CARVING UP THE LANDSCAPE

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roads and bats, interactions and mitigation

Why bats?

Obscure?

An evolutionary sideline?

1200 species worldwide

Over 20% of all mammals

Most diverse group of mammals

Crested free-tailed bat

Yellow-winged bat

flying foxes: *1 kg, 2 m wingspan*

Bumblebee bat: *1.5 g*


Long-tongued bat


Epaulleted bat


Brazilian free-tailed bat

Ecosystem services

Pollination
Seed dispersal
Insect control

Bats are small mammals with big mammal lifestyles

Long life: 15-25 years not uncommon
Low fecundity: rarely more than 1 pup per year

Vulnerable to rapid environmental change
Slow to recover from population clashes

Bats are small mammals with big mammal lifestyles

Operate over landscape scale:

large home ranges

wide range of resources

Foraging

Hibernation

Summer nurseries

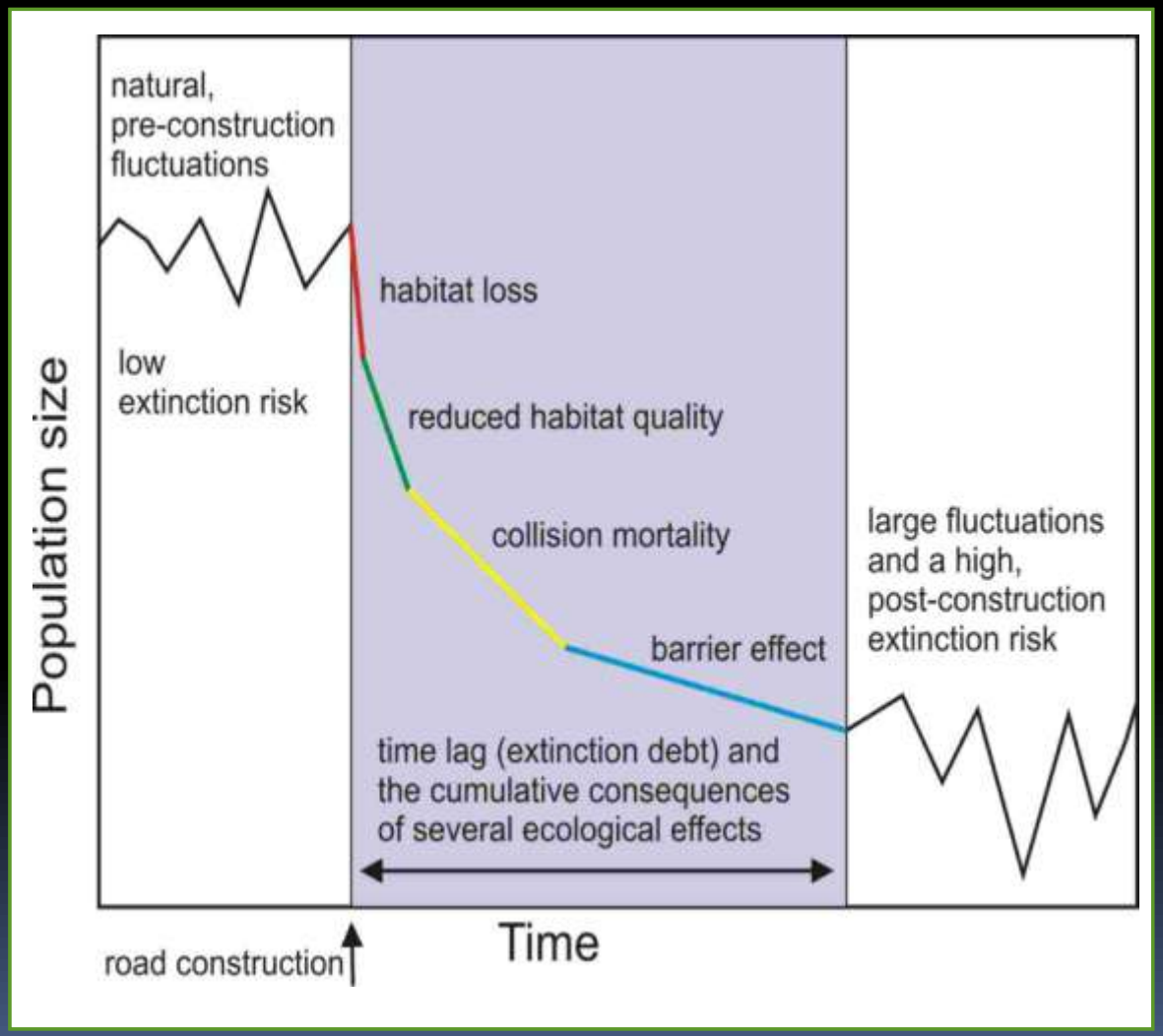
25% of the 1200+ species are under threat

Habitat loss
Habitat fragmentation
Habitat degradation

Transport infrastructure has the potential to contribute to all of these

Flight does not confer immunity to roads

What effects *might* roads have?



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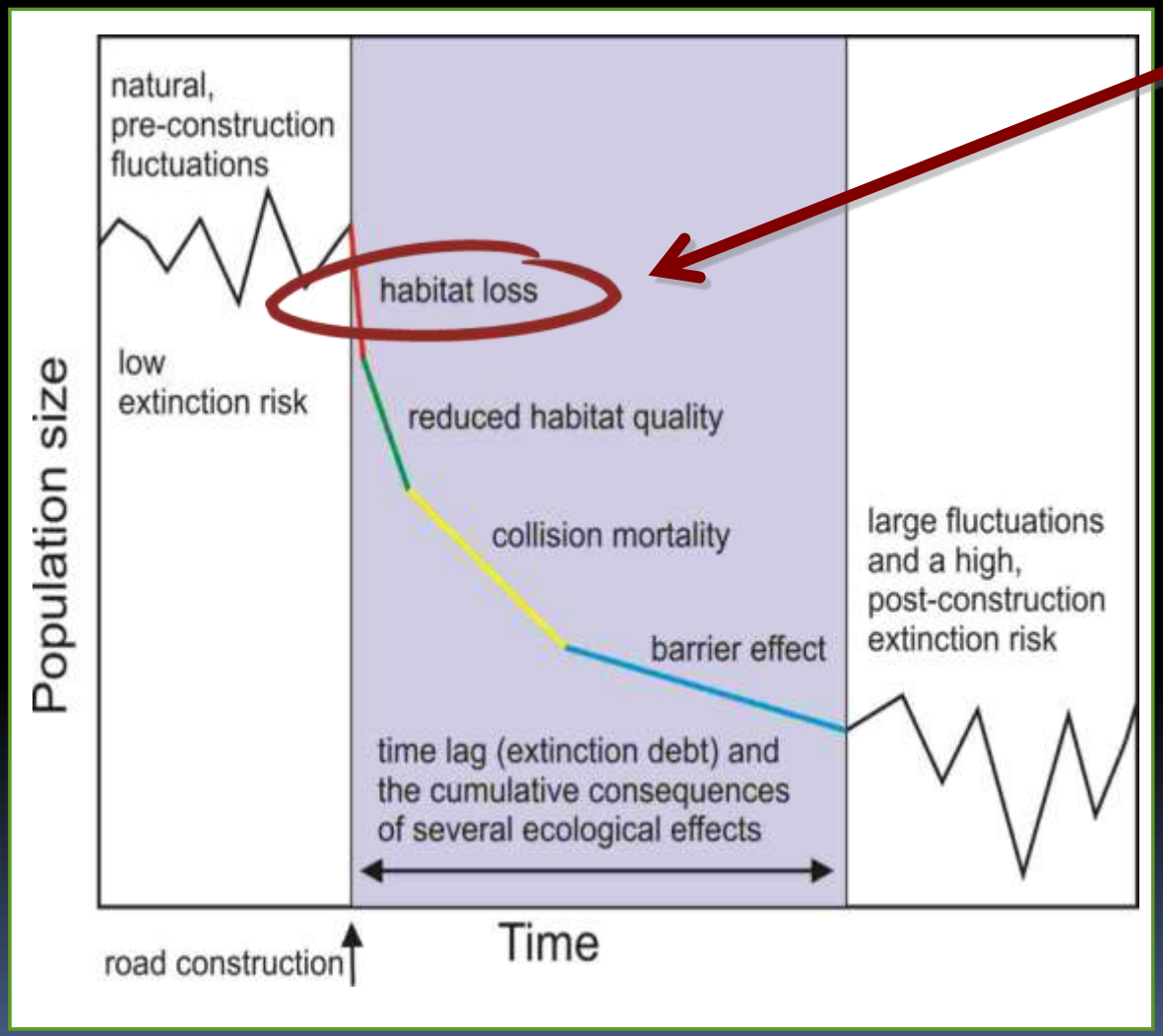

Self-evident:

