

# The impact of roads on bat activity and diversity and the effectiveness of mitigation in the UK



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**CONSERVATION  
FIRST**



# Bats and roads



Seven years of research:

PhD research (2009 – 2013):

The effect of roads on bats and effectiveness of mitigation

Defra – funded project WC1060 (2013 – 2015):

Developing cost-effective methods for assessing impact of roads on bats and effectiveness of mitigation

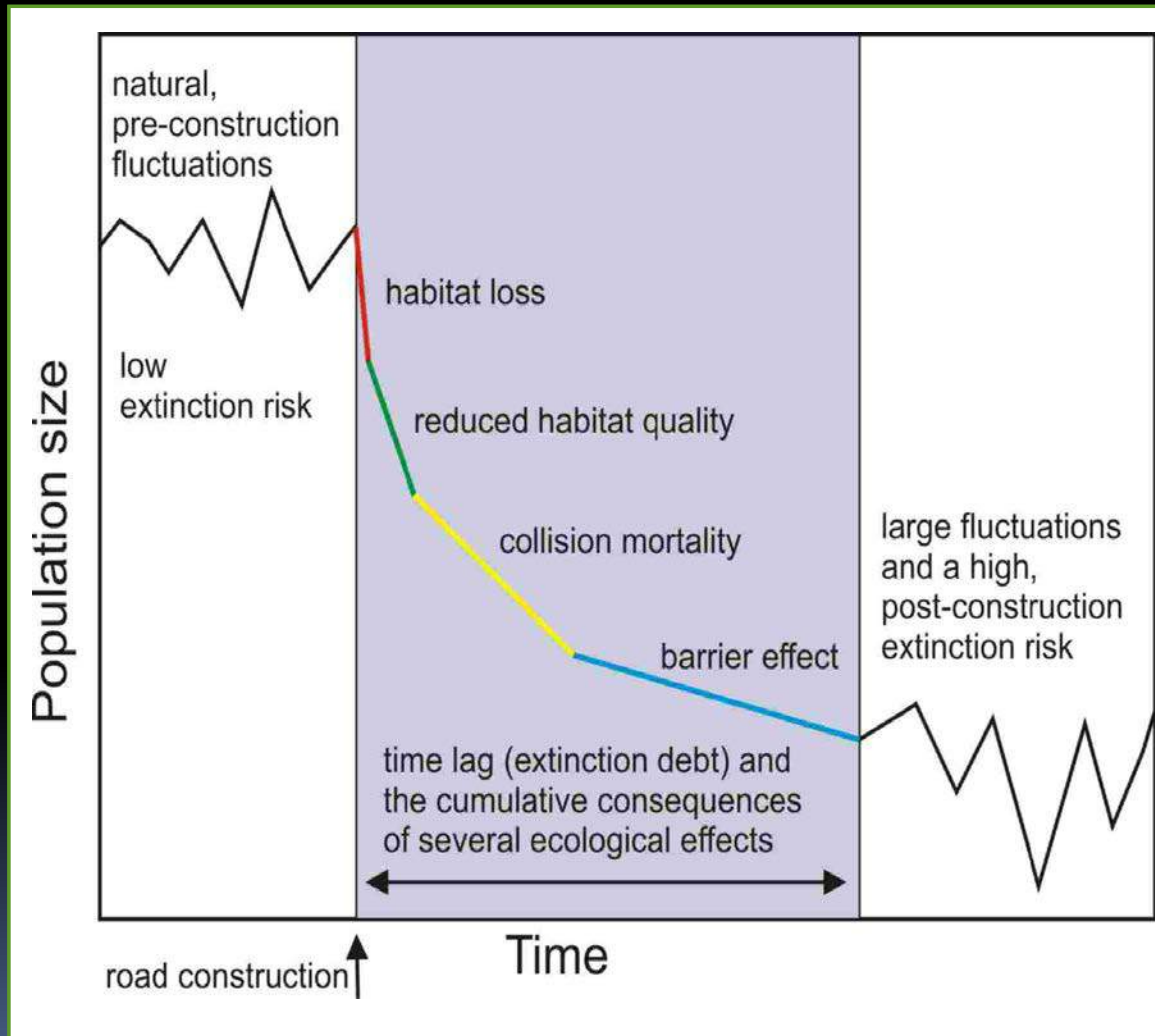


Berthinussen, A. & Altringham, J. (2012) The effect of a major road on bat activity and diversity. *Journal of Applied Ecology*, **49**, 82-89

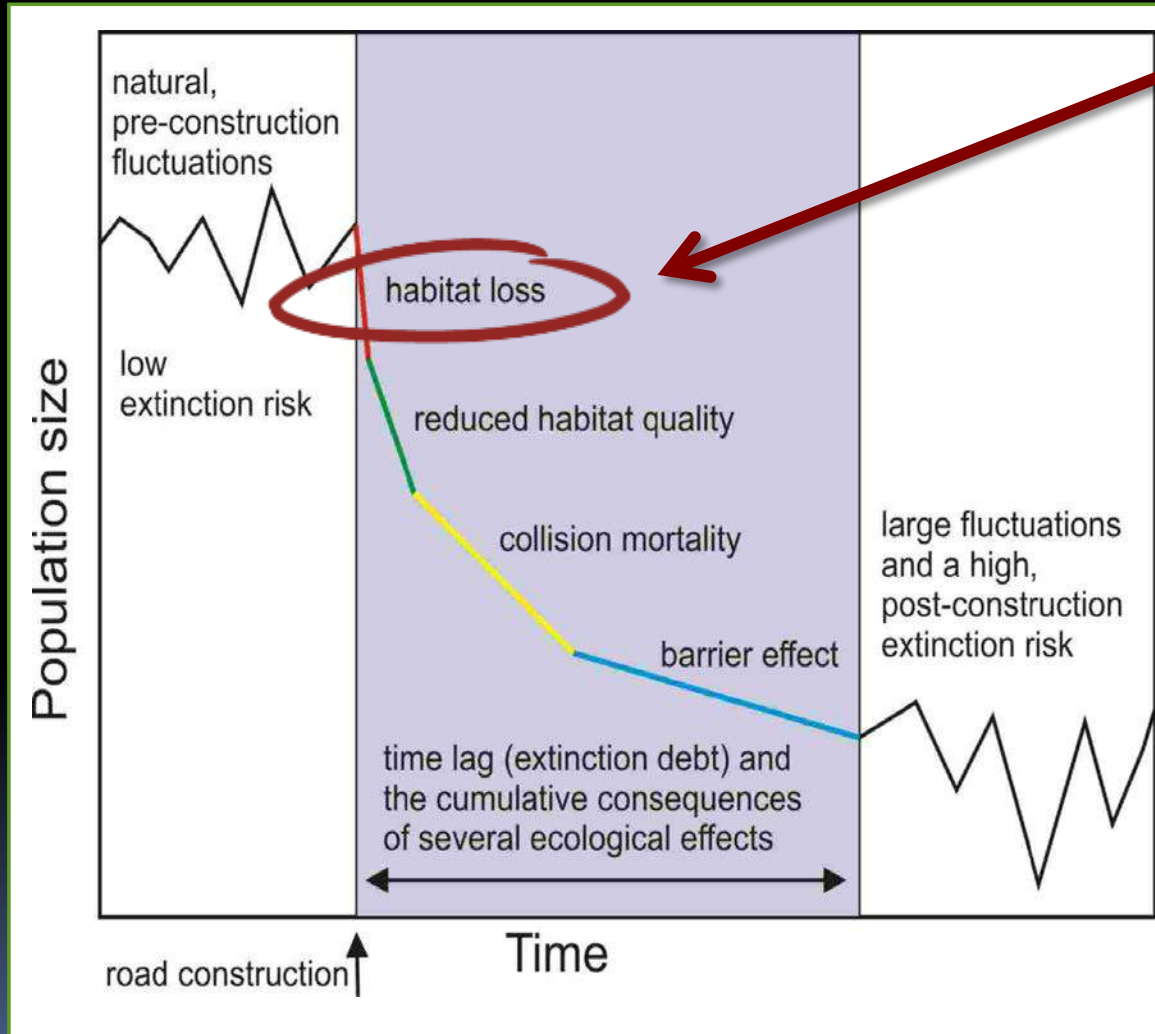
Berthinussen, A. & Altringham, J. (2012) Do Bat Gantries and Underpasses Help Bats Cross Roads Safely? *PLoS ONE* 7(6): e38775

