^a, Jody A. Ettema^{a,b}, Maurice Donners^c, Michiel F. WallisDeVries^{b,d}, Dick Groenendijk^{b,*}

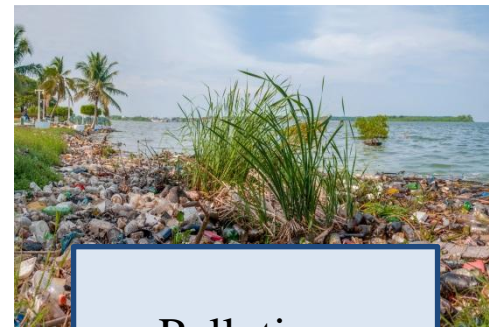
Artificial light puts ecosystem services of frugivorous bats at risk

Daniel Lewanzik^{1,2*} and Christian C. Voigt^{1,2}

The nature, extent, and ecological implications of marine light pollution

Thomas W Davies*, James P Duffy, Jon Bennie, and Kevin J Gaston

Introduction



Pollutions

Light
pollution

Habitat loss
and
fragmentation

Biodiversity

Climate
Change

Ressource
overexploitation



Introduction



vs.



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

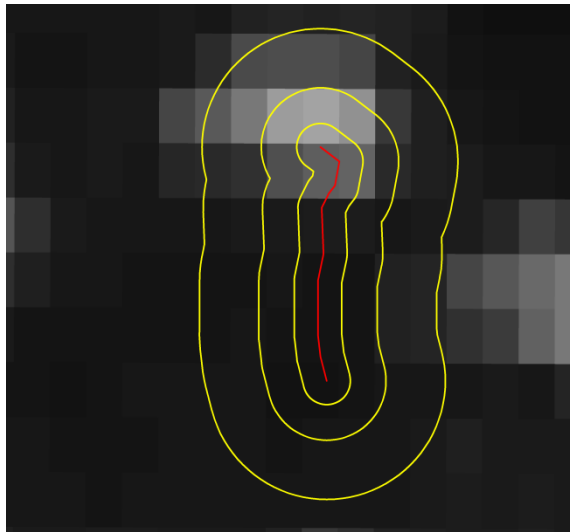
Introduction



vs.



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



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

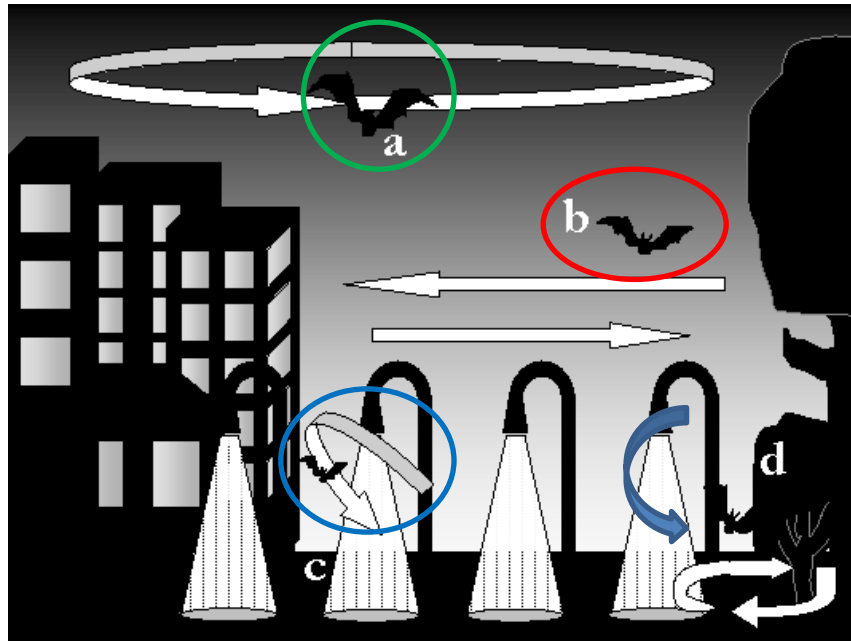
To determine the **spatial extent** at which a given population can be affected by ALAN

Introduction

- Model species: 4 common species of bats



©Laurent Arthur



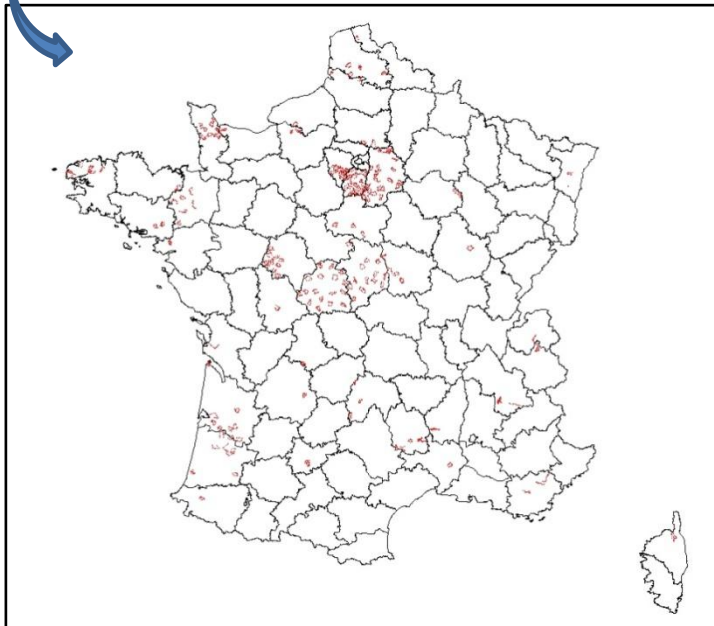
(Rydell 2006)



Increased foraging opportunities

Materials & Methods

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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
- ✓ Start 30 minutes after sunset
- ✓ June/July
- ✓ $T > 12^{\circ}\text{C}$, no wind, no rain

- From 2006 to 2013
398 circuits = 3996 transects
- **4 common species : 22 500 bat passes**



