

# Effects of urban growth on bats in Kent, UK

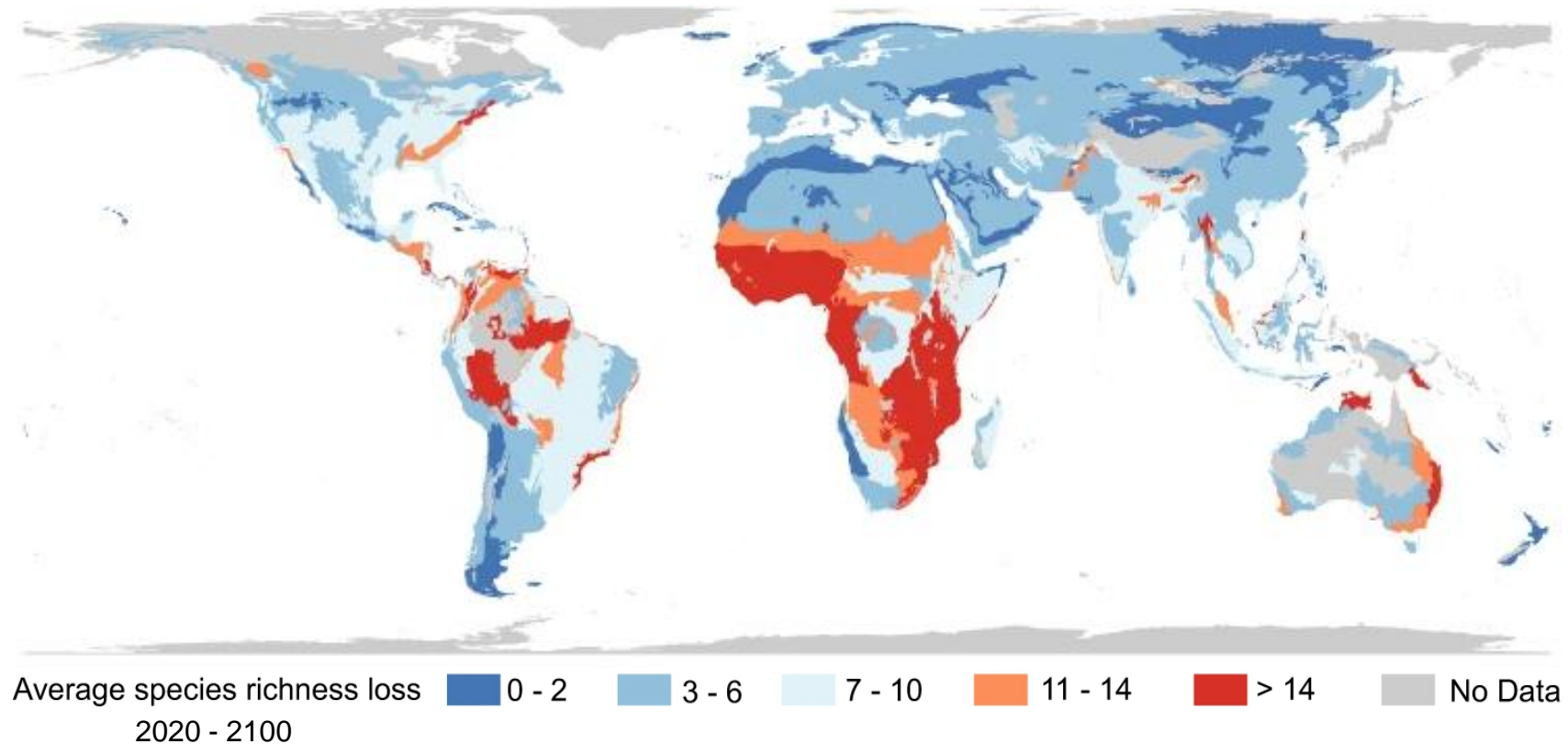
Daisy Jowers

Primary Supervisor: Dr Jim Labisko

Secondary Supervisor: Dr Ella Browning



# Biodiversity is globally threatened by urban growth



# Bats can act as indicators of wider population trends

- Increasingly easy to monitor.
- Successfully used for other ecological changes.
- Monitored across the UK and the EU.
- More knowledge required in urban landscapes.



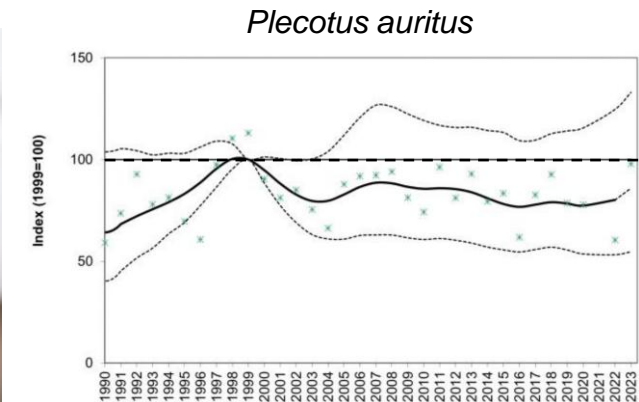
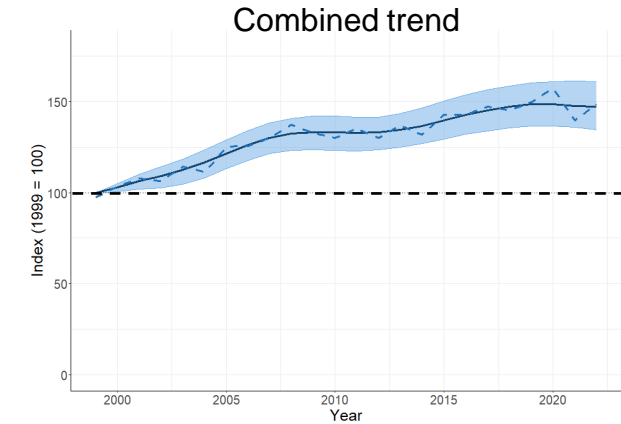
Russo et al. (2021) *Do We Need to Use Bats as Bioindicators?* (Review)

Hill et al. (2018) *AudioMoth: Evaluation of a smart open acoustic device for monitoring biodiversity and the environment.*

Gibb et al. (2019) *Emerging opportunities and challenges for passive acoustics in ecological assessment and monitoring.*

# A brief overview of British bats

- 18 species (17 breeding).
- Overall UK population trend is positive.
- Variation across species.
- Limited knowledge of some species.