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# What effects *might* roads have?

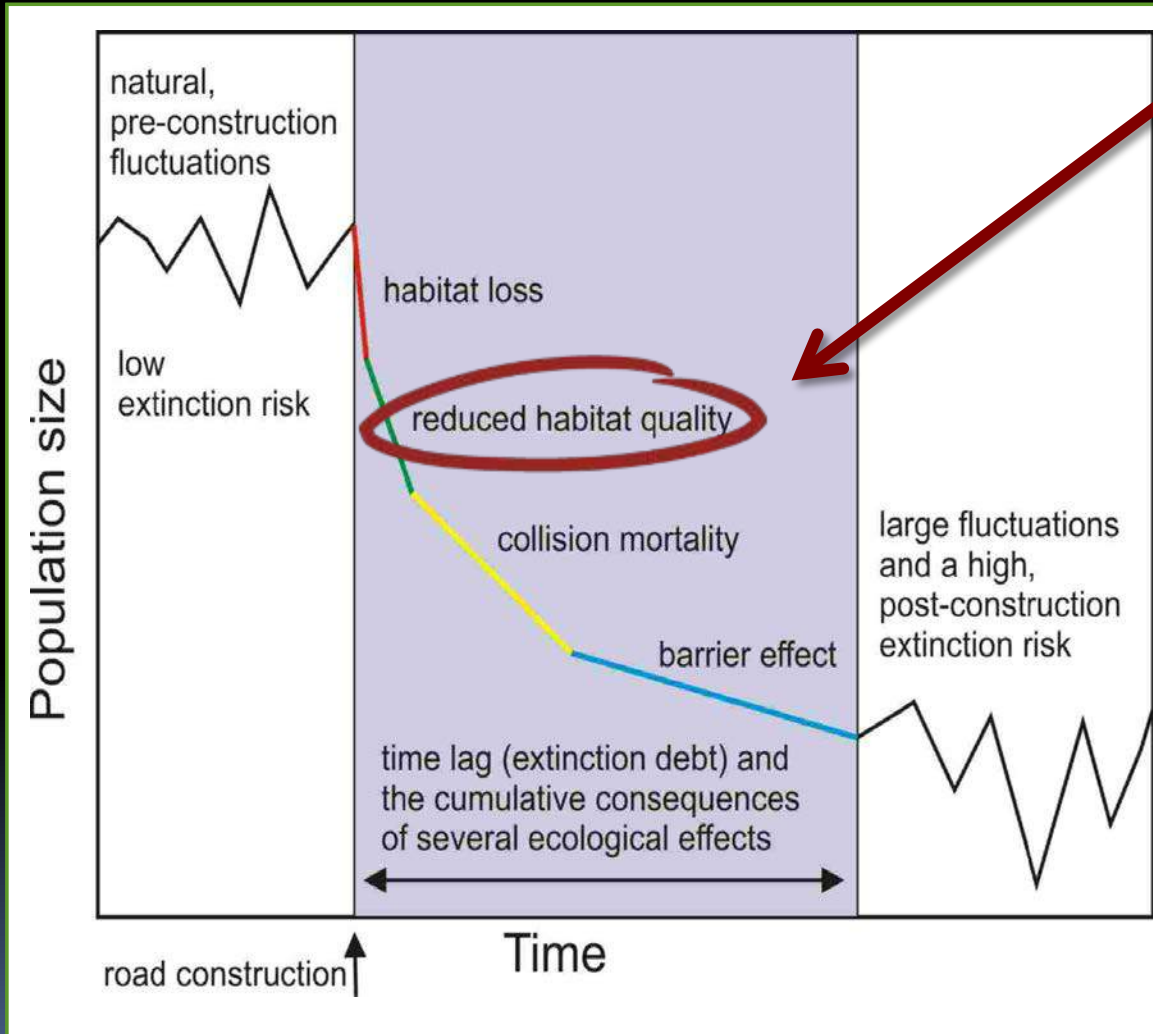


# What effects *might* roads have?



10 km of 7 m wide,  
two-lane tarmac = 7 ha

# What effects *might* roads have?



## Light pollution

Stone EL, Jones G (2009) Street lighting disturbs commuting bats. *Current Biology* 19: 1-5