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

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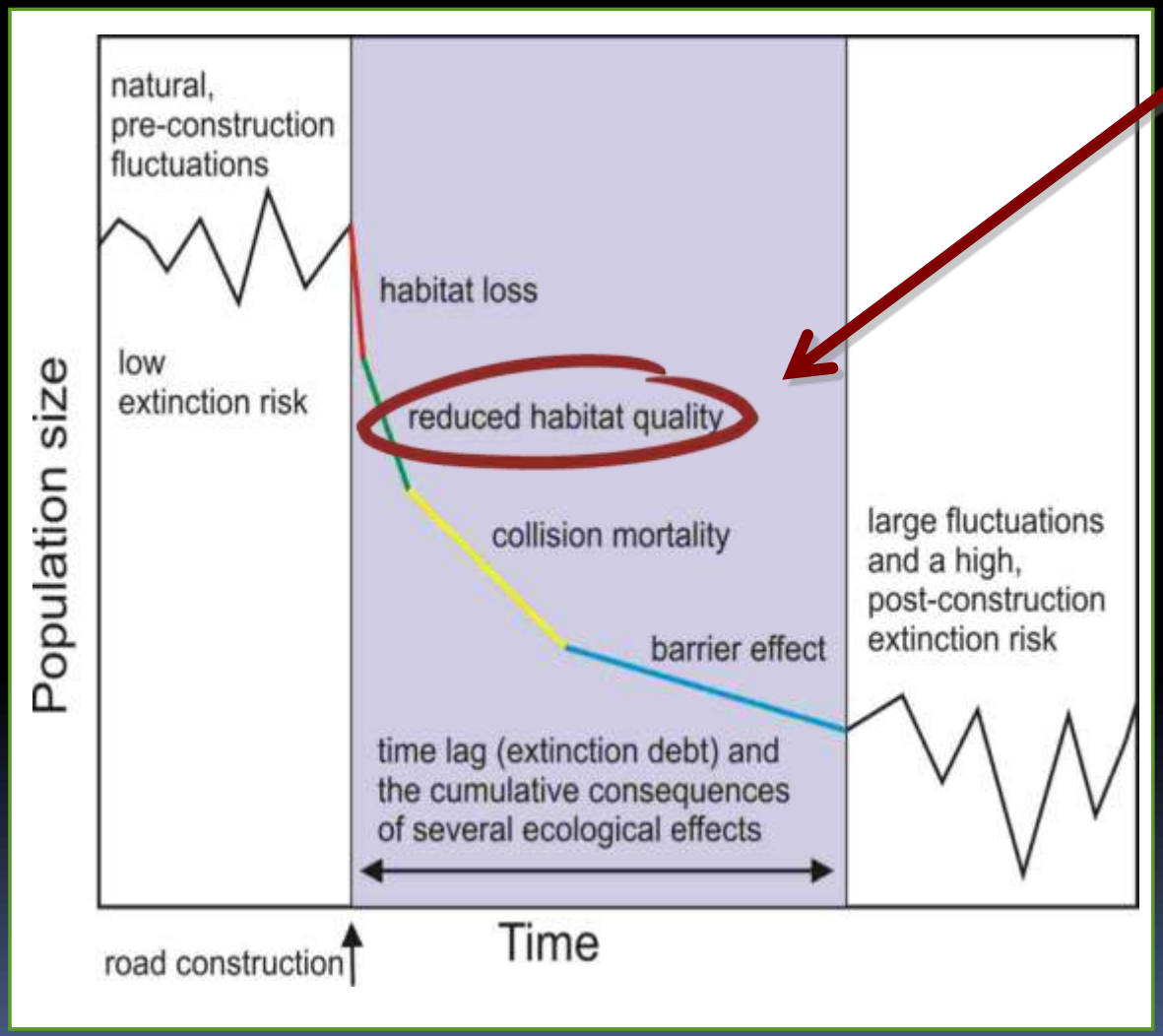


Light pollution

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

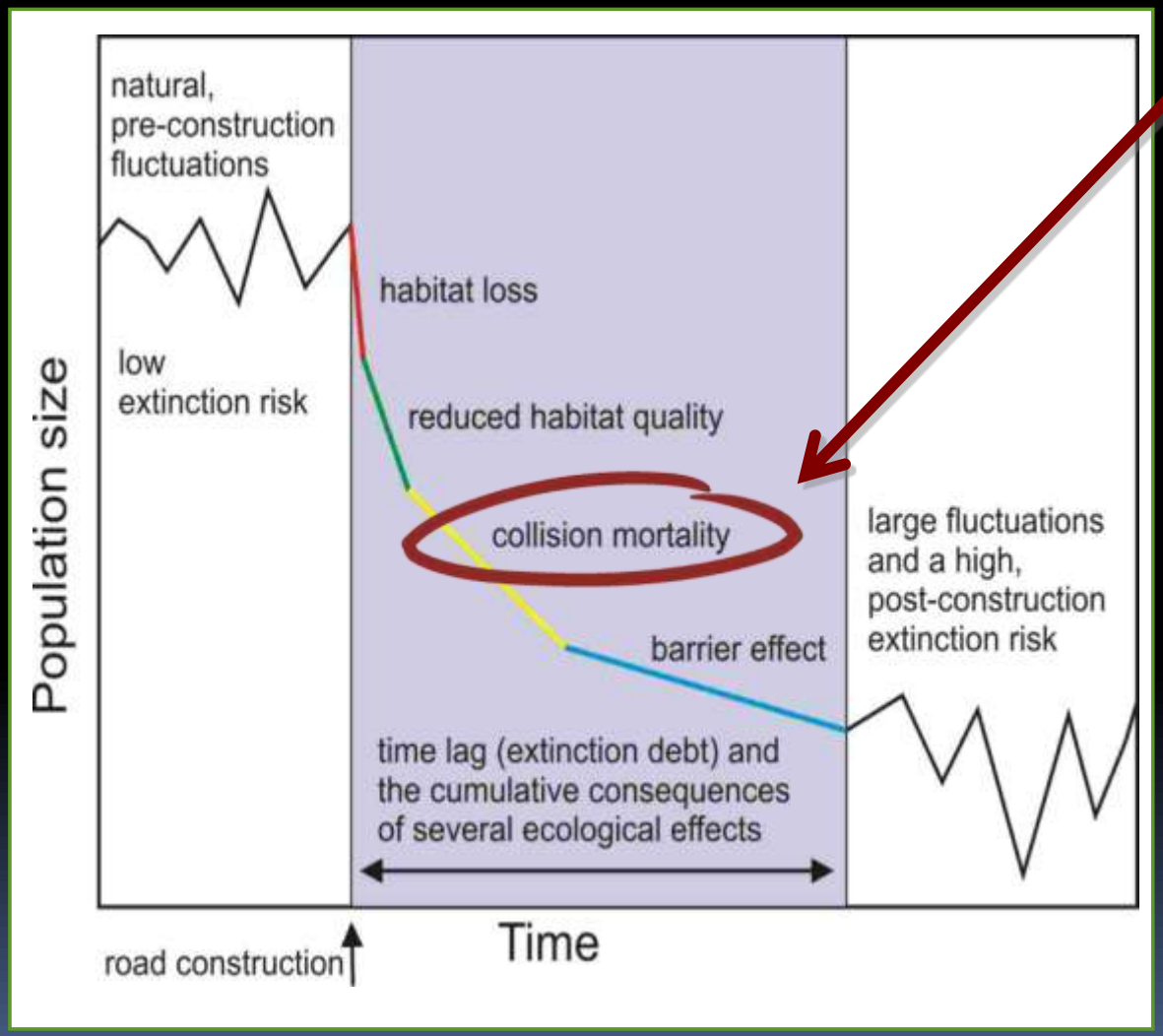
Noise pollution

e.g. Schaub A, Ostwald J, Siemers BM (2008) Foraging bats avoid noise. Journal of Experimental Biology 211: 3174-3180.

Chemical pollution

Evidence for insects, not for bats.

What effects *might* roads have?