P. Pipistrellus
P. Kuhlii



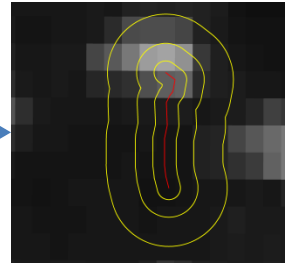
E. serotinus



N. leislerii

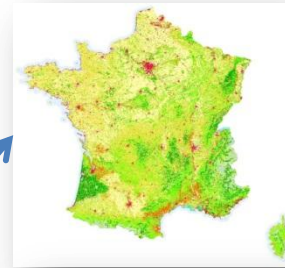
Materials & Methods

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200 -500-1000 m
Buffers

Environmental data



➤ % of intensive agriculture

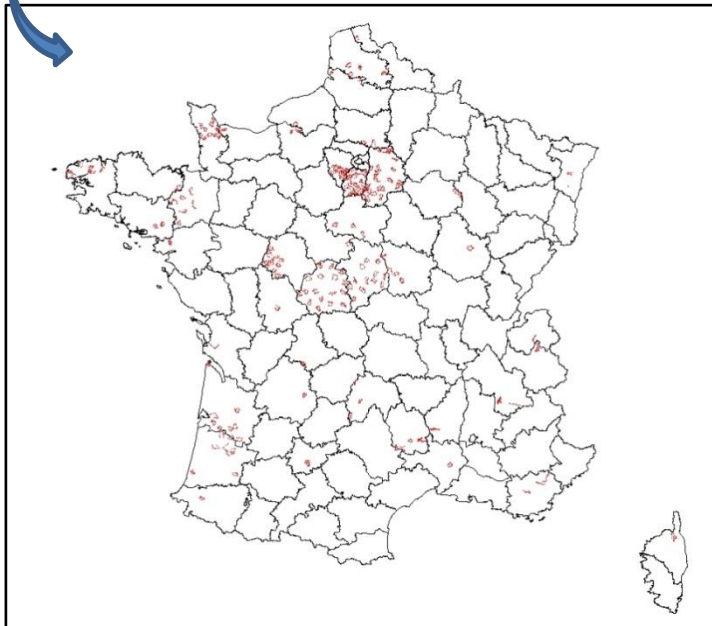
➤ % of impervious surface

➤ Average luminance

(nano-Watts/(cm²*sr))

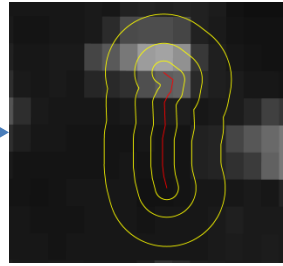


VIIRS-DNB (2012)



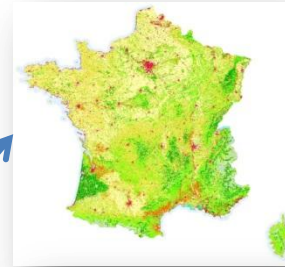
Materials & Methods

VIGIENATURE
Un réseau de citoyens qui fait avancer la science



200 -500-1000 m
Buffers

Environmental data



➤ % of intensive agriculture

➤ % of urban areas

➤ Average luminance

(nano-Watts/(cm²*sr))



VIIRS-DNB (2012)

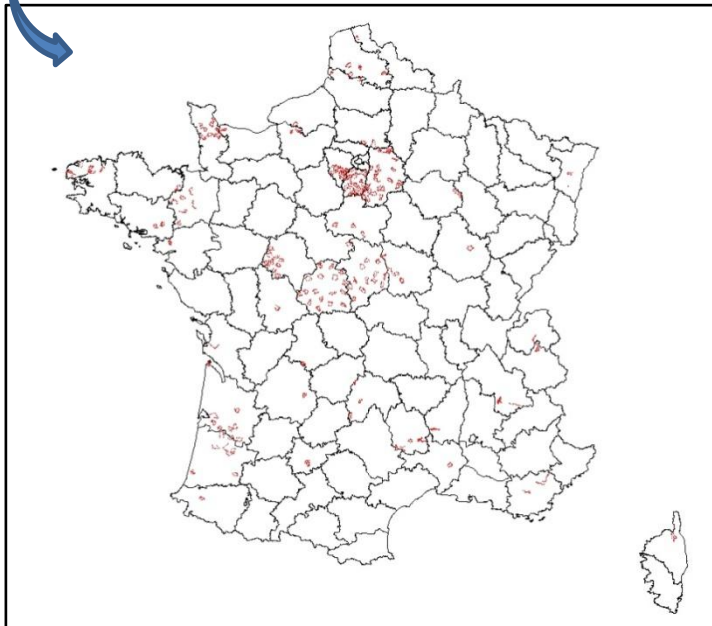
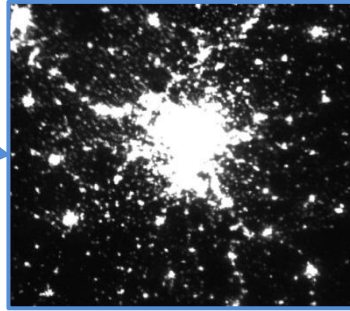


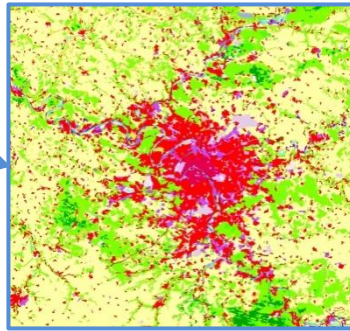
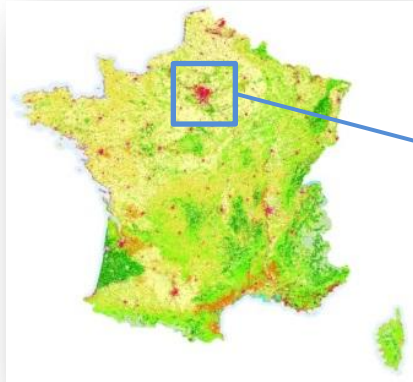
Table 1. Proportion of land cover type and luminance at the national scale and around the transects