## Noise pollution

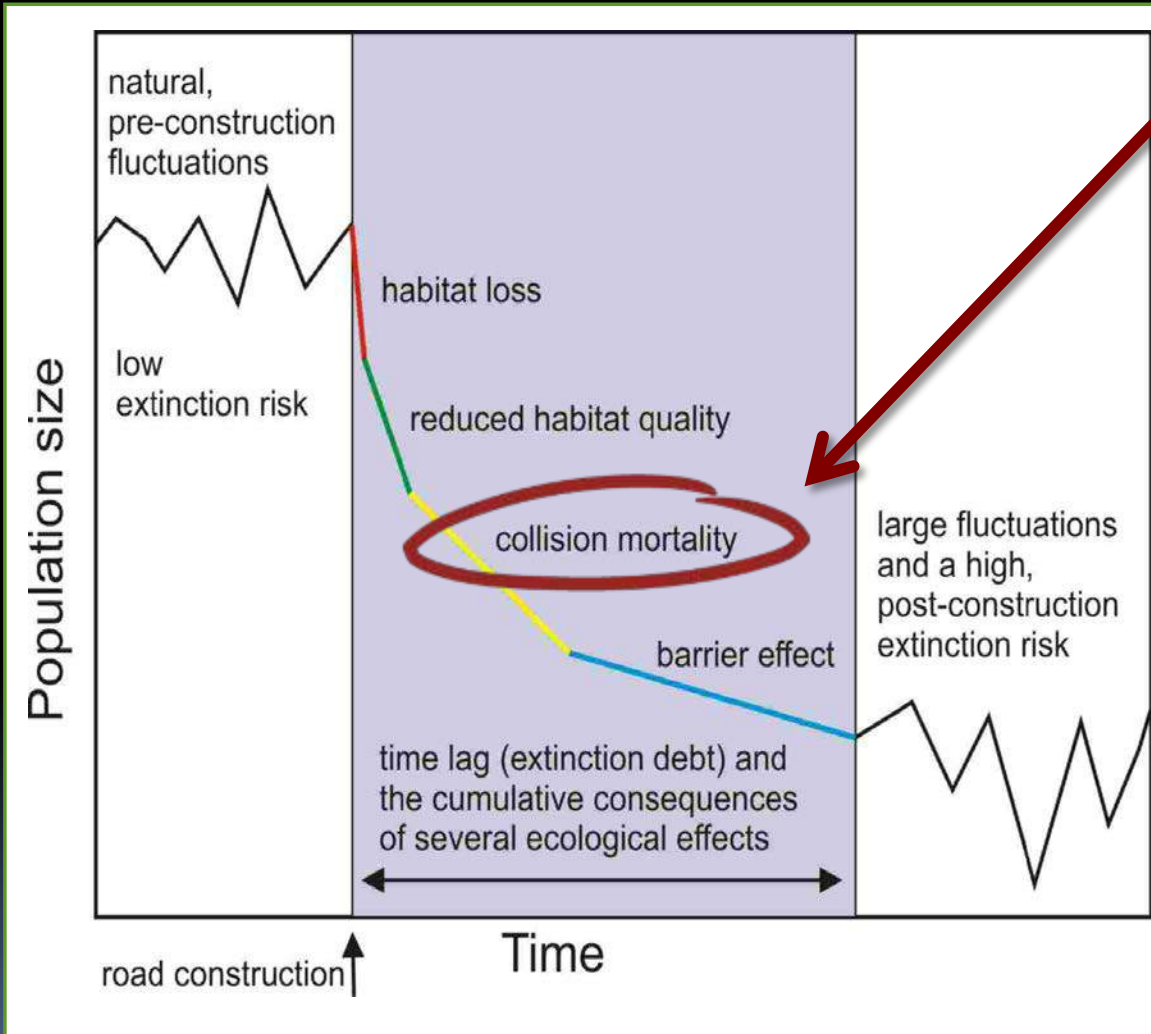
Schaub et al. (2008) Foraging bats avoid noise. *Journal of Experimental Biology* 211: 3174-3180

Luo et al. (2015) How anthropogenic noise affects foraging. *Global Change Biology* 21: 3278-3289

## Chemical pollution

Evidence for insects, not for bats.

# What effects *might* roads have?



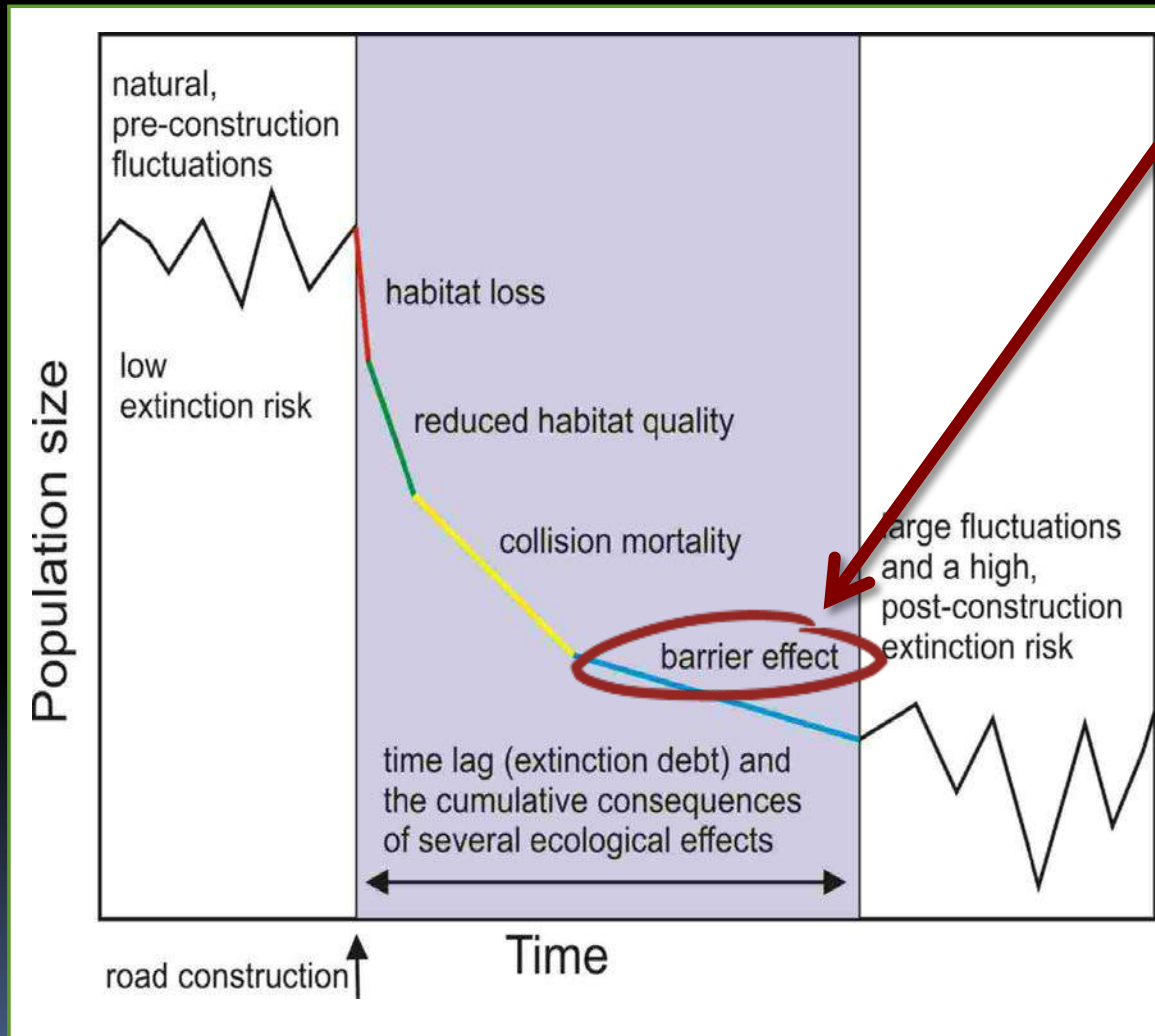
## Roadkill

Russell et al. (2009) Road-killed bats, highway design, and the commuting ecology of bats. *Endangered Species Research* 8: 49–60.