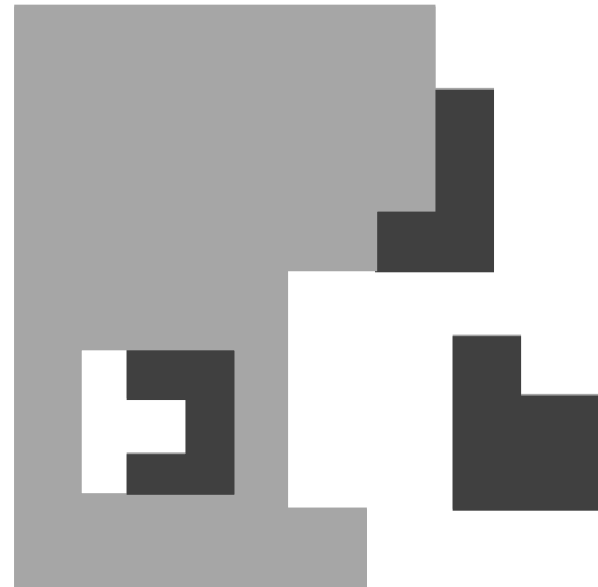
# Three hypotheses about urban growth effects

**H1: Urban Extent**



Extent

**H2: Urban Growth**



New Extent

**H3: Pattern of Urban Growth**



Infilling  
Edge Expansion  
Outlying

# 43 years of unexamined citizen science data



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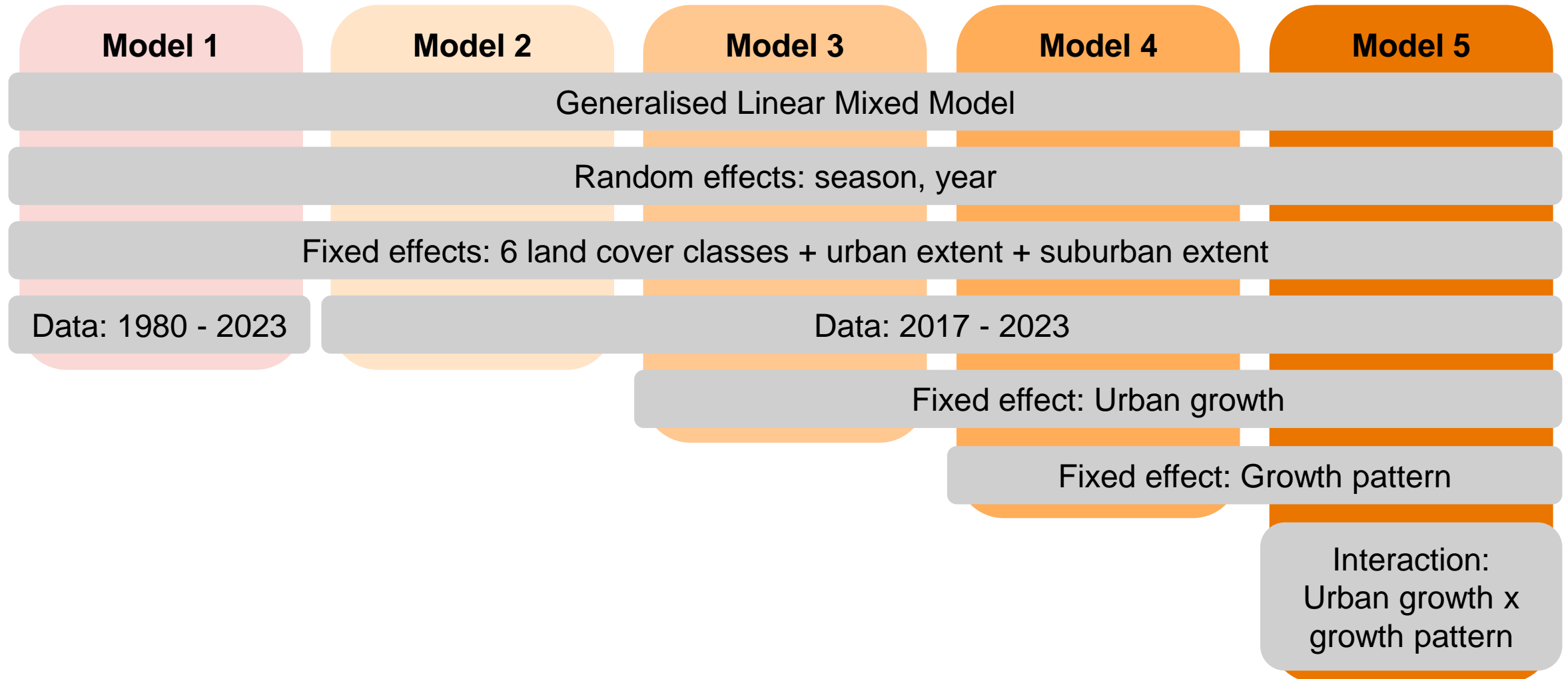
24,783 unique  
observations