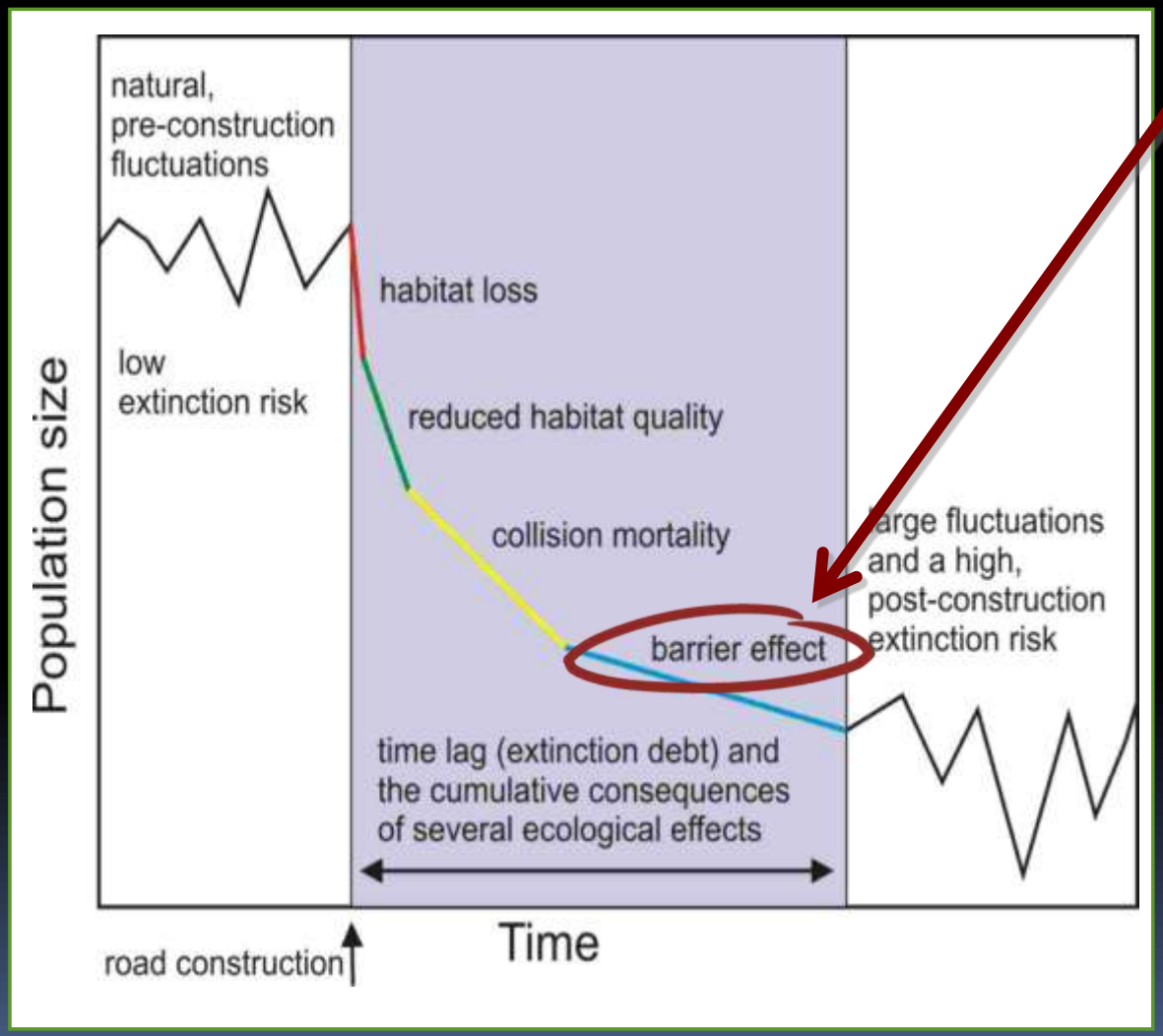
Roadkill

e.g. Russell AL, Butchkoski CM, Saidak L, McCracken GF (2009) Road-killed bats, highway design, and the commuting ecology of bats. Endangered Species Research 8: 49–60.

Lesinski G, Sikora A, Olszewski A (2010) Bat casualties on a road crossing a mosaic landscape. European Journal of Wildlife Research 57: 217–223.

Casualties 0.3-6.8 bats/km/year
=
15,000-340,000 per year in UK

What effects *might* roads have?

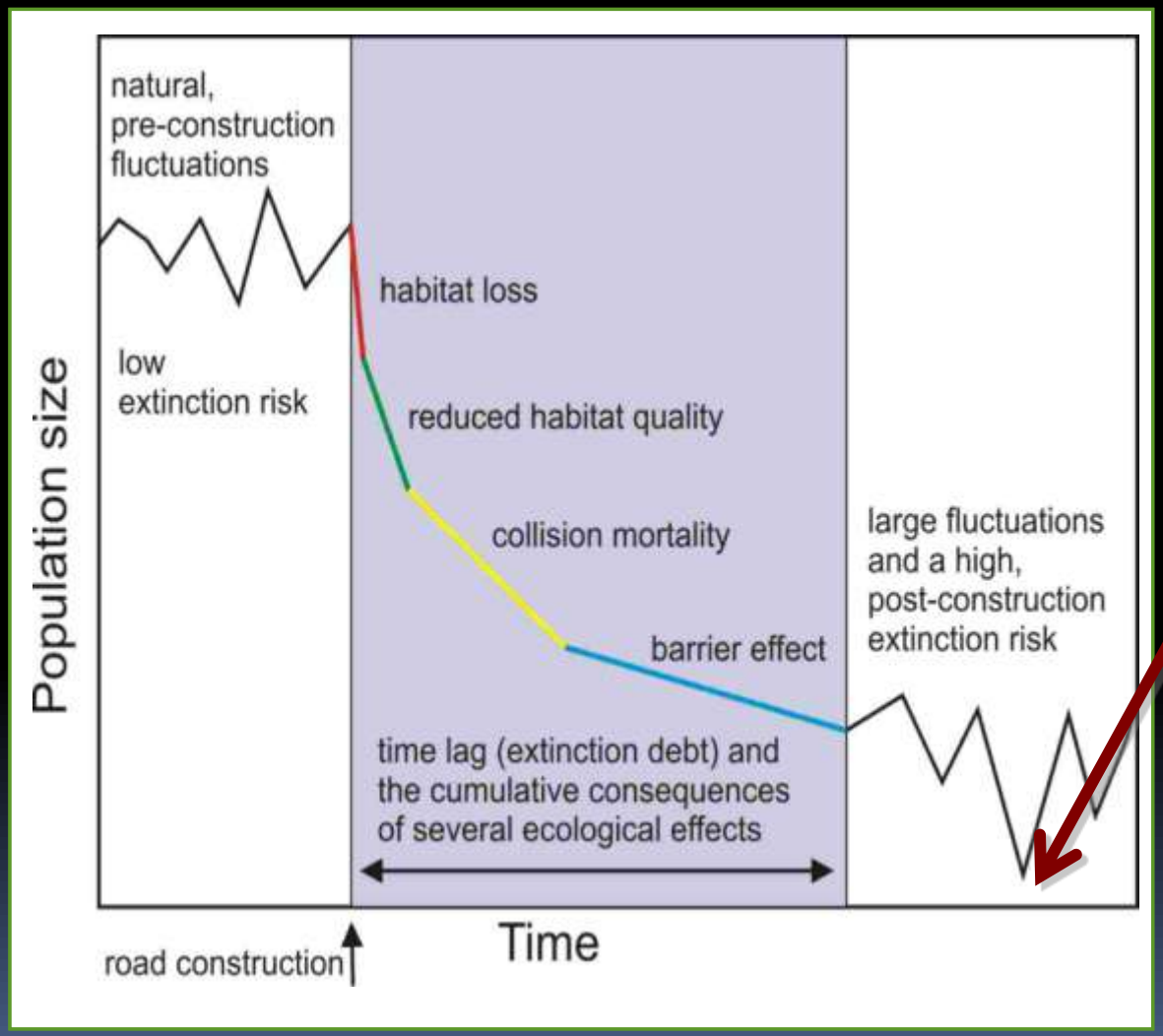


Reduced foraging area

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?



Population decline and extinction risk?

All bats are protected under European law

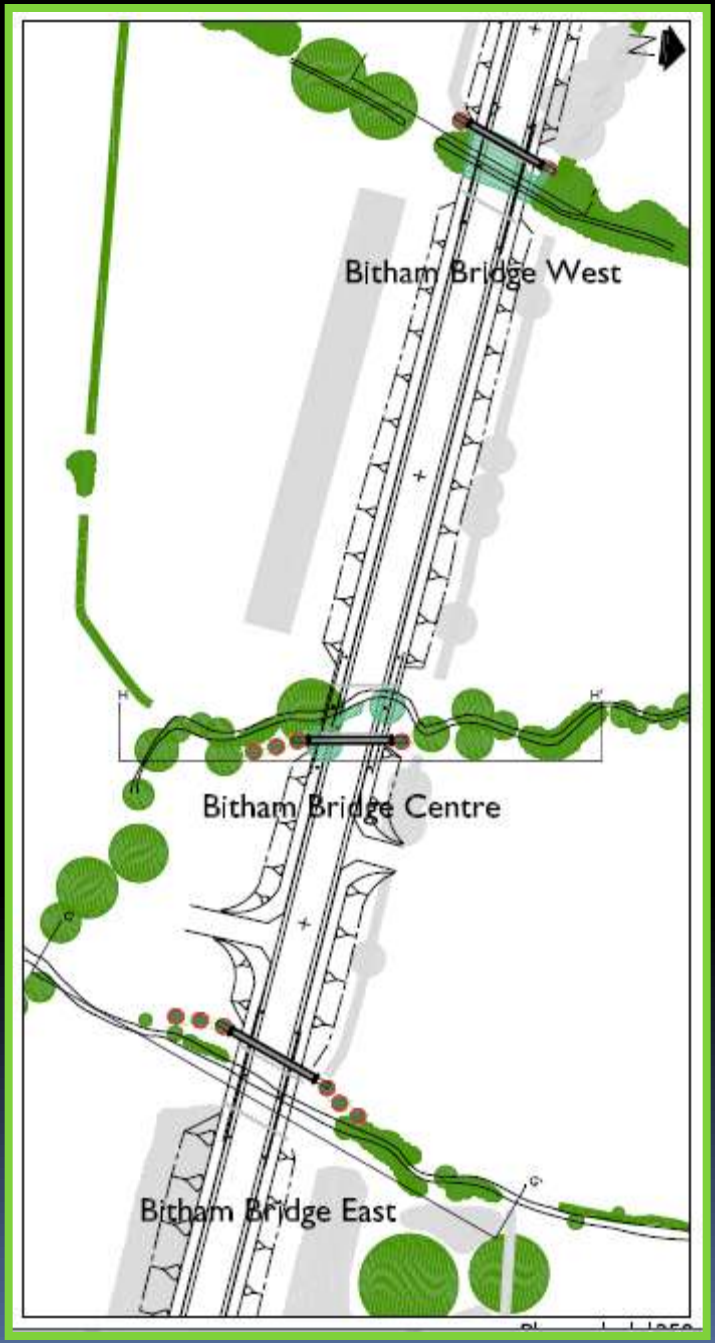
Development has an obligation to:
1. Avoid
2. Mitigate
3. Compensate
4. Enhance

Assumed that roads may affect bats:

Created a rapidly-growing 'industry' in environmental impact assessment and mitigation

It's controversial

A public planning inquiry asked me:
Does mitigation work?