Lesinski et al. (2010) Bat casualties on a road crossing a mosaic landscape. *European Journal of Wildlife Research* 57: 217–223

Likely to be underestimated

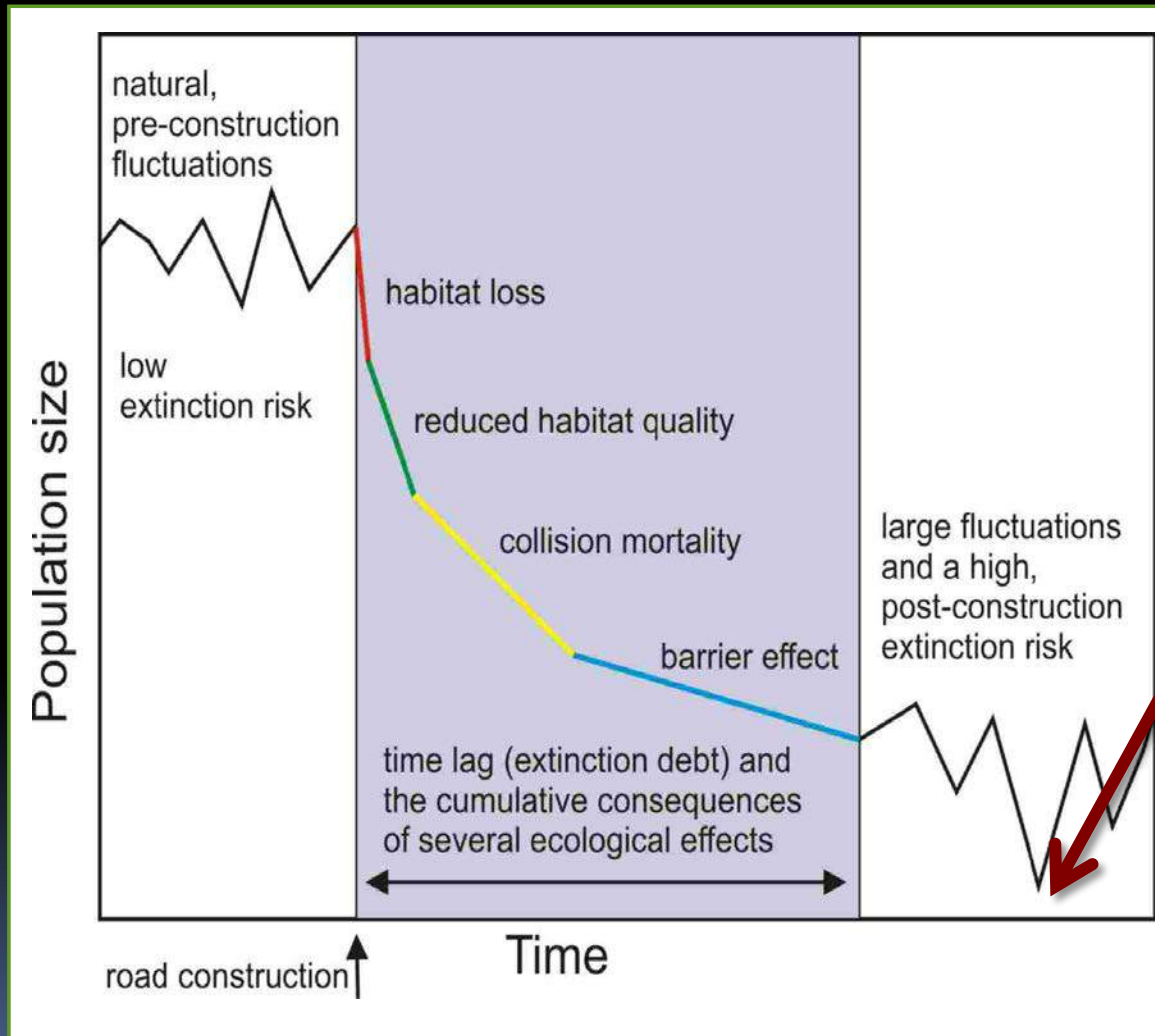
# What effects *might* roads have?



Reduced foraging area  
Reduced reproductive success

Kerth G, Melber M (2009) Species-specific barrier effects of a motorway on the habitat use of two threatened forest-living bat species. *Biological Conservation* 142: 270–279.

# What effects *might* roads have?





Two key questions:

Are roads a threat to bats at the population level?

Do current mitigation strategies help maintain bat populations?

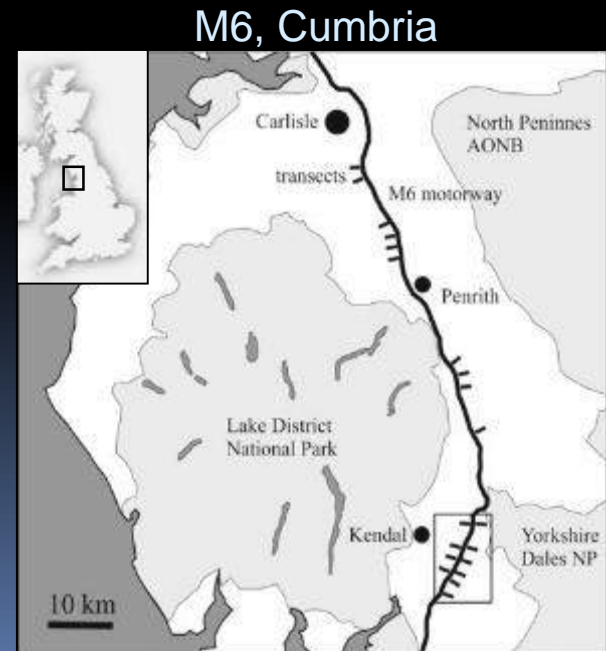
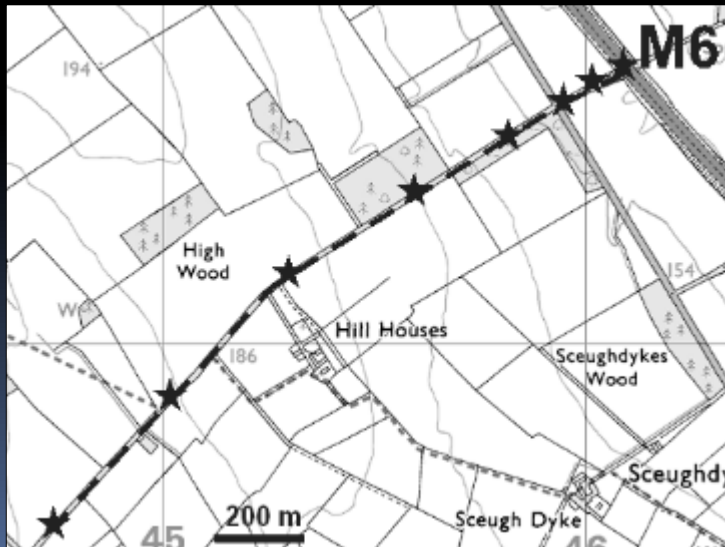
Framed as questions we can address experimentally:

1. Are bat activity and diversity related to road proximity?
2. Do current mitigation strategies help bats to cross roads safely?