1980 - 2023



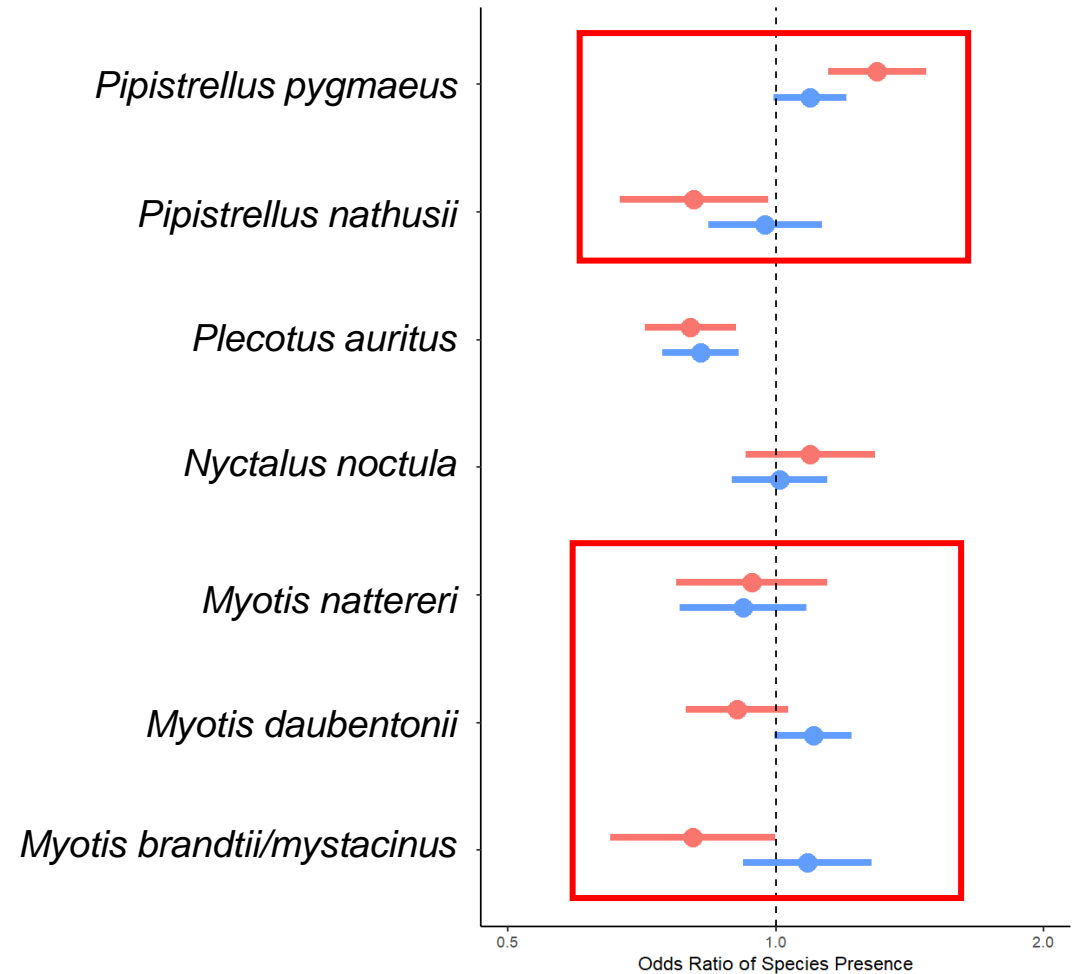
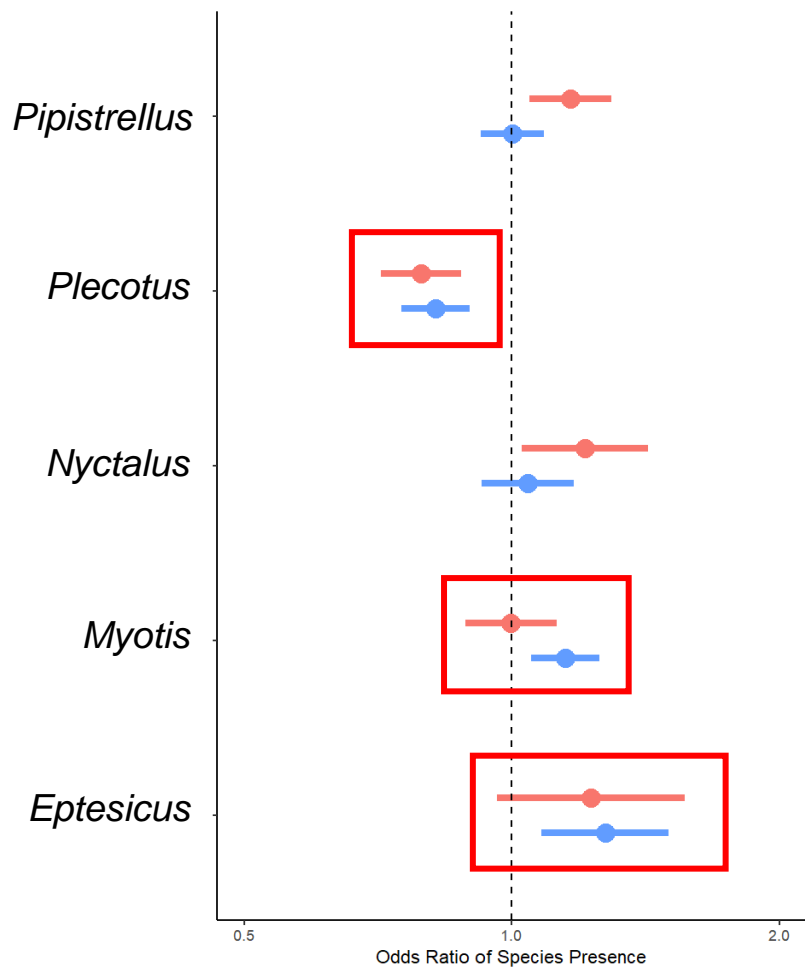
```
> unique(combined_data$sex)
[1] NA      "Female" "unknown"
[9] "1"     "2-3"    "1-2"
[17] "-"     "Dwelling" "Church"
```