Are roads a threat to bats at the population level?

Does the substantial legal and commercial industry surrounding bats protect them and help maintain populations?

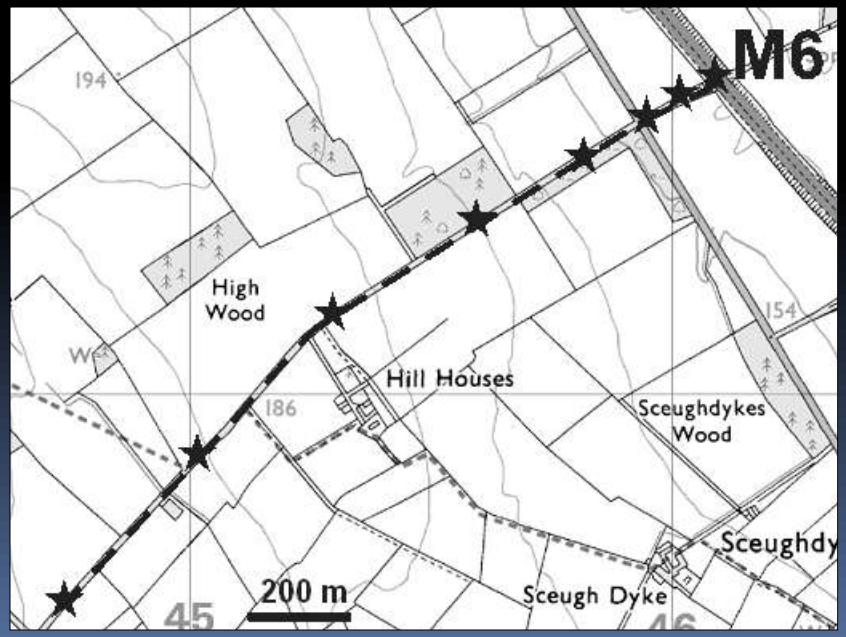
Framed as questions we can address scientifically:

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

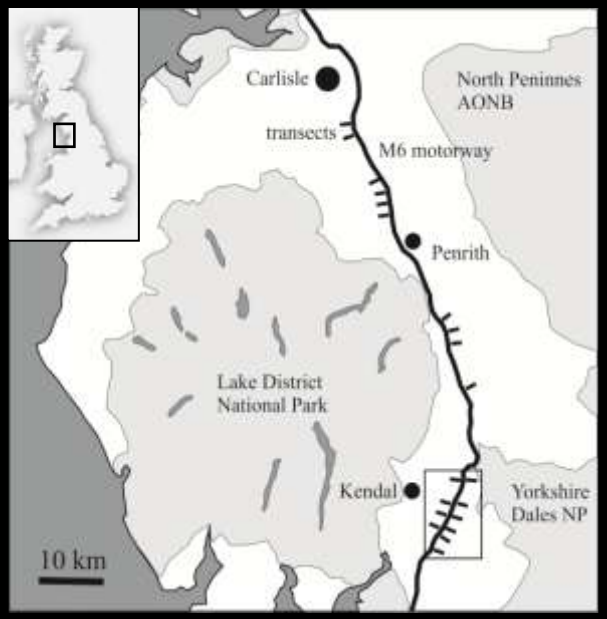
2. Do mitigation strategies help bats to cross roads safely?

Are bat activity and diversity related to road proximity?

- 20 X 1.6 km transects perpendicular to the road at each site
- Recorded bat activity and number of species at different distances along transects