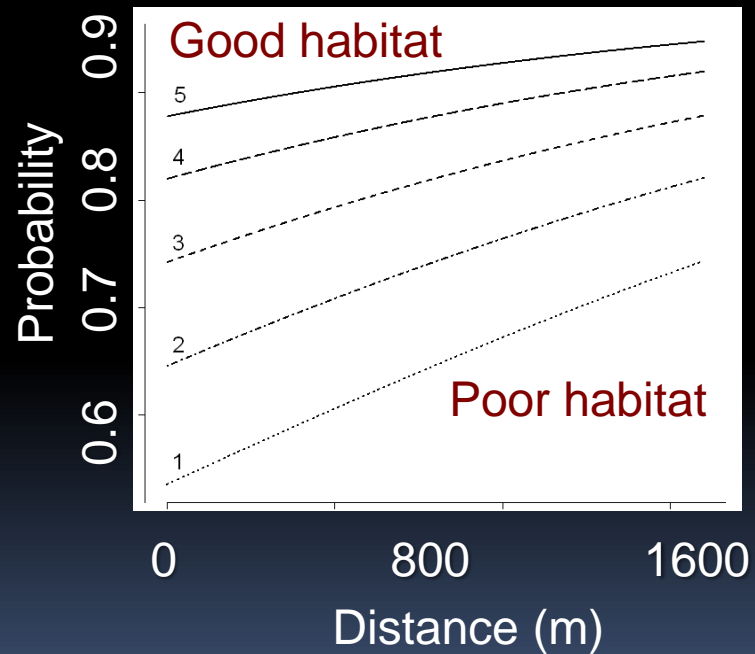
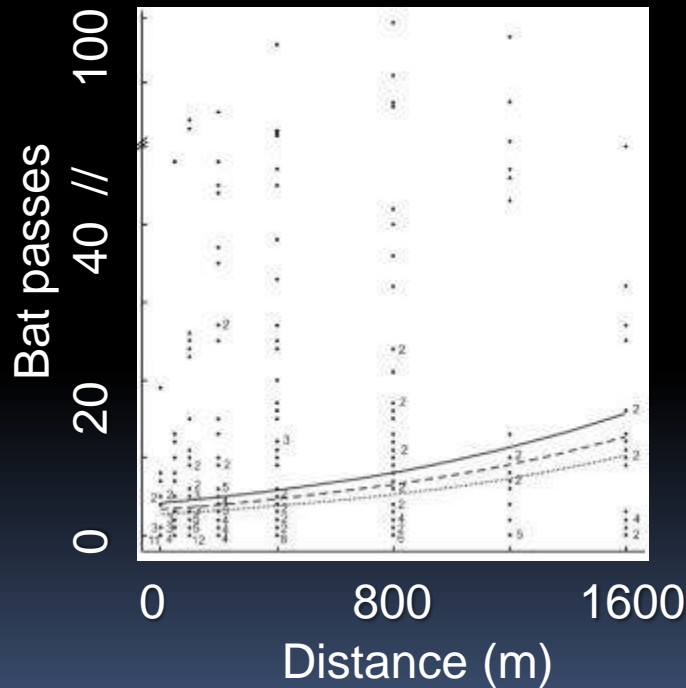
# 1. Are bat activity and diversity related to road proximity?

- Large scale transect study
- 20 x 1.6 km transects perpendicular to the road
- Recorded bat activity and number of species at different distances along transects
- Statistical modelling used to detect effects



# Results

- Total bat activity increased 3-fold between 0 and 1600 m from the road
- The number of bat species also increased significantly with distance
- Habitat 'quality' mitigated against the effects of the road

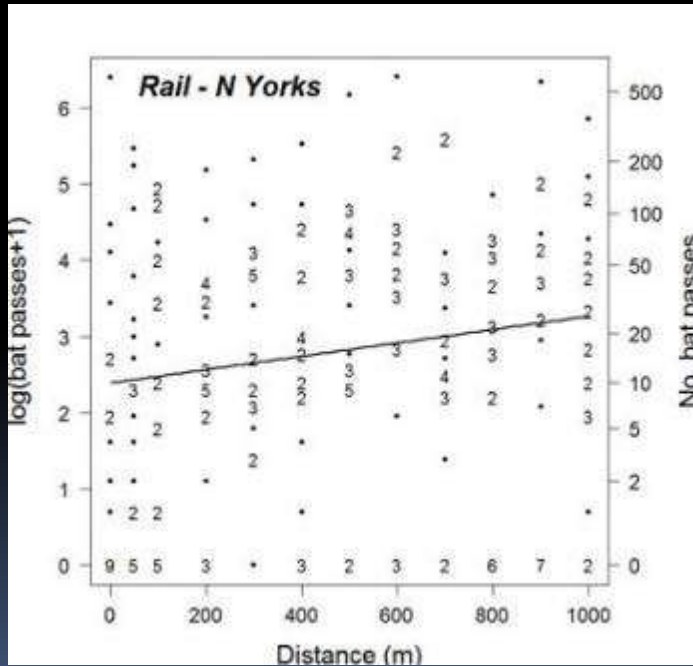




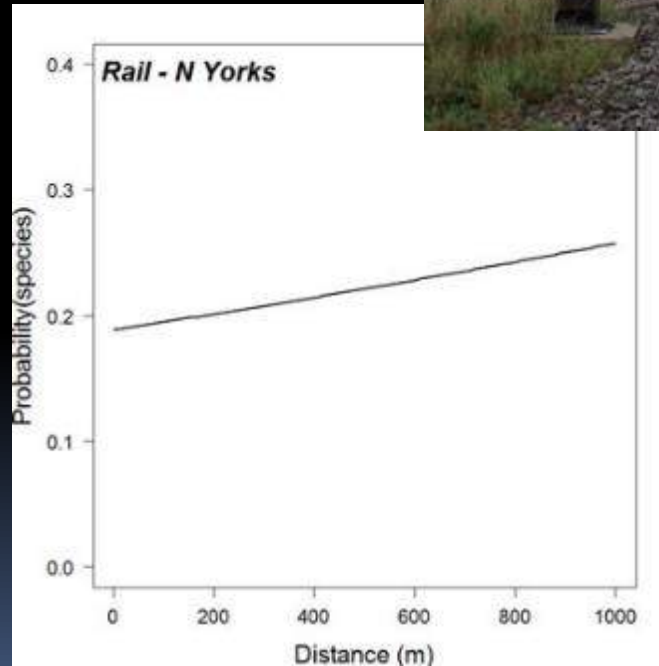


# More results...

Some railways also show the effect (1 of 2 studied)



Activity down



Diversity down

Roads DO affect bats – impact assessment and mitigation ARE important

Has mitigation been effective? Are we helping bats cross roads safely?



Roads DO affect bats – impact assessment and mitigation ARE important

Has mitigation been effective? Are we helping bats cross roads safely?

We studied 16 road crossing structures for bats in the UK

These are designed to:

- Increase road permeability
- Reduce roadkill

and hence maintain bat populations



- Little / no evidence of effectiveness
- Monitoring absent
- Poor monitoring, focus on **use** by individuals



## Use *versus* Effectiveness

Conservation is the protection of species and ecosystems at the population level: maintaining 'favourable conservation status' means maintaining stable populations.