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

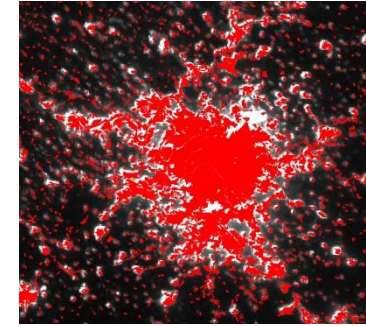
Materials and Methods



Paris by night

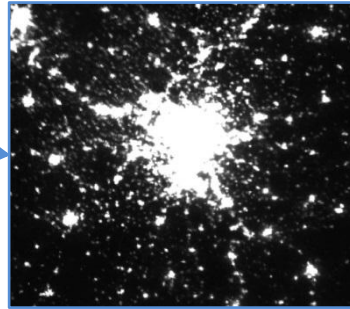


Paris conurbation

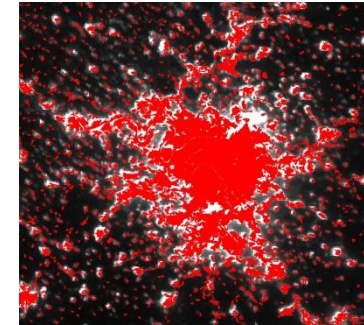


Overlap between urbanization
and artificial lighting

Materials and Methods



Paris by night



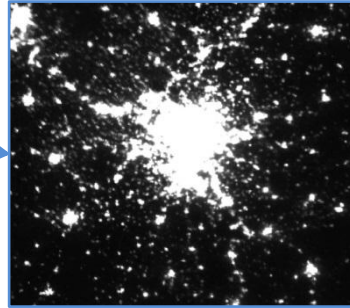
Overlap between urbanization and artificial lighting

➤ Generalized Linear Mixed Models

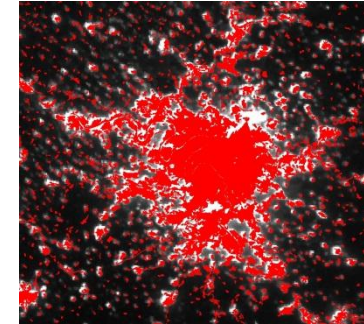
- **Response variable:** Presence/absence of the species
- **Fixed effects:** **Av. luminance** **OR** **% impervious surface + % agriculture**
+ meteorological covariables + date
- **Random effect:** Circuit number

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

Materials and Methods



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**

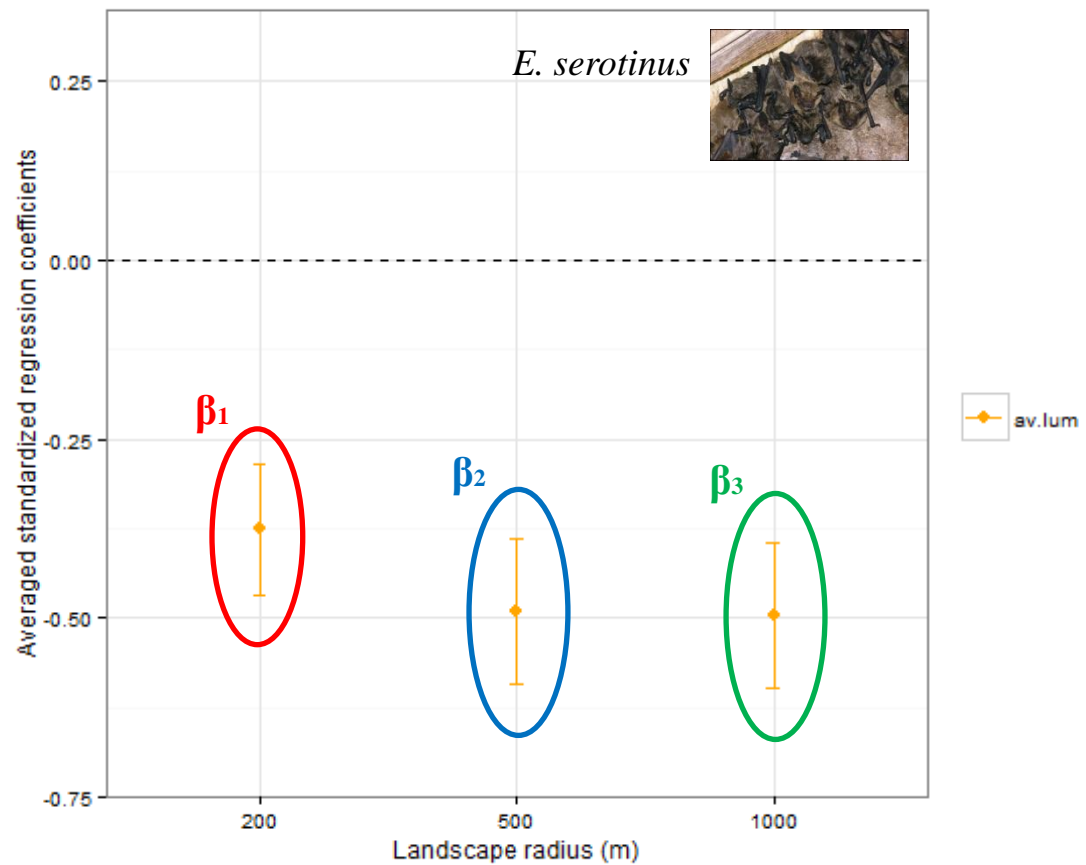
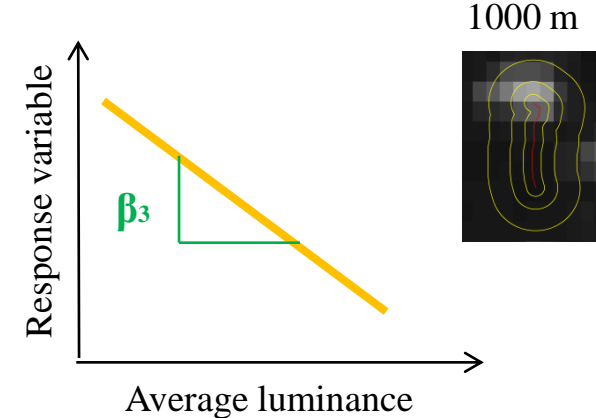
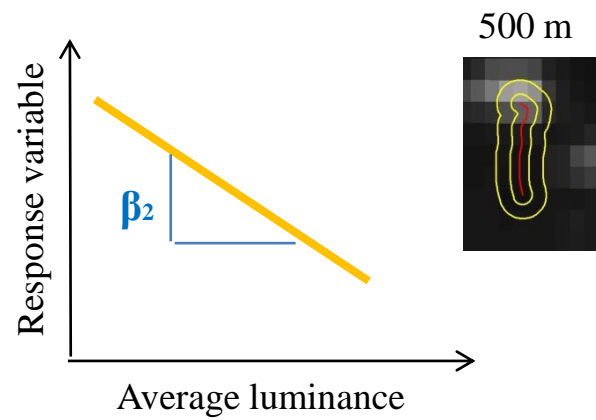
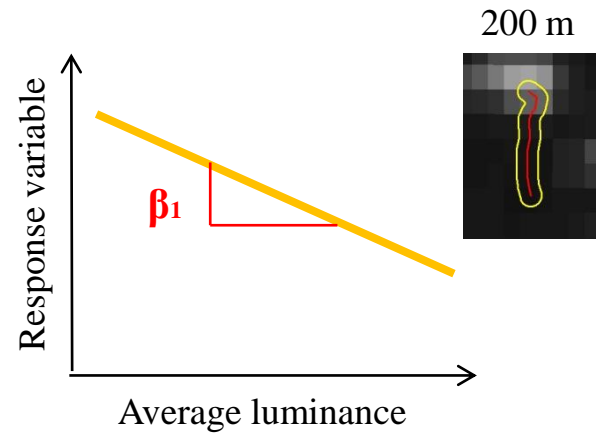
+ meteorological covariables + date