# Five model specifications

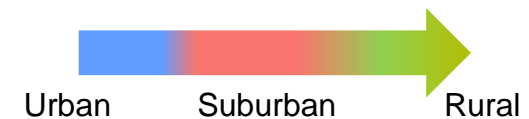
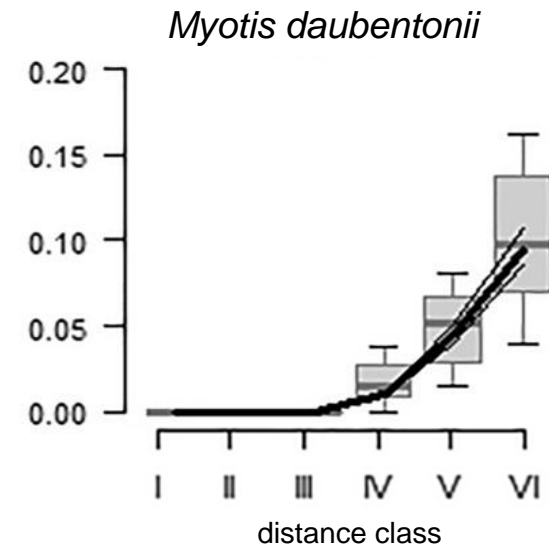
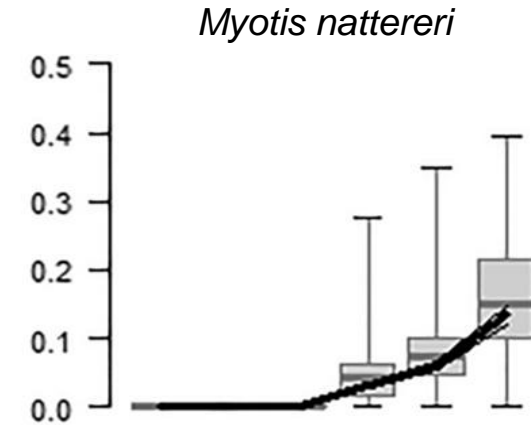
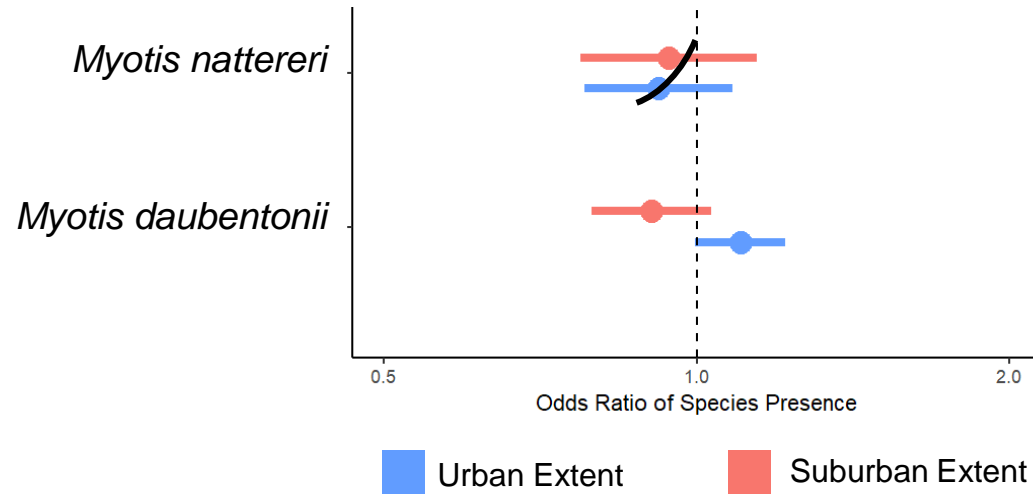