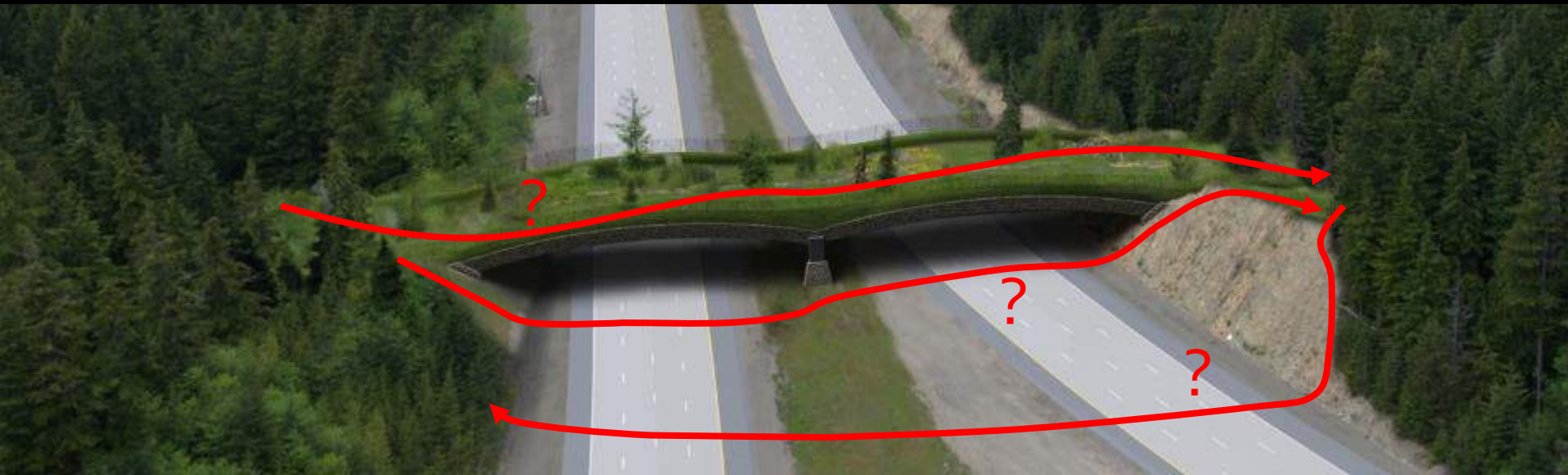
It is not enough to say "bats use green bridges" **Current common practice**



# Use *versus* Effectiveness

Conservation is the protection of species and ecosystems at the population level: maintaining favourable conservation status means maintaining stable populations.

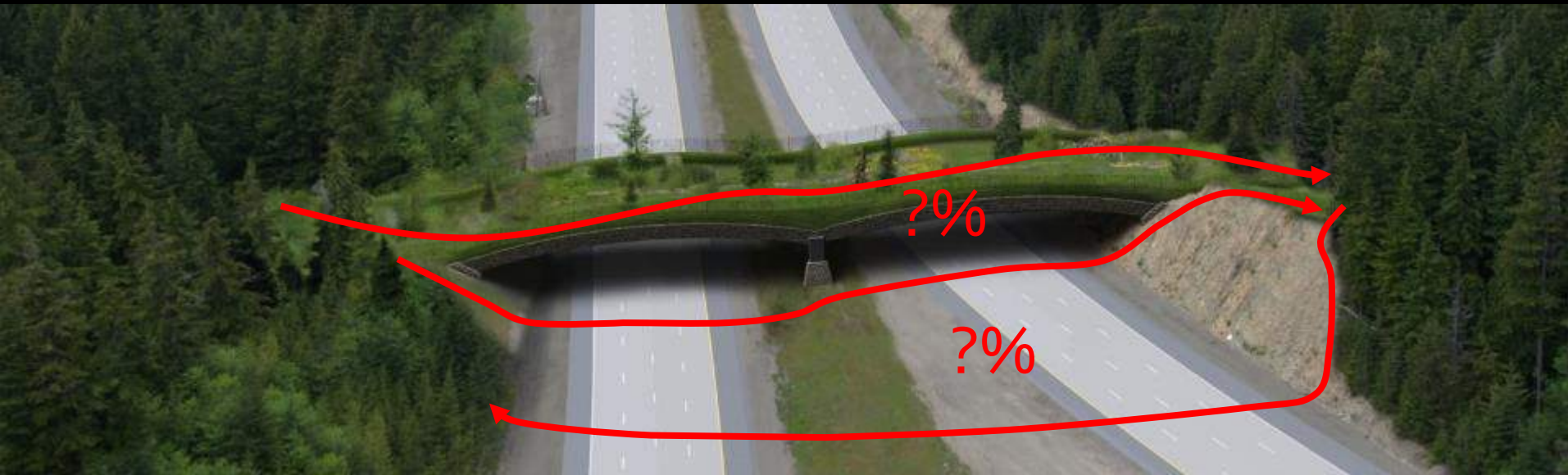
Do they also fly over the road?



## Use *versus* Effectiveness

Conservation is the protection of species and ecosystems at the population level: maintaining favourable conservation status means maintaining stable populations.

What proportion of bats crossing use the green bridge?



# Use *versus* Effectiveness

Conservation is the protection of species and ecosystems at the population level: maintaining favourable conservation status means maintaining stable populations.

If bats cross the road, are some killed?



## Use *versus* Effectiveness

Conservation is the protection of species and ecosystems at the population level: maintaining favourable conservation status means maintaining stable populations.

How many? What proportion of those crossing? What proportion of population? Is this mortality rate sustainable?



Not all easy questions to answer, but we can ask some simple ones

Do we help enough bats to cross the road safely?

## 2) Assessing the effectiveness of crossing structures

- Visual observations of crossing bats paired with echolocation recordings
- 6 x 60 min surveys at dusk or dawn per site
- Count crossing bats and record flight height and distance from crossing structures
  - LED markers for distance
  - Night vision and infra-red lights in underpasses



## 2) Assessing the effectiveness of crossing structures

### Analysis

- Set definitions:

***'Use' of the structure:** bats flying within 5 m of it / through an underpass*

***Unsafe crossing height:** < 5 m above road*

- Used boxplots / percentages to compare proportions of bats 'using' structure to those not using it or at risk of collisions with traffic

### Interpretation

- To be effective:

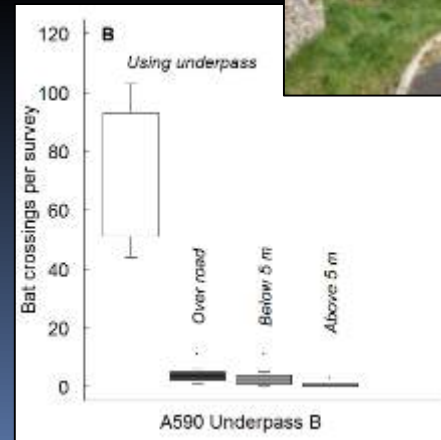
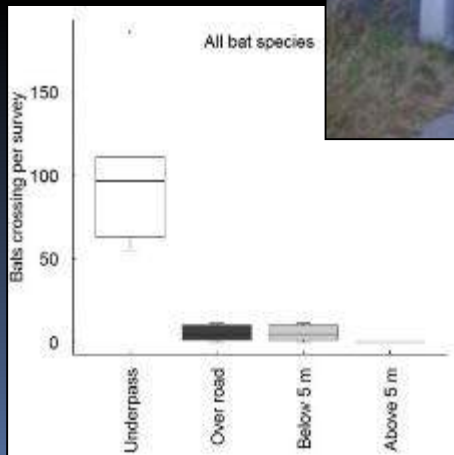
***At least 90%** of bats must be 'using' the structure to cross the road safely*

# Underpasses

Two of six underpasses studied were effective:

Both used by ~95% of crossing bats

*Both large, wide and bridge existing bat flight paths*



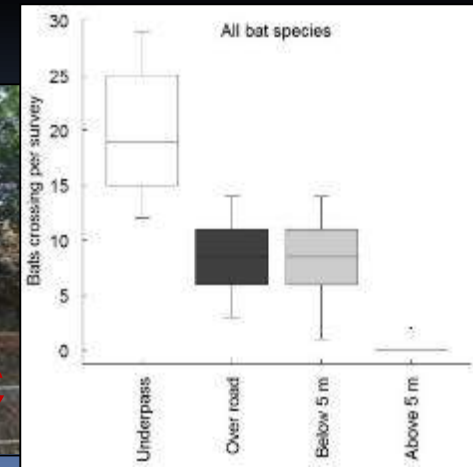
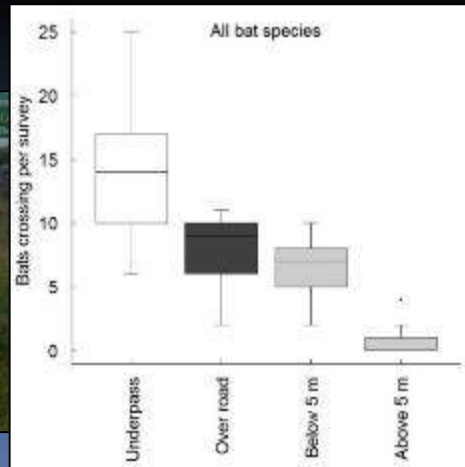
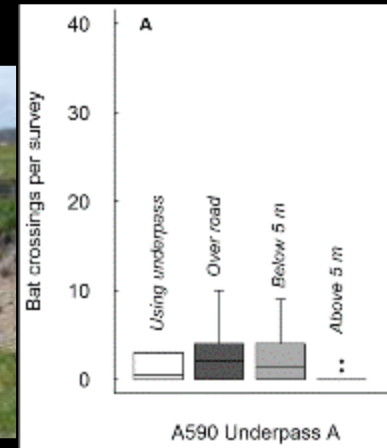
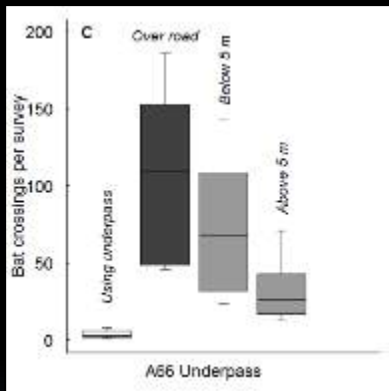


# Underpasses

Four of six underpasses studied were less effective:

30–67% of bats crossed the road unsafely

*All smaller and/or do not bridge existing flight paths*

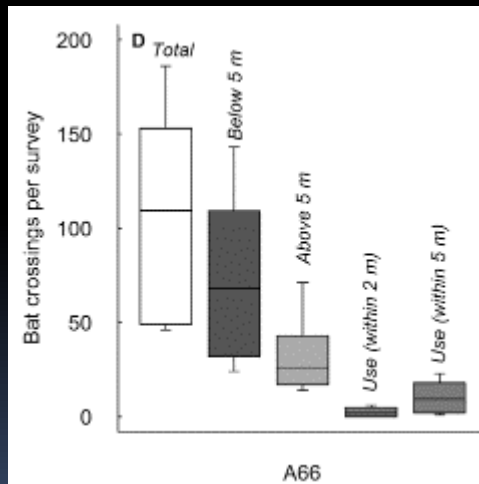


# Bat gantries – ‘wire and ball’ design

None of the four gantries were effective:

<1% - 11% of bats ‘used’ the gantries

Up to 84% crossed at unsafe heights

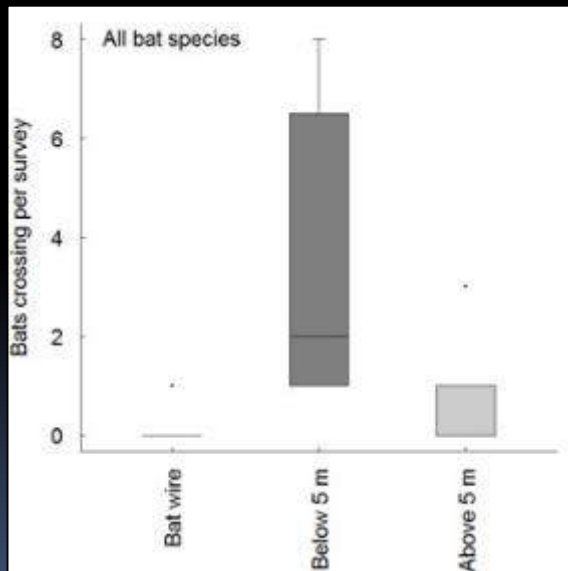


# Bat gantries – mesh ‘V’ design

None of the three gantries were effective:

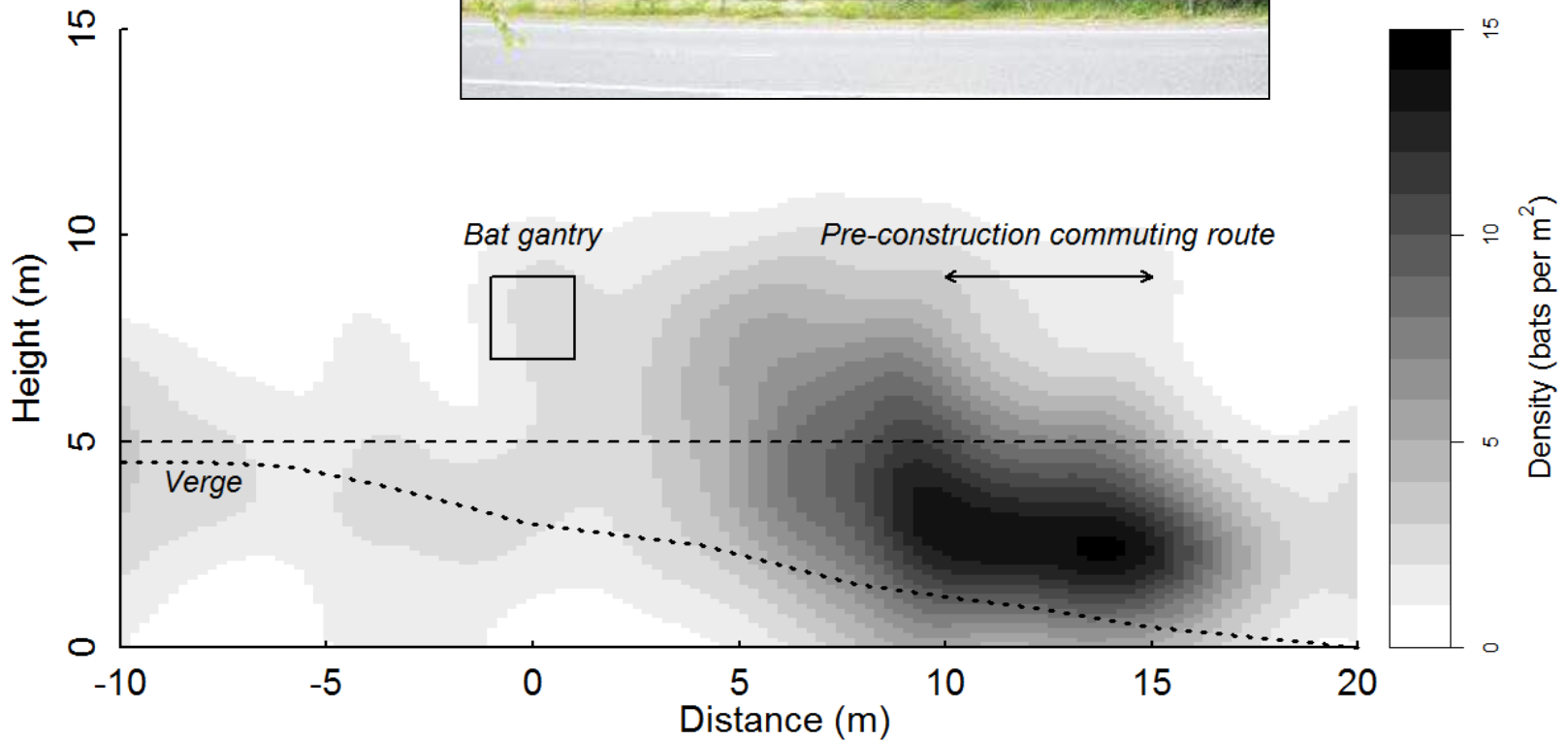
0% - 3% of bats ‘used’ the gantries

80% crossed at unsafe heights



# Do bats adapt?

9-year old gantry ...



Kernel intensity estimation

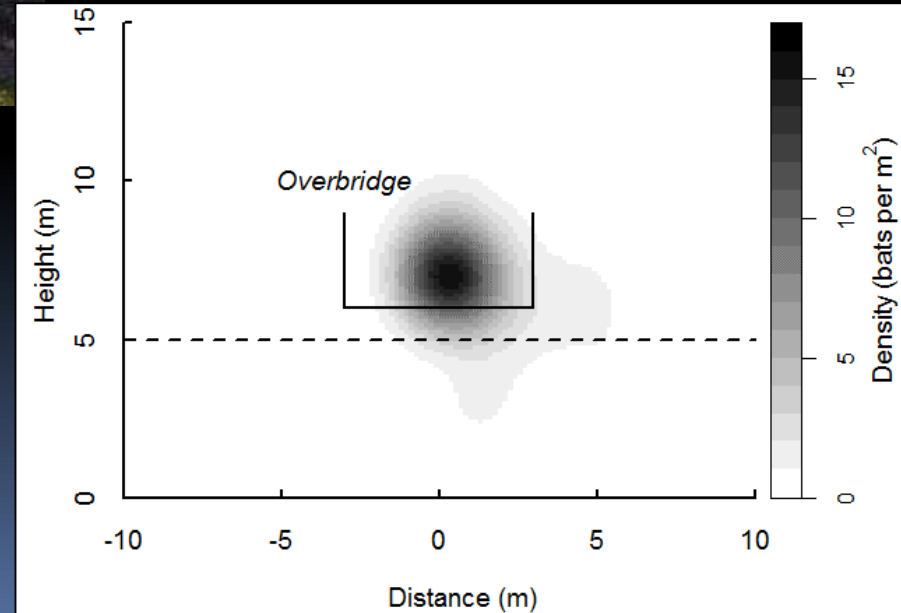
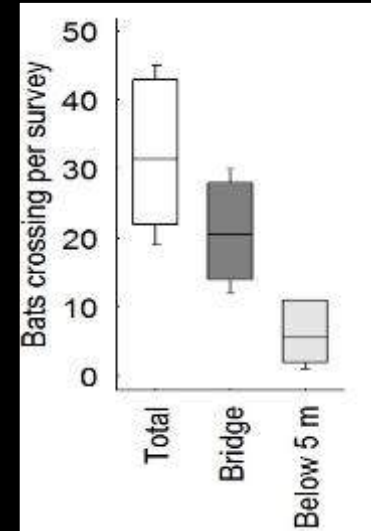
# Overpass

Only 3 bats observed in the vicinity, none flew over the bridge



# Environmental overbridge

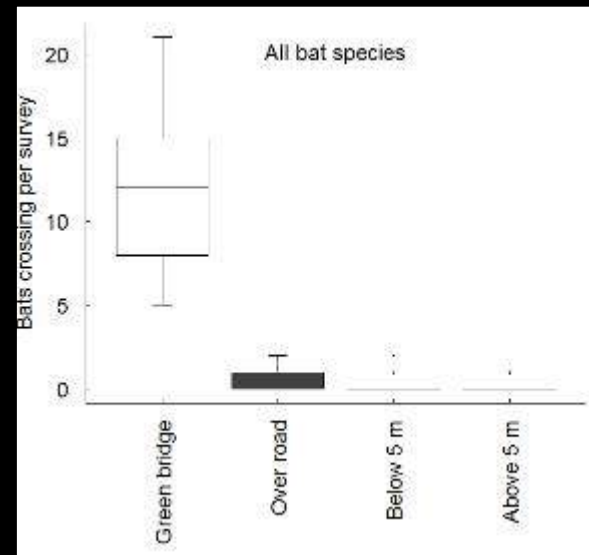
Some potential – used by 62% of bats, but 19% crossed at unsafe heights



Better news!

## Scotney Castle green bridge

Effective - used by 97% of crossing bats



# Conclusions

- Roads *and* railways can have a negative impact on bat abundance and diversity

*We found negative effects along 6 of 8 roads— including smaller roads*

- Mitigation is essential both during and after construction, but largely failing

*Only 2 of 16 structures tested were effective*

- Wire bat gantries don't work
- Green bridges and underpasses have most potential, but design, location and connectivity are important





# Where next?

A more evidence-based approach to mitigation

experimentation

better design

better monitoring

better evaluation

Standardised and objective methods should be used routinely and results reported and shared

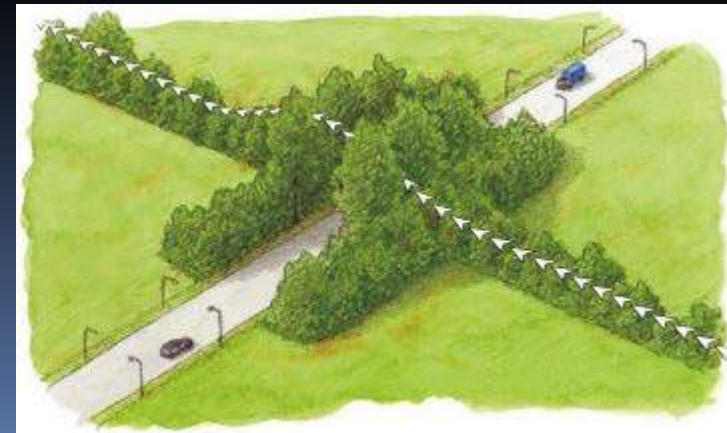
## More research needed:

*How to mitigate sensitive construction period?*

*Hop-overs?*

*Habitat enhancements around roads?*

*Impacts of railways?*



# References

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Defra report:

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Available at: <http://tinyurl.com/bats-roads>