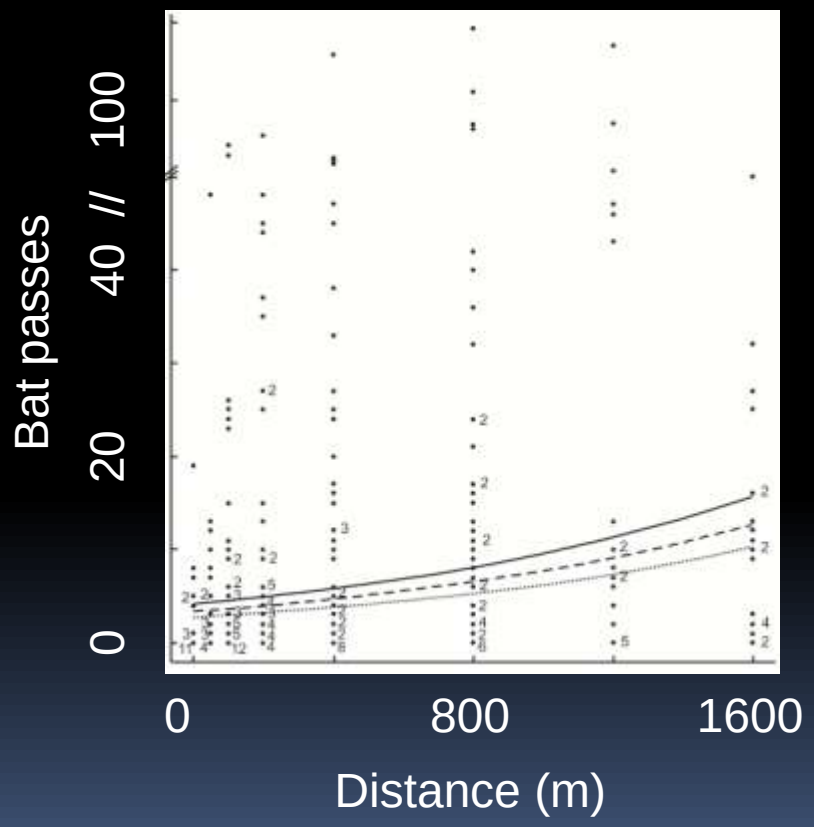
M6, Cumbria

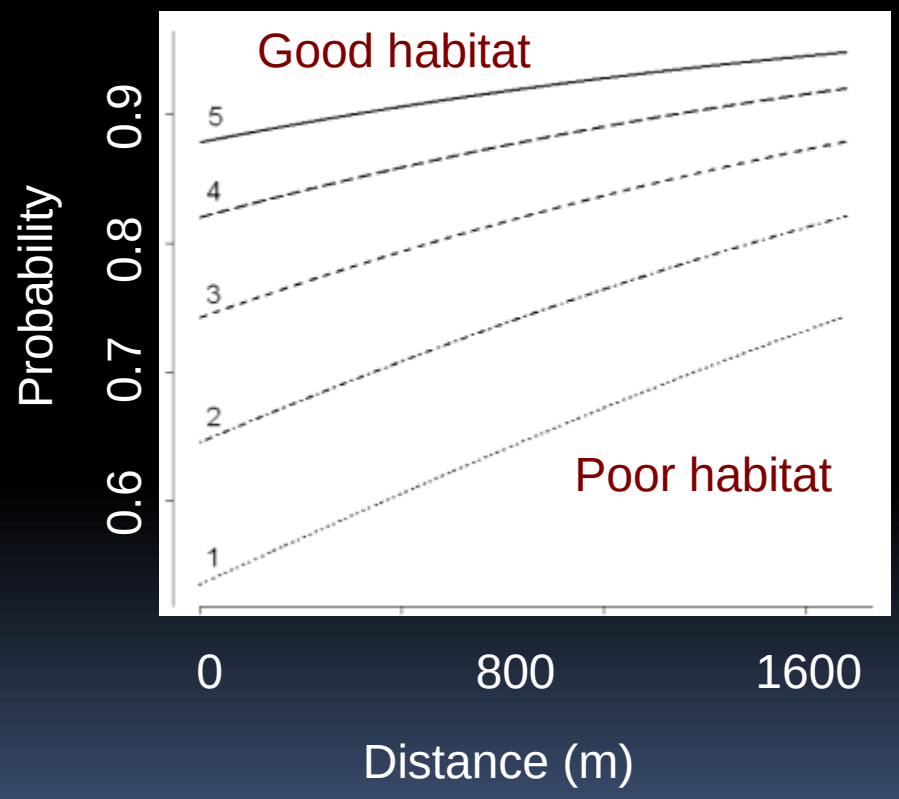


M5, Somerset & Devon

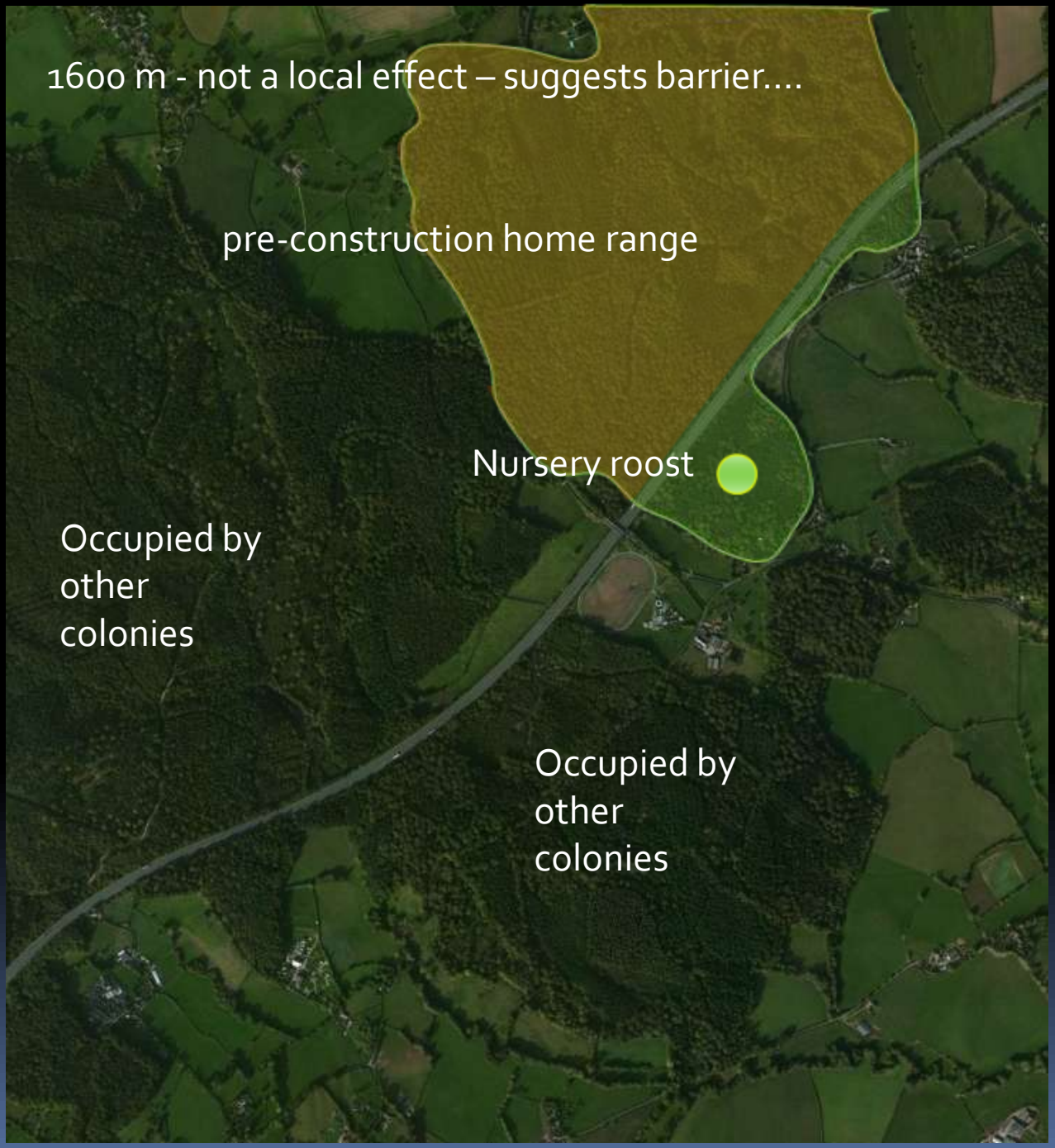
After accounting for weather and habitat:

- Total bat activity increased 3-fold between 0 and 1600 m from the road
- The number of species also increased significantly with distance





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



Access lost or compromised to pre-construction home range

Home range decreases in area and or quality

Roadkill increases

Bats stay: increased mortality, reduced reproductive output, local population decline

Bats move away from road: local population decline

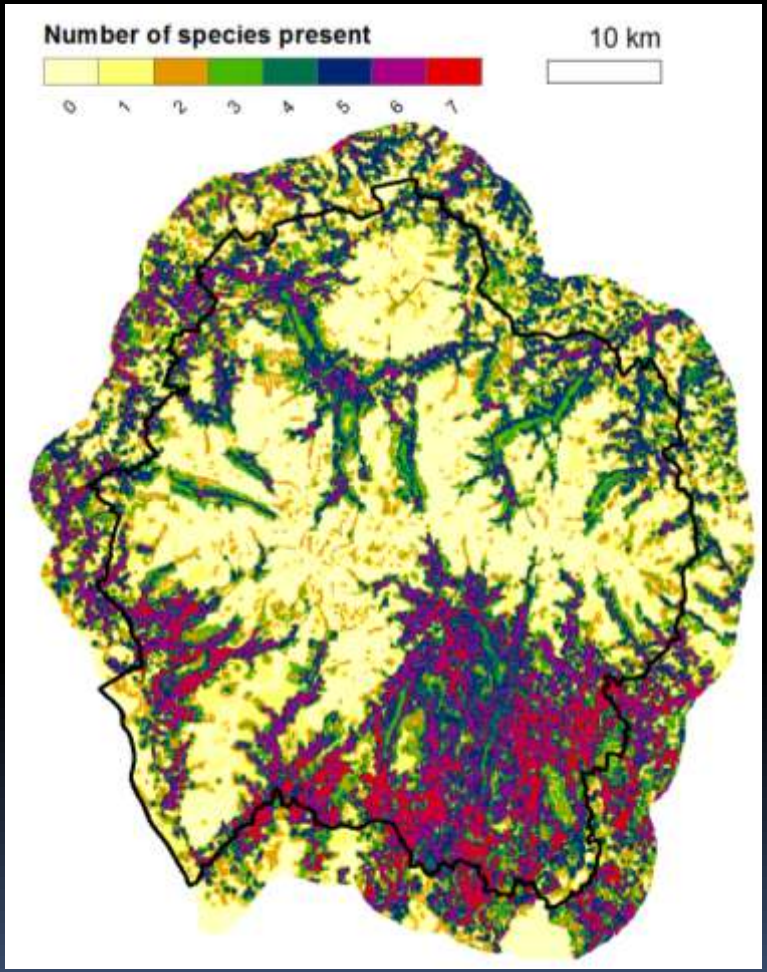
Big picture: reduced habitat quality, lowered bat populations

Habitat suitability modelling

Predictive distribution maps based on species presence and habitat data

Surprisingly accurate on small datasets

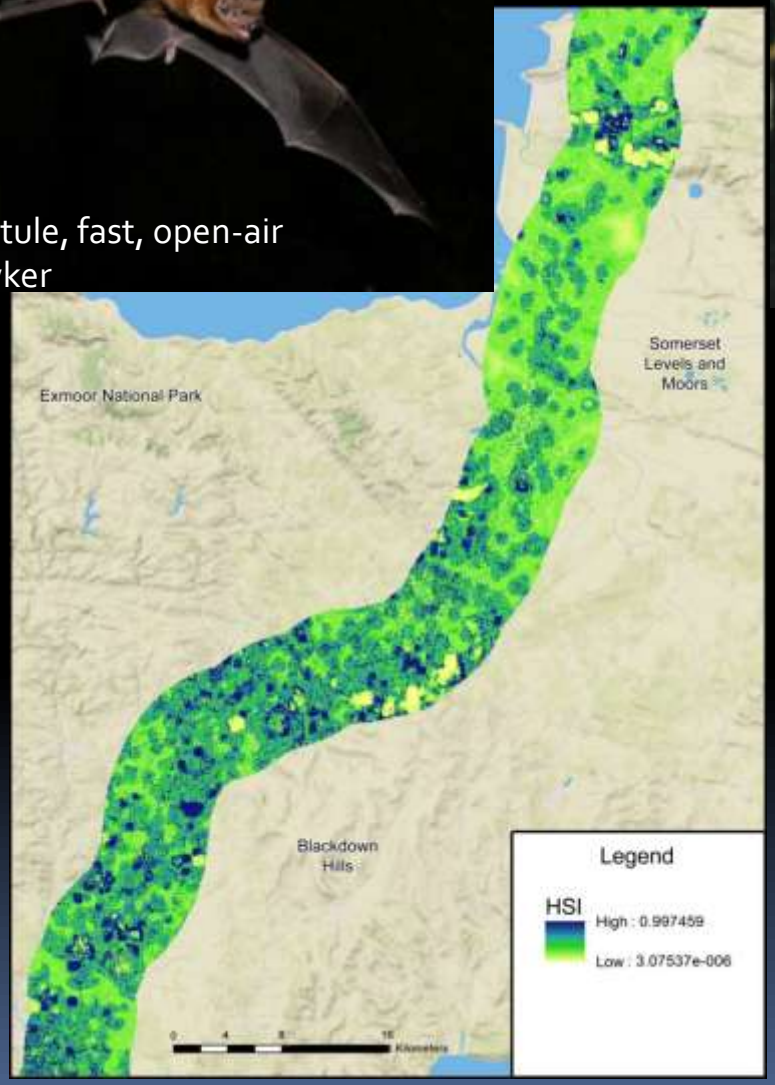
Used to look at effects of Networks of minor roads