# More species utilise urban land than expected

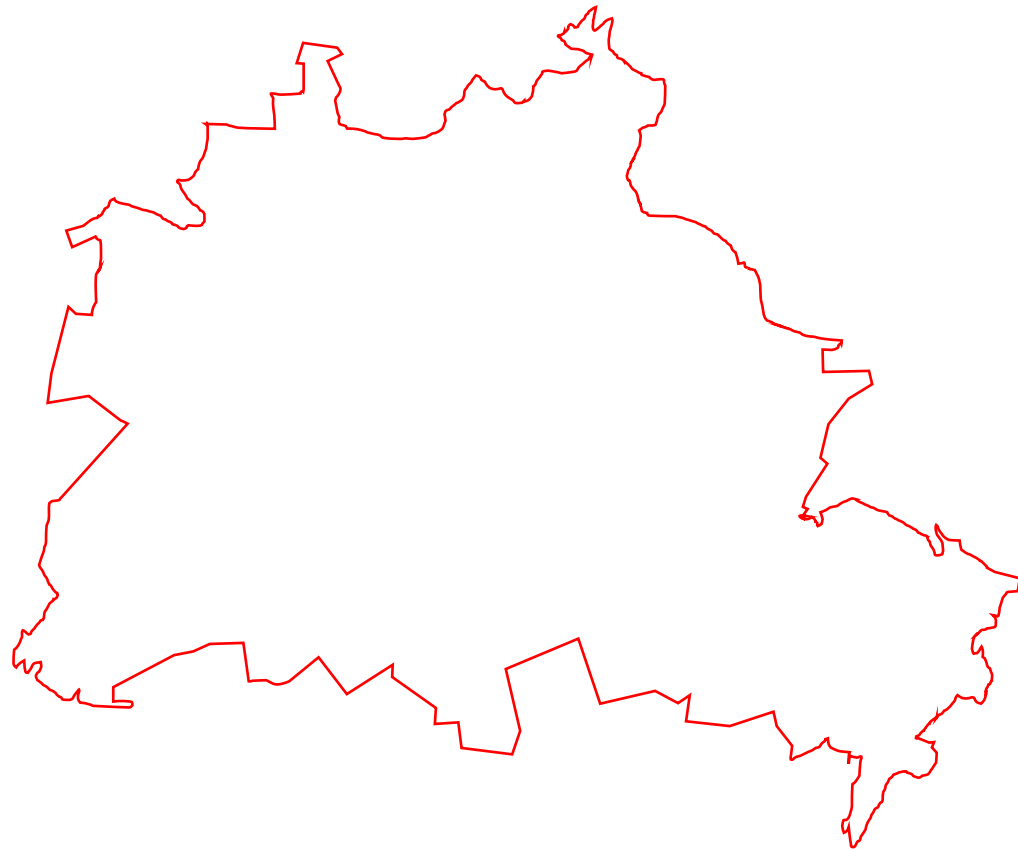


# Findings contrast with previous studies for *Myotis* species

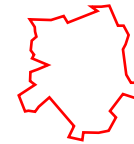


# Scale of urban extent may explain difference in findings

Berlin



Canterbury

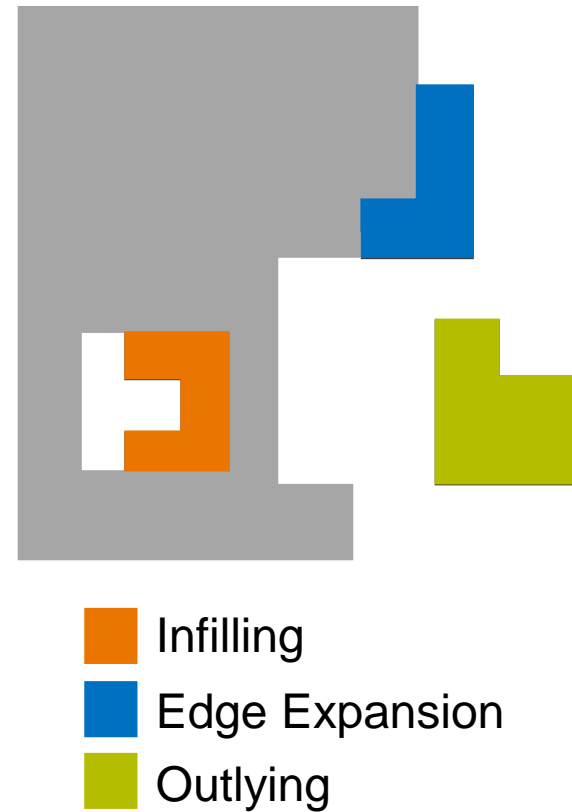


Study Scale  
(3 km x 3 km)



3 km 

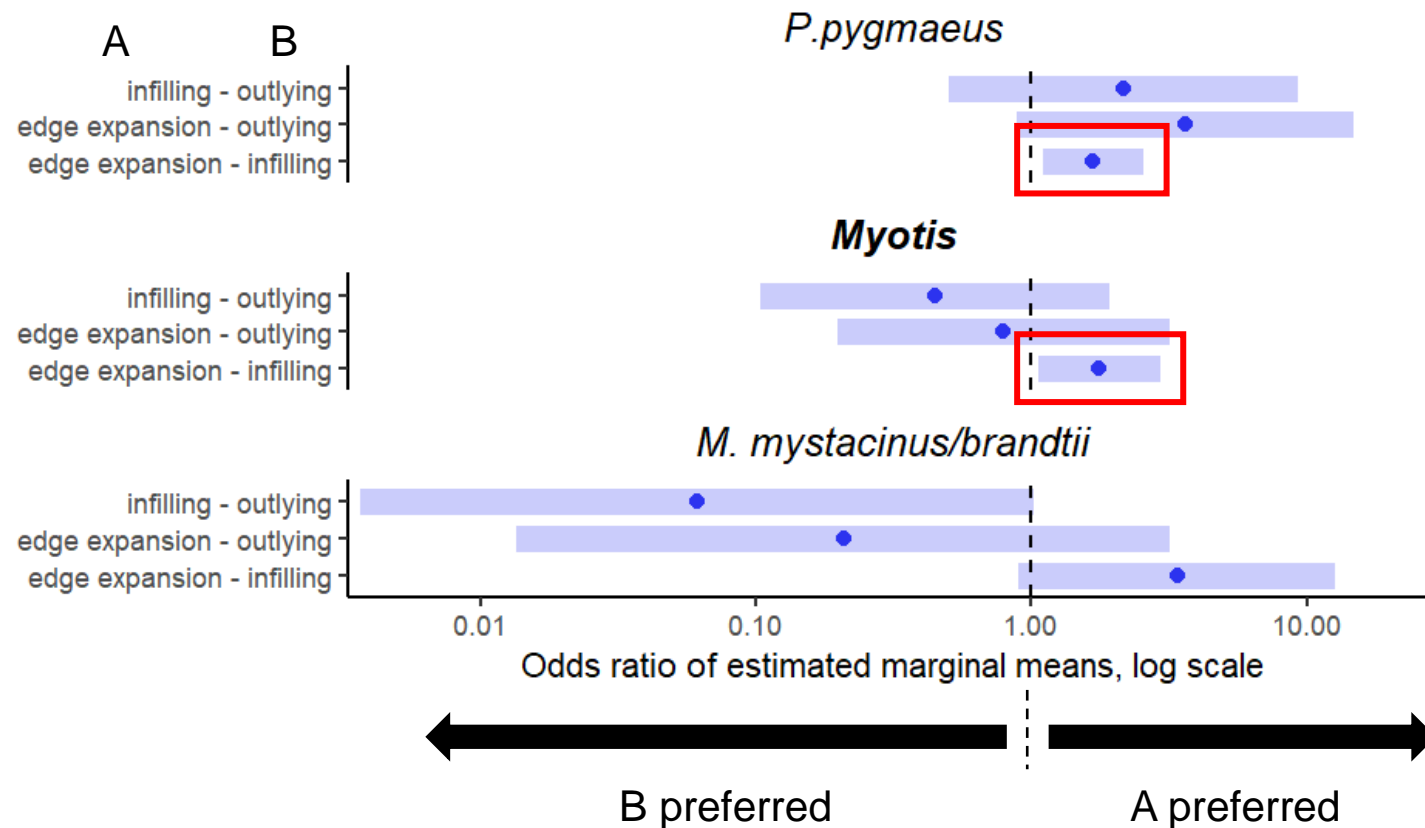
# Where urban growth is important, its pattern matters