➤ **Random effect:** Circuit number

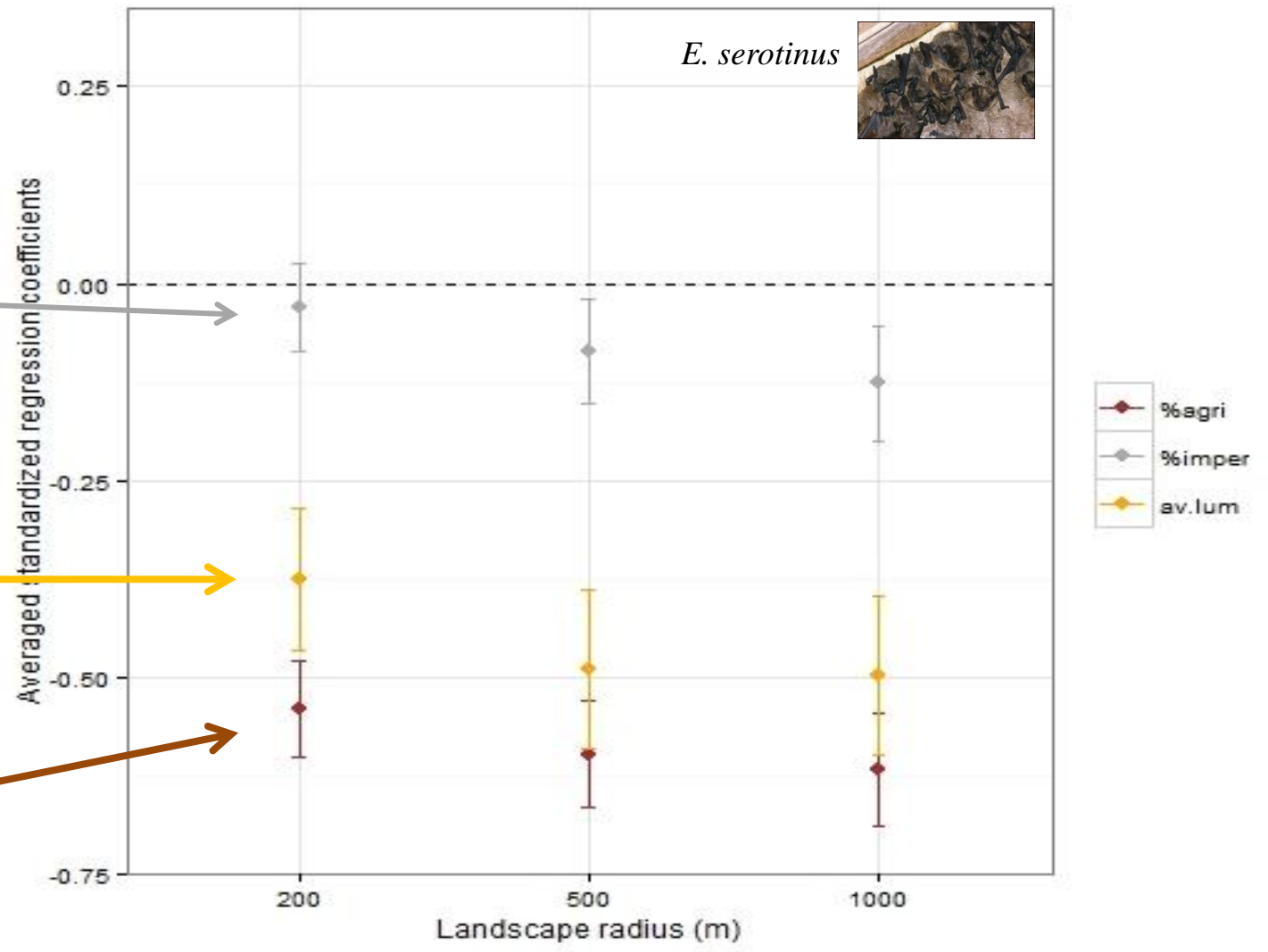
Ran models with **all the combinations of predictors** (Luminance **vs.** Impervious)