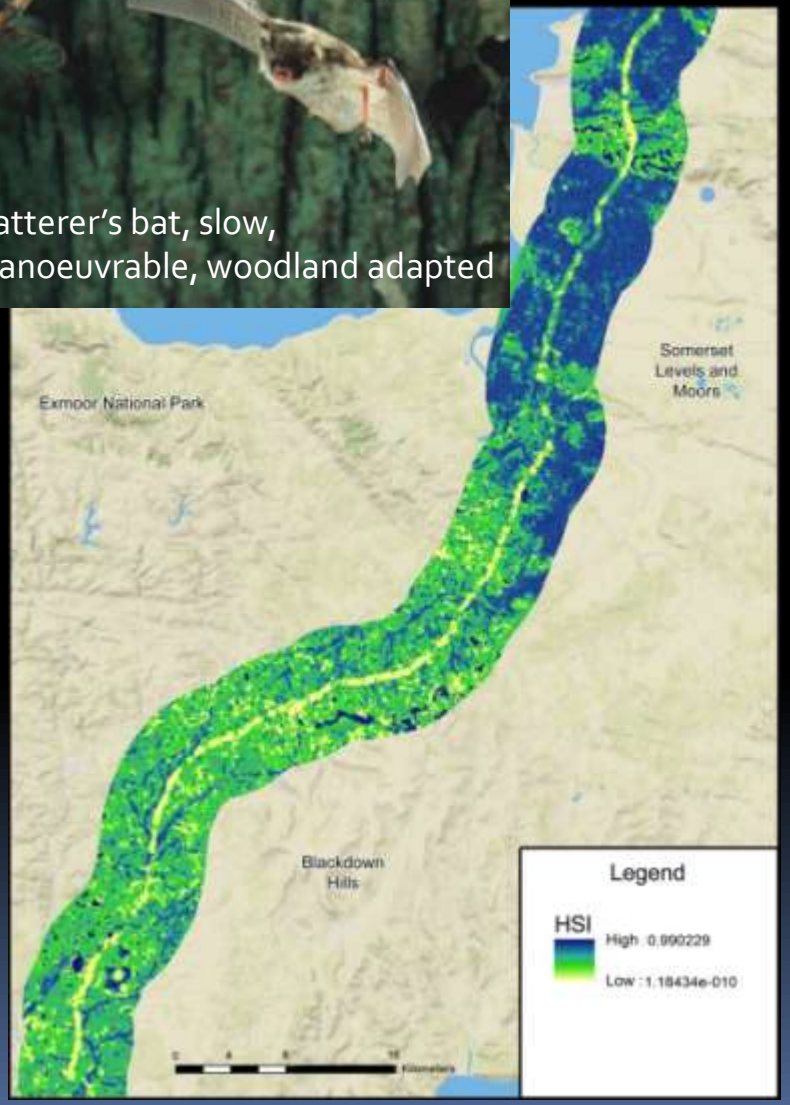
Bellamy CC, Scott CD and Altringham JD. (2013) Multiscale, presence-only habitat suitability models: fine resolution models for eight bat species. **Journal of Applied Ecology.** 50, 892-901.

Species differences

Noctule, fast, open-air hawker



Natterer's bat, slow, manoeuvrable, woodland adapted



Roads do affect bats – impact assessment and mitigation ARE important

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

We looked at two mitigation strategies: underpasses and bat 'gantries'

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

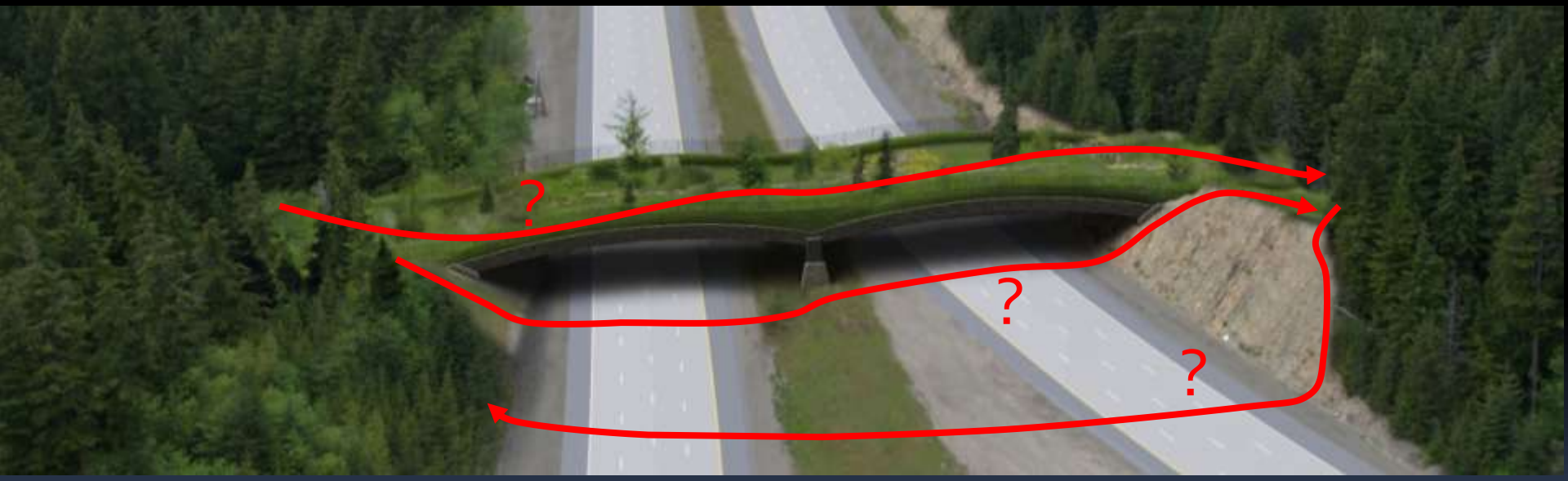
Conservation is the protection of species and ecosystems at the population level: maintaining 'favourable conservation status' means maintaining stable populations.

It is not enough to say "bats use green bridges" Current 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 still use the road?



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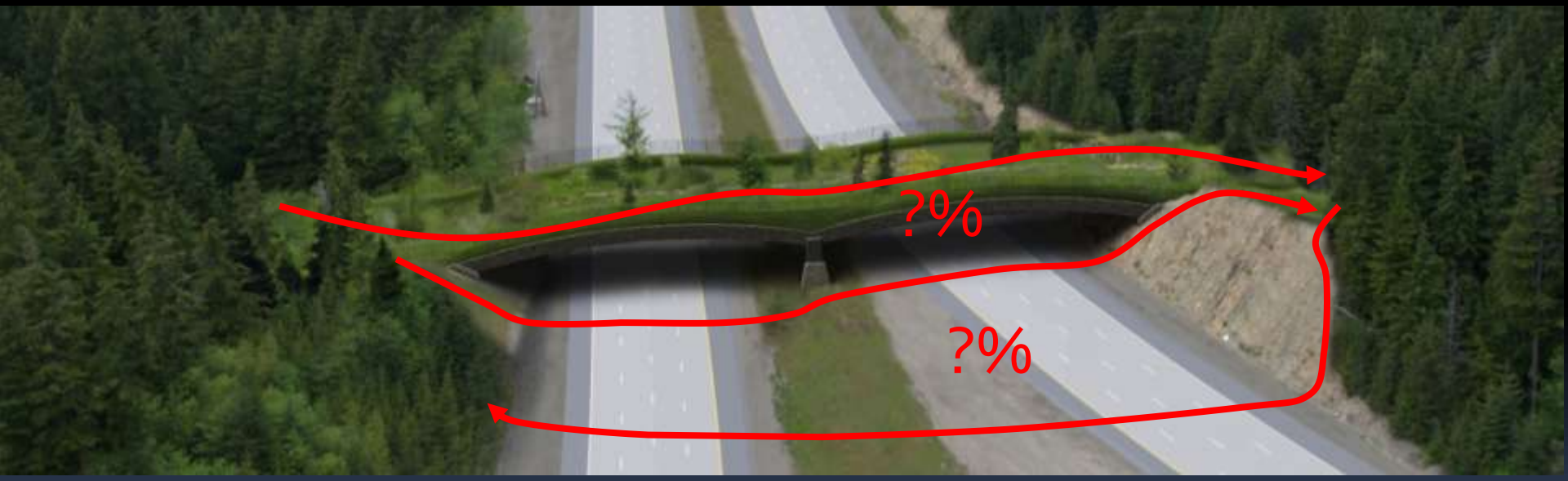
What proportion use the green bridge?