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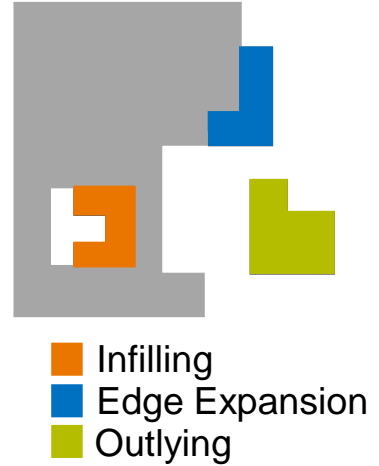
Improved model fit in:

- 2 of 7 species
- 1 of 5 genera



- Infilling
- Edge Expansion
- Outlying

# Where urban growth is important, its pattern matters



**Mechanism 1:** ↑ Edge expansion ↑ Suburban extent ↑ Populations of regular suburban exploiters

**Mechanism 2:** ↑ Infilling ↓ Urban fragmentation ↓ Populations of opportunistic urban exploiters

# Conclusions

- Valuable historic information is hidden in poorly-standardised databases.
- Scale matters when considering effects of urban extent.
- In smaller cities and large towns, more species may be able to exploit urban resources – as long as sufficient fragmentation is maintained.
- Future research: rarer species, activity levels, greater temporal coverage.

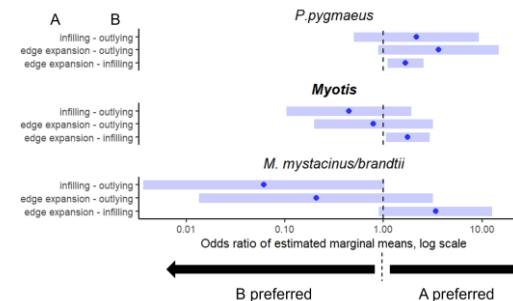
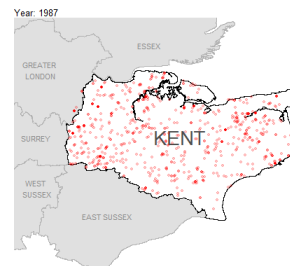
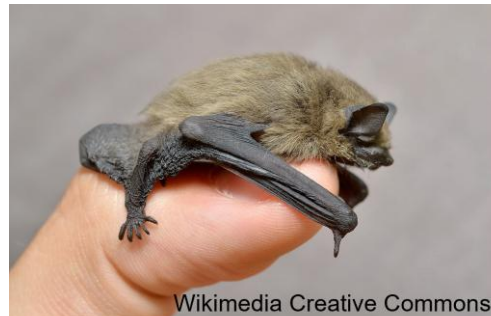
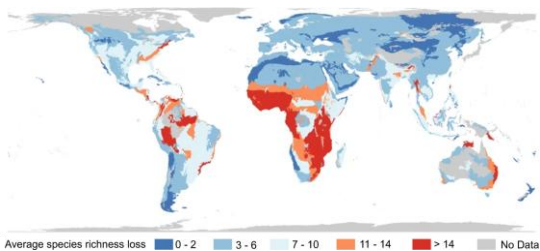
# References

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# Summary

- Global biodiversity is threatened by urban growth.
- Bats are a promising indicator group.
- A large citizen science dataset was used to investigate effects of urban growth on populations.
- Edge expansion is better for *Myotis* and *P. pygmaeus* than infilling.
- More research is needed to investigate effects in other genera/species.



# Model Equation

```
glmer(presence ~ fixedeffect1 + fixedeffect2 + ... + (1|season) + (1|year), family = "binomial")
```

$$Y_i \sim \text{Binomial}(1, \pi_i)$$

$$\log\left(\frac{\pi_i}{1 - \pi_i}\right) = \beta_j Z_{j,i} + b_k W_{k,i}$$

$Y_i$	Response in observation $i$ .	$Y_i \in \{0, 1\}$
$\pi_i$	Probability of observation $i$ being 1.	$0 \leq \pi_i \leq 1$
$\beta_j$	Coefficient (slope) of fixed effect $j$ .	$j \in \{\text{deciduous woodland}, \dots, \text{growth pattern}\}$
$Z_{j,i}$	Value of fixed effect $j$ in observation $i$ .	$Z_{j,i} = \frac{X_i - \mu_j}{\sigma_j}$
$b_k$	Coefficient (slope) of random effect $k$ .	$k \in \{\text{season}, \text{year}\}$
$W_{k,i}$	Value (level) of random effect $k$ in observation $i$ .	$W_k \in \left\{ \begin{array}{l} \text{hibernation, active} \\ 1980, \dots, 2023 \end{array} \right\}$

# Motivation behind research focus



## The Telegraph

Bats, newts and badgers: The planning laws bringing Britain to a halt

As political parties vow to turn their attention to the housing crisis, the animal vs.