➤ **Multi-Model Averaging**

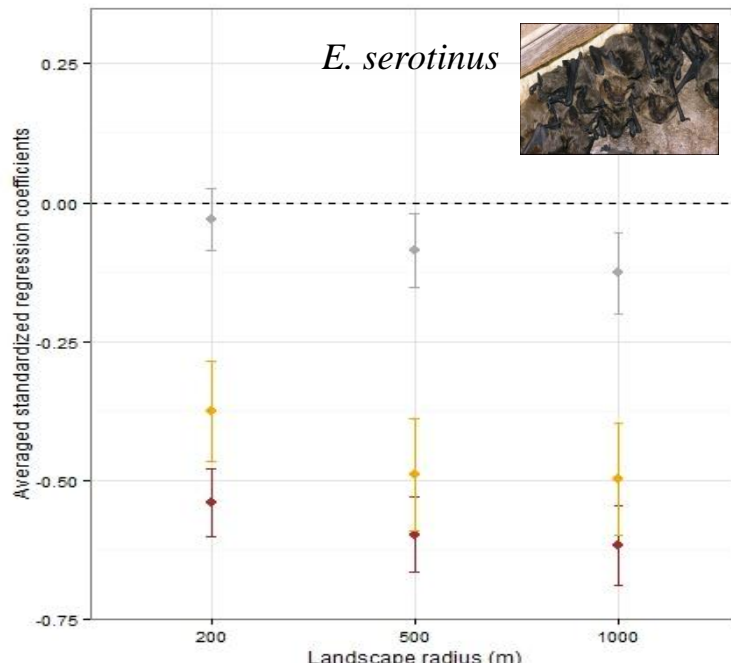
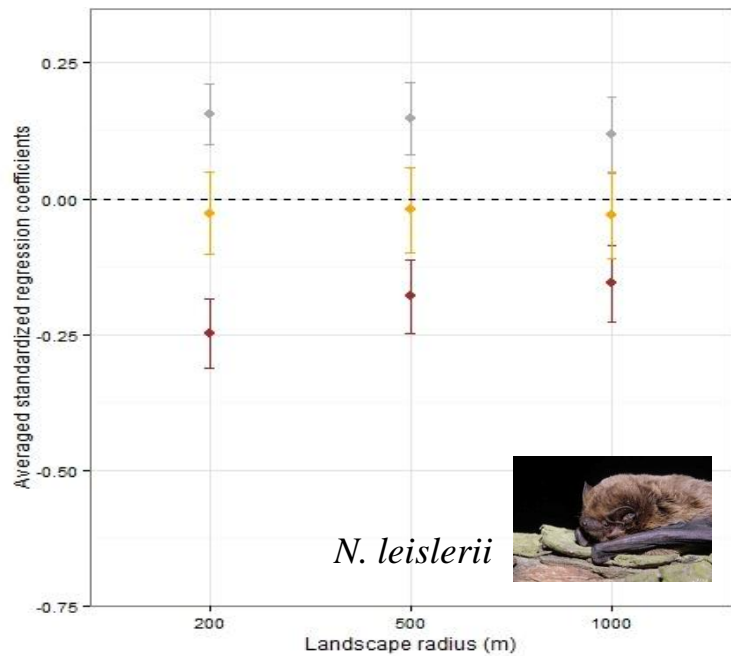
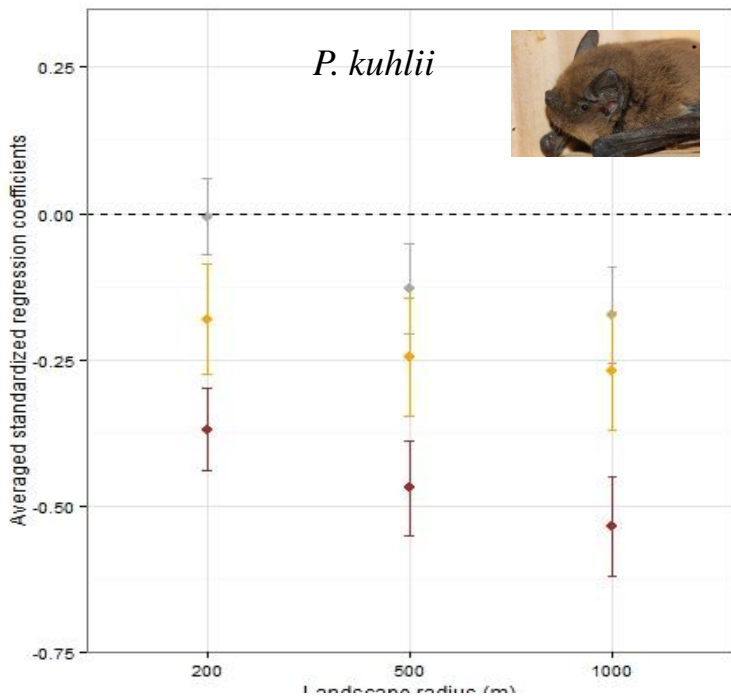
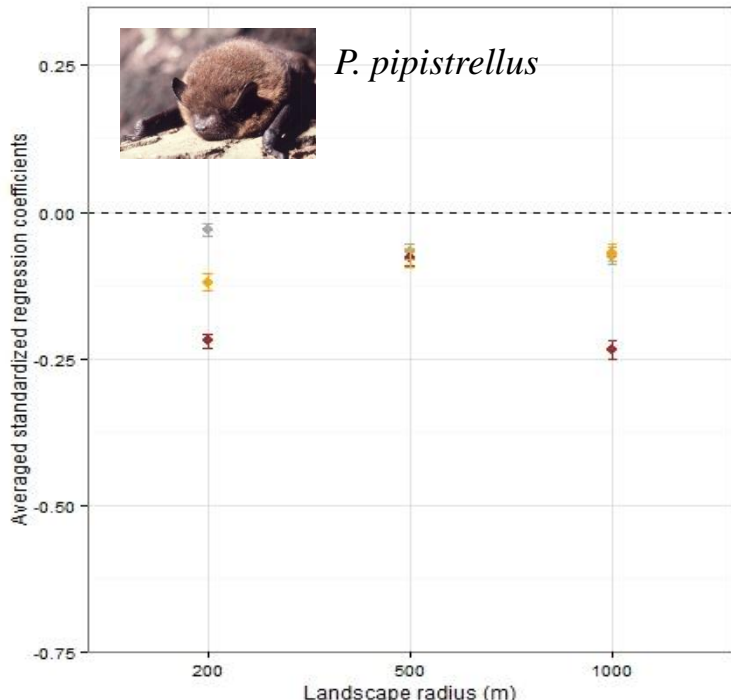
Results