**BBC**  
**NEWS**

**MyLondon**

**Anti-ULEZ protesters installing bat boxes to stop TfL repairing cameras**

**Residents install bat boxes to slow redevelopment**

**The Economist**

Britain | Construction and red tape

**Why Britain cannot build enough of anything**

The problem is bad rules, not bad people

Bats are a nightmare for anyone renovating or developing (enterprising NIMBYs sometimes install bat boxes in order to attract them to a potential site). Protected under law, it is a crime to harm a bat or destroy its roost. A full report, which involves ecologists scouring a property with bat-hunting microphones plugged into iPhones, can cost £5,000 (\$5,800).

If a roost must be destroyed, a like-for-like replacement must be built. In 2012, a railway line, was forced to build a £40m bat tunnel to avoid the creatures being squished; its route is lined with bat boxes. The tunnels are large enough for humans. For developers, the rules are a massive annoyance. For bats, however, the legislation has been a lifesaver. Numbers of the common pipistrelle have almost doubled since records began in 1999.

**Irish Examiner**

**Planning refused for Killarney apartments amid fears of impact on bats**

The application failed because of concern about how artificial lighting might disturb Lesser Horseshoe Bats on their way to and from its roost in the nearby demesne area of the Killarney National Park

**The Post and Courier**

FOUNDED 1803 WINNER OF THE PULITZER PRIZE

**In the South, developers enter a complicated relationship with endangered bats**

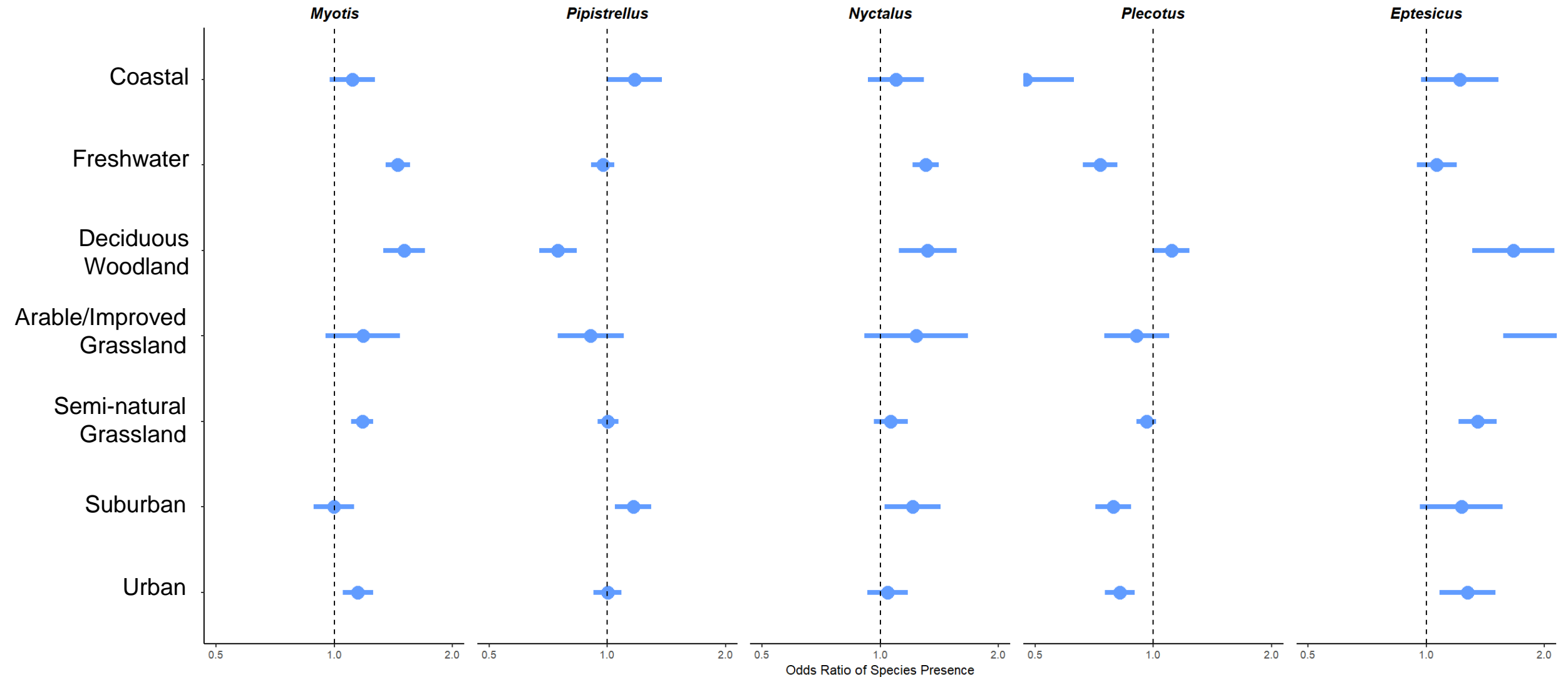
**EASTLONDONLINES**

**Discovery of protected species could stop Limehouse development**

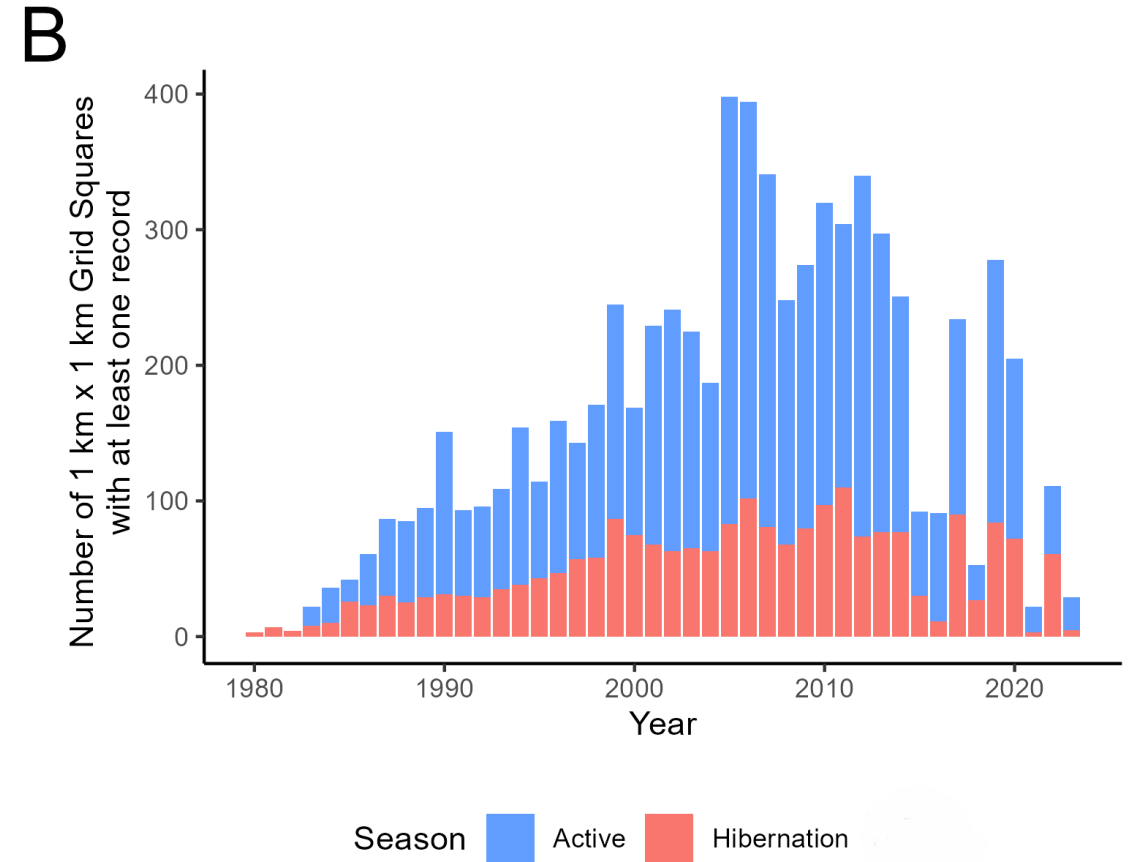
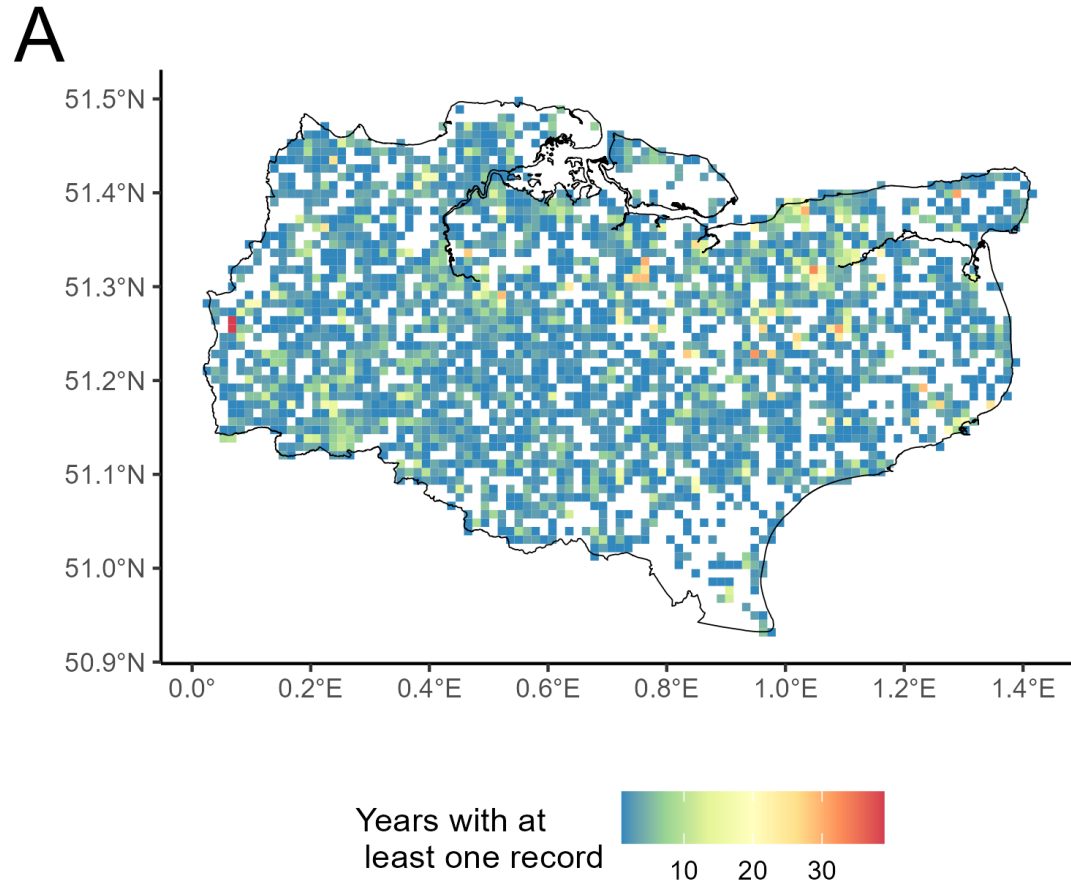
**Reuters**

**Lawsuit pits Miami development against endangered bats, beetles**

# Results of non-urban land cover types



# Spatial and temporal distribution of records





# The Kent Bat Group

<https://www.kentbatgroup.org.uk>

- Formed in 1983.
- Monitor populations.
- Run the 'bat ambulance'.
- Educate local residents.