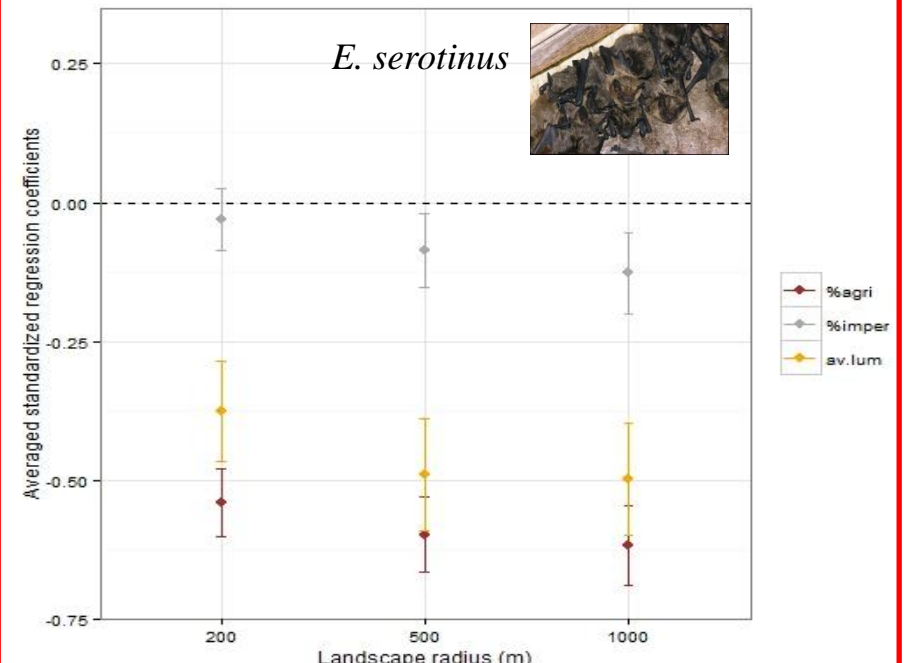
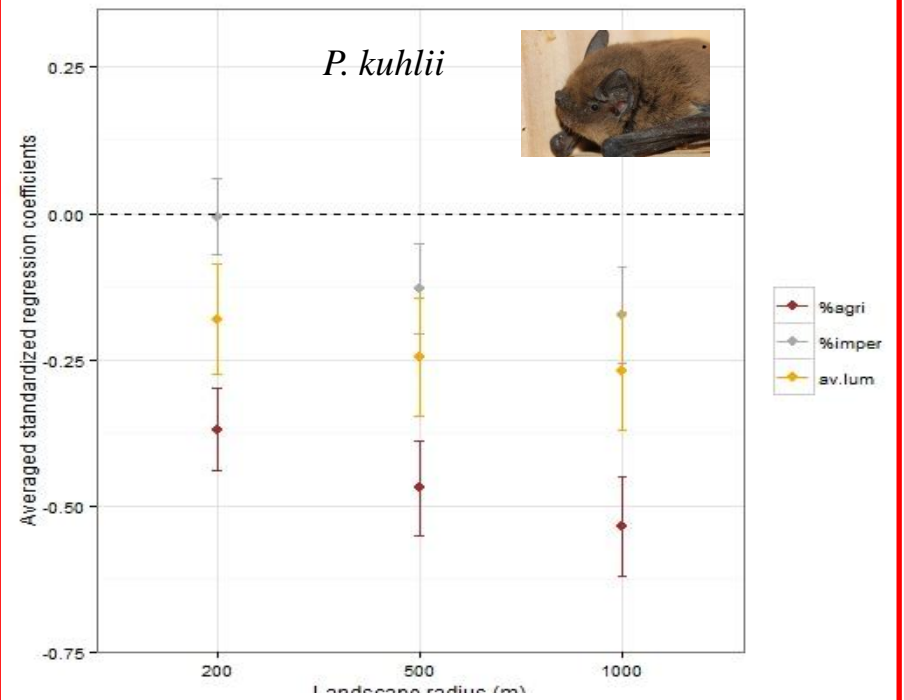
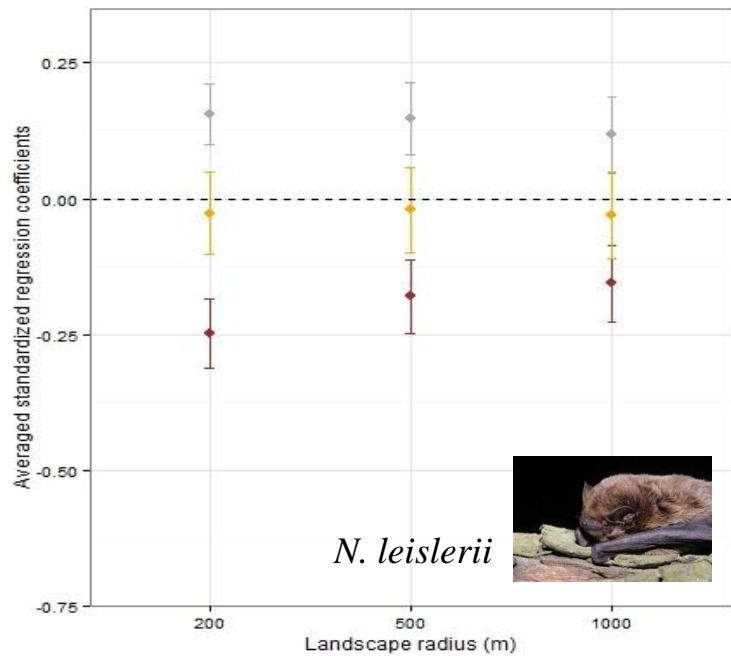
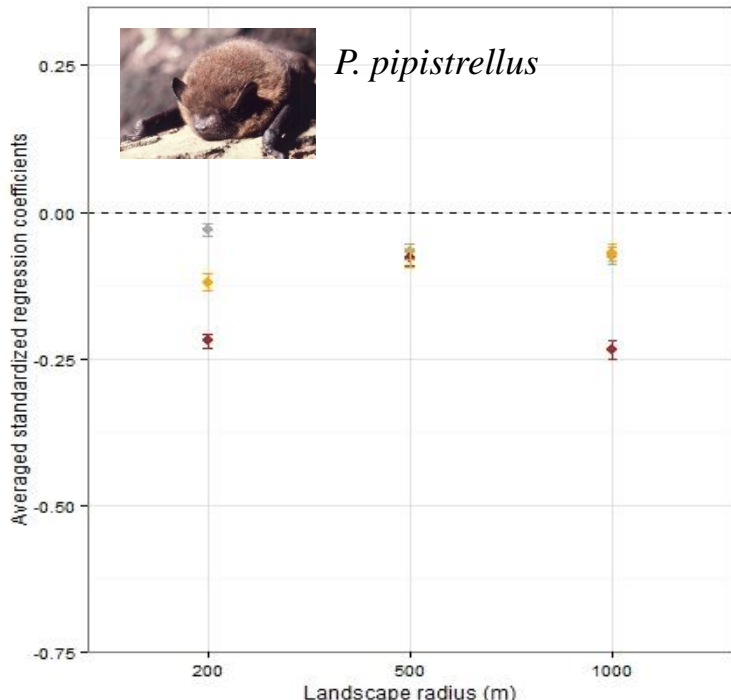
Results



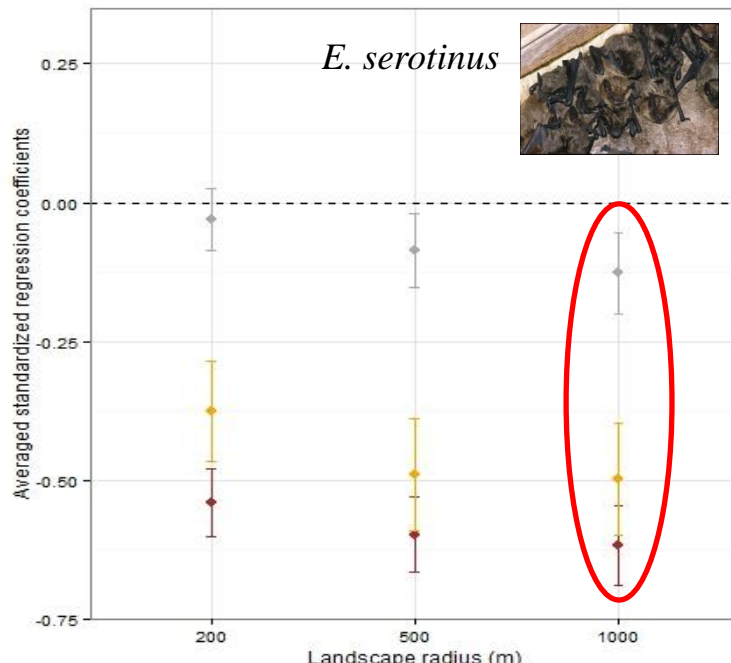
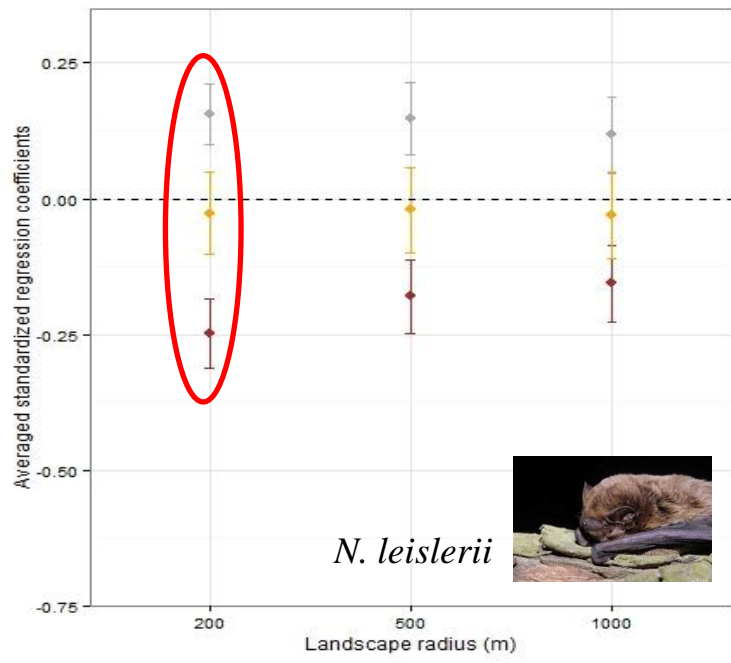
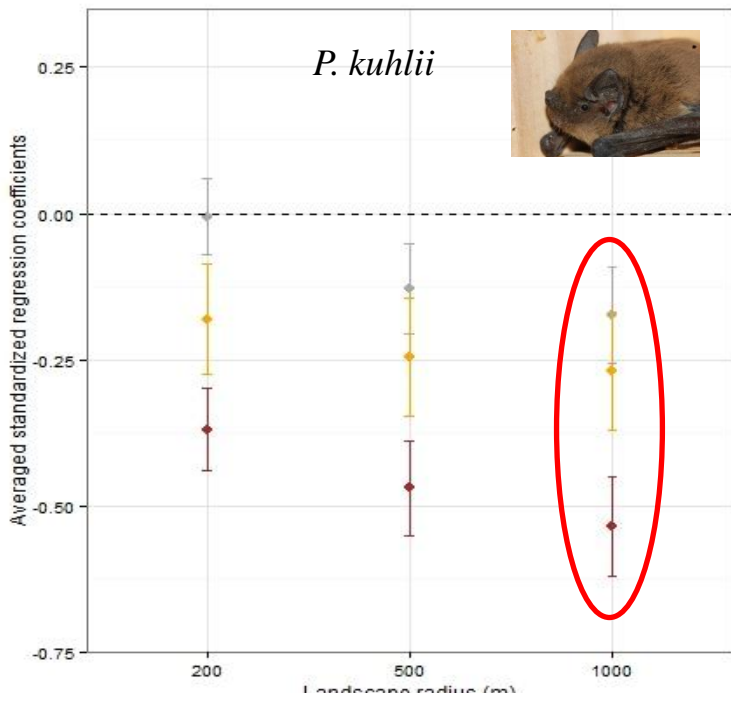
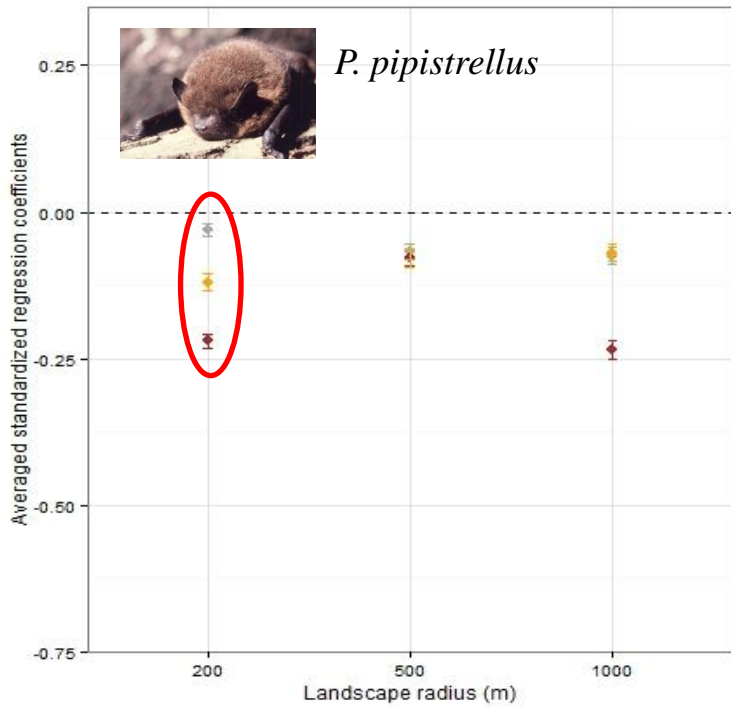
Results



Results



Results



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

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

- Large scale negative effect on “light-attracted species”

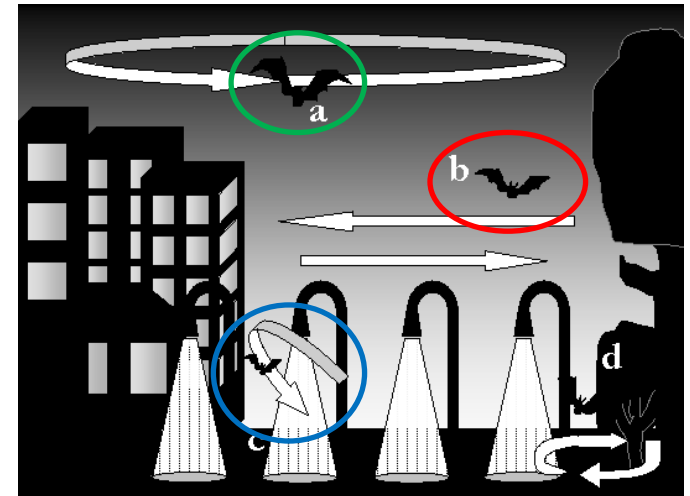
Rapid declines of common, widespread British moths provide evidence of an insect biodiversity crisis

Kelvin F. Conrad^{a,*}, Martin S. Warren^b, Richard Fox^b, Mark S. Parsons^a, Ian P. Woiwod^a

^aRothamsted Research, Plant and Invertebrate Ecology, West Common, Harpenden, Hertfordshire AL5 2JQ, UK

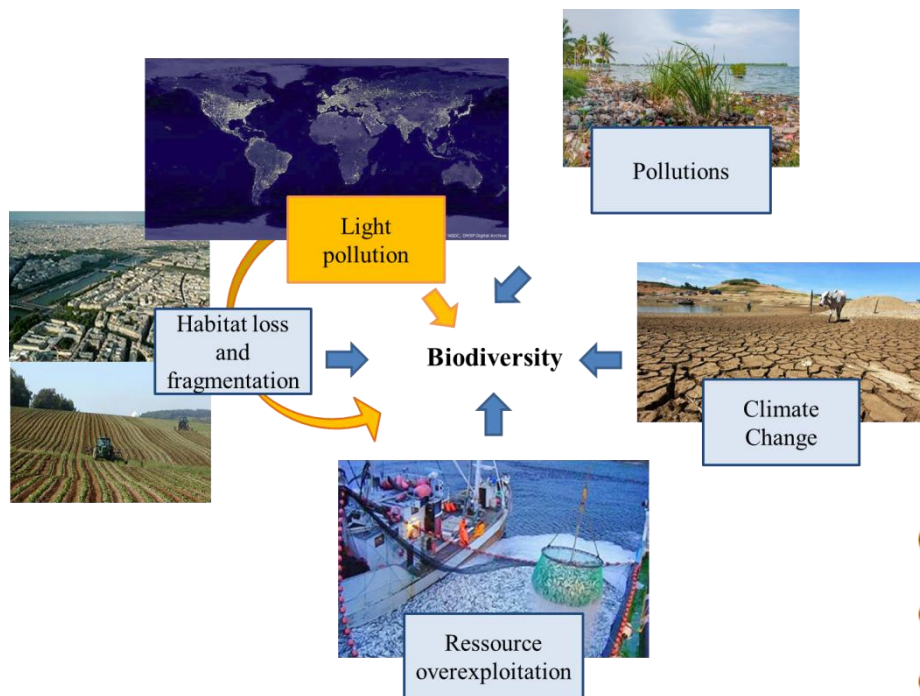
^bButterfly Conservation, Manor Yard, East Lulworth, Wareham, Dorset BH20 5QP, UK

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



(Rydell 2006)

Discussion



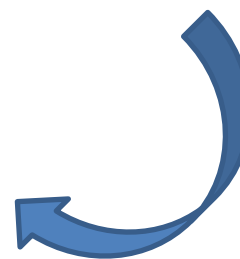
Contrasting trends in light pollution across Europe based on satellite observed night time lights

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?



Acknowledgements:

All the participants of the Vigie Chiro survey

The screenshot shows the VIGIE NATURE website interface. At the top, the logo 'VIGIE NATURE' is displayed with the tagline 'Un réseau de citoyens qui fait avancer la science'. Below the logo are links for 'LE SITE' and 'LE BLOG', and a Facebook icon. A navigation bar lists various categories: 'Nos observatoires', 'POUR TOUS', 'NATURALISTES', 'GESTIONNAIRES D'ESPACES', 'AGRICULTEURS', 'ENSEIGNANTS', and 'VIGIE-MANIP'. On the left, a sidebar menu highlights 'VIGIE-NATURE' and 'NATURALISTES', with a list of observation programs including 'Suivi Hivernal des Oiseaux Communs (SHOC)', 'Suivi Temporel des Libellules (STELI)', 'Suivi Temporel des Oiseaux Communs (STOC)', 'Suivi Temporel des Rhopalocères de France (STERF)', 'Suivi des Orthoptères Nocturnes (SON)', and 'Vigie-Chiro'. The 'Vigie-Chiro' section is expanded, showing sub-links for 'Participer', 'Protocoles', 'Aides et Guides', 'Résultats', 'Publications', 'Liens', and 'Vigie-Flore'. The main content area is titled 'Vigie-Chiro' and 'Suivre les populations de chauves souris en France'. It includes a paragraph of text about the 34 species of bats in France and a photograph of a bat in flight against a dark background.

**Yves Bas
Nathalie De Lacoste
Arthur Vernet**

cazam@mnhn.fr