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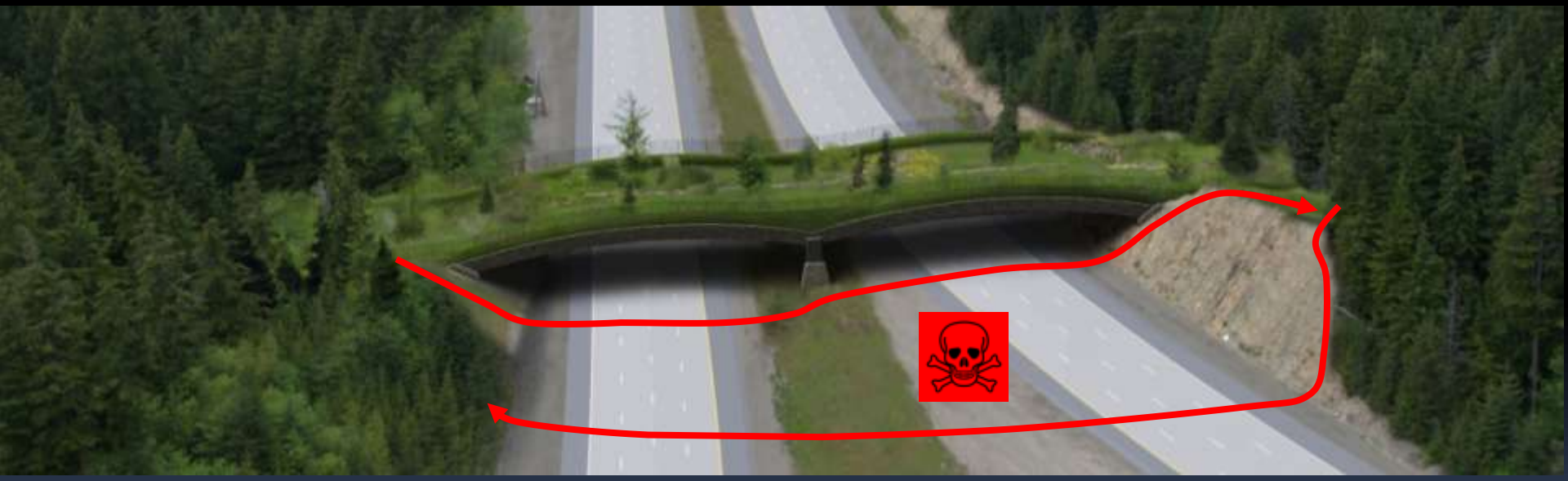
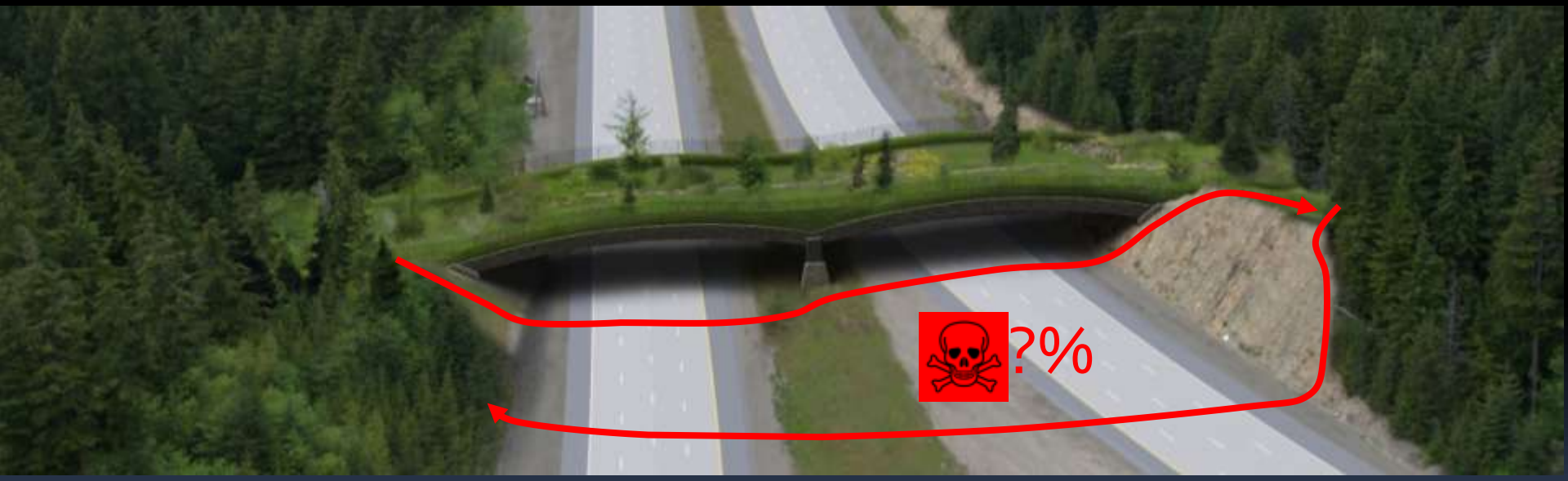
If bats cross the road, are some killed?



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?



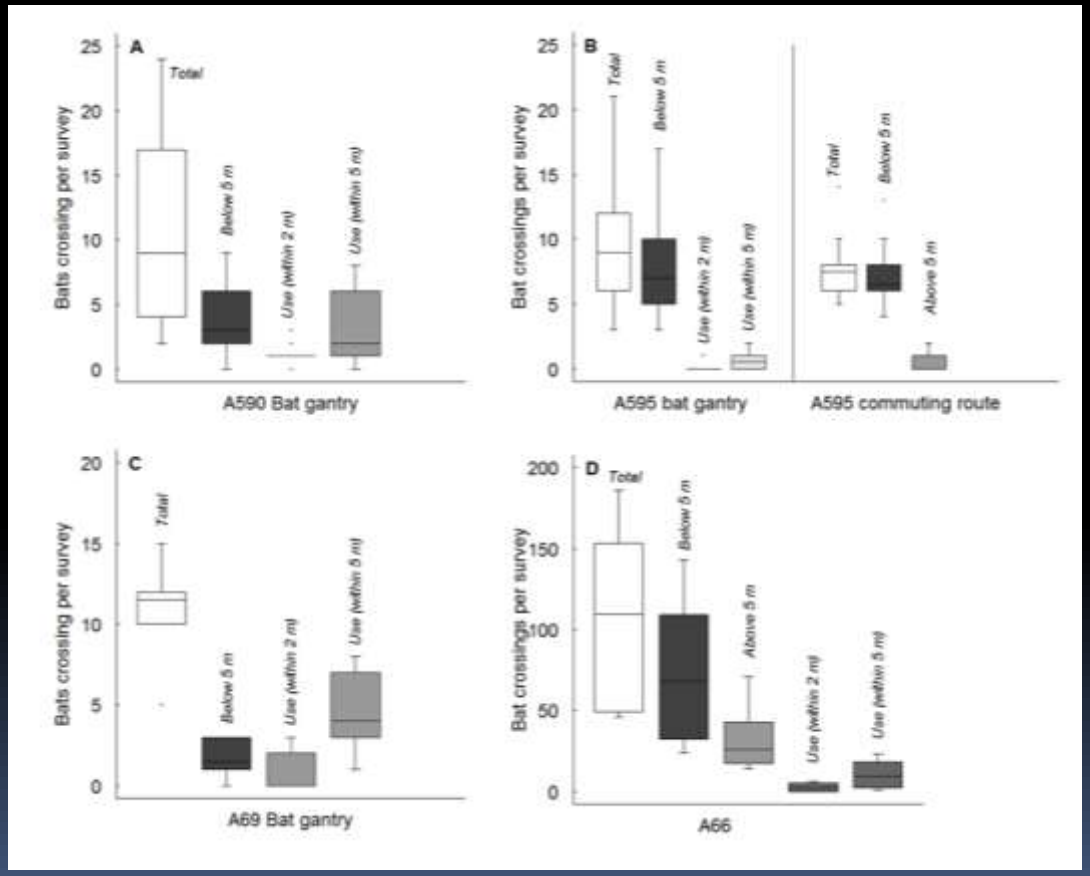
Tracked all bats crossing a road at mitigation structures and determined:

Number crossing using structure

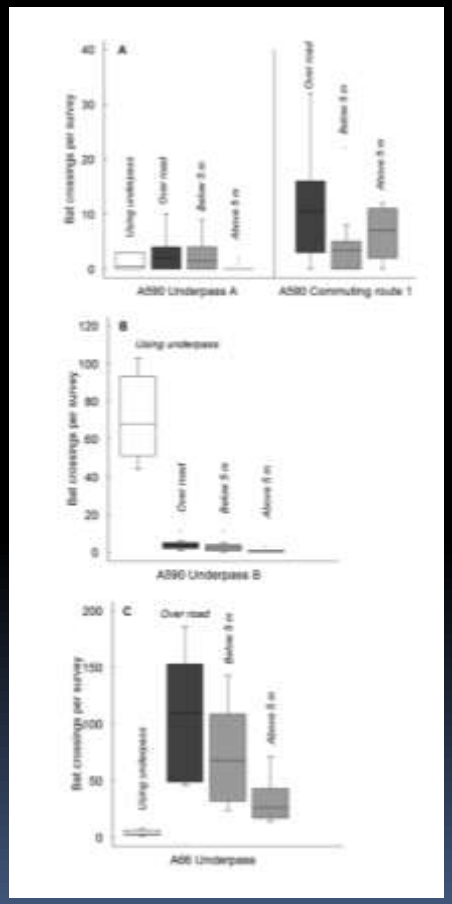
Number crossing not using structure

Number crossing safely

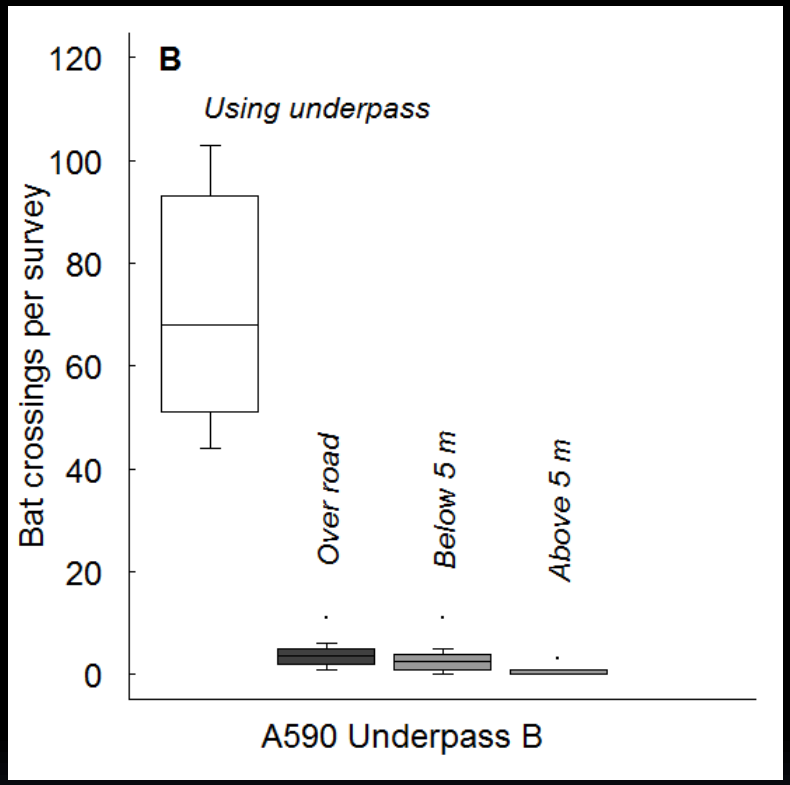
Number crossing unsafely

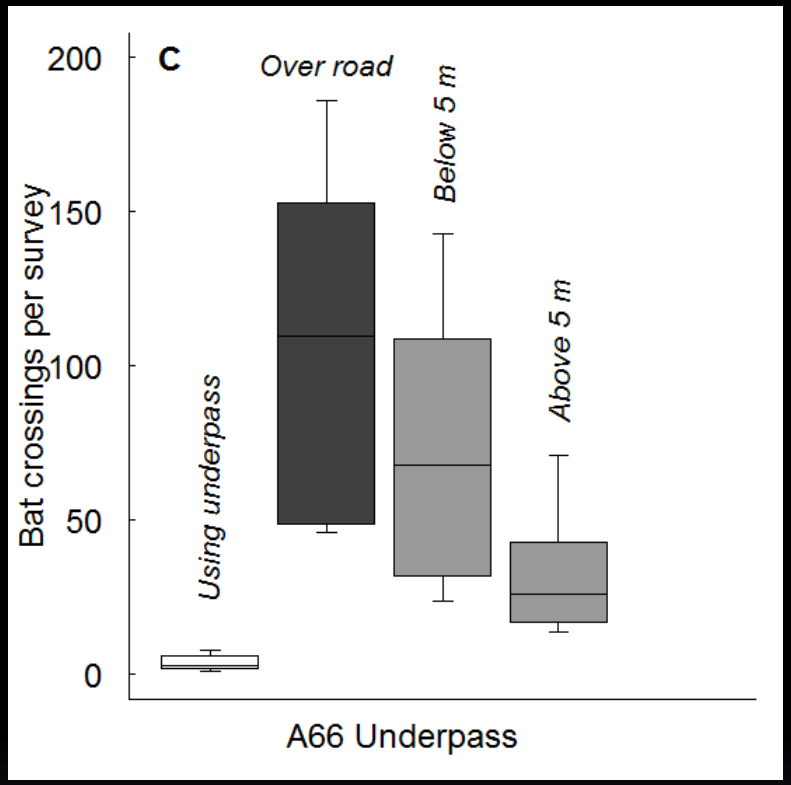


Bat gantries



Underpasses





Effective versus ineffective

Berthinussen A and Altringham JD. (2012) Do bat gantries and underpasses help bats cross roads safely. **PLoS ONE** 7(6): e38775.

1 Underpass:

96% (864 bats) flew through it in preference to crossing the road above

Located on a pre-construction commuting route

2 underpasses:

4% and 31% flew through

>60% (32 bats) crossed road unsafely

Diversion from original commuting routes unsuccessful

4 Bat gantries:

<1% - 11% 'used' the gantries

Up to 84% (751 bats) crossed road at unsafe heights

Most bats near gantries crossed roads along severed, pre-construction commuting routes at unsafe heights

1 Underpass:

96% (864 bats) flew through it in preference to crossing the road above

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2 underpasses:

4% and 31% flew th[illegible]

>60% (32 bat[illegible]ely

Diversio[illegible]muting routes unsuccessful

Ongoing work on wider range and number of structures reinforces these results

4 Bat gantries:

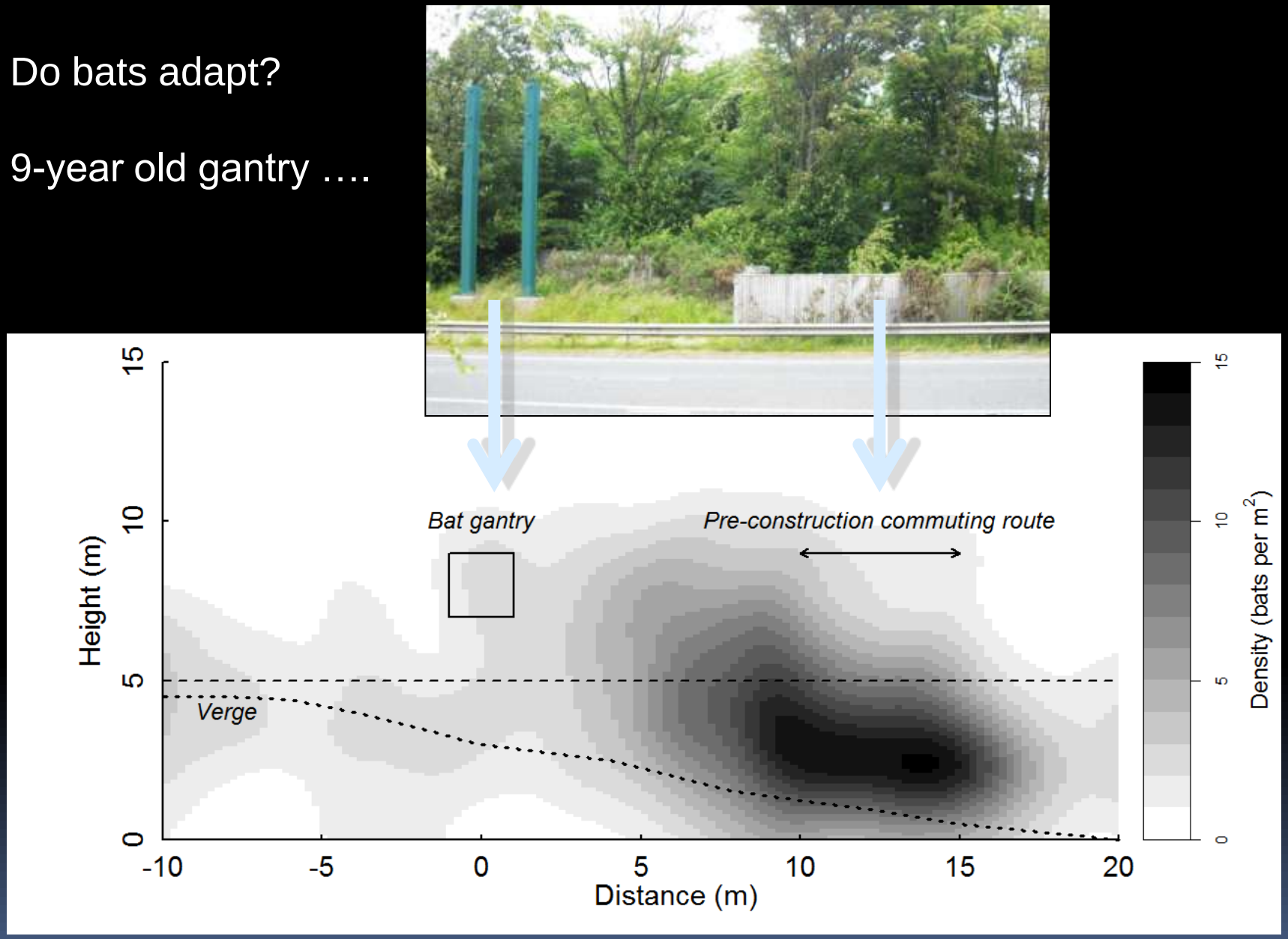
<1% - 11% 'used' the gantries

Up to 84% (751 bats) crossed road at unsafe heights

Most bats near gantries crossed roads along severed, pre-construction commuting routes at unsafe heights

Do bats adapt?

9-year old gantry ….



Kernel intensity estimation

What have we learned?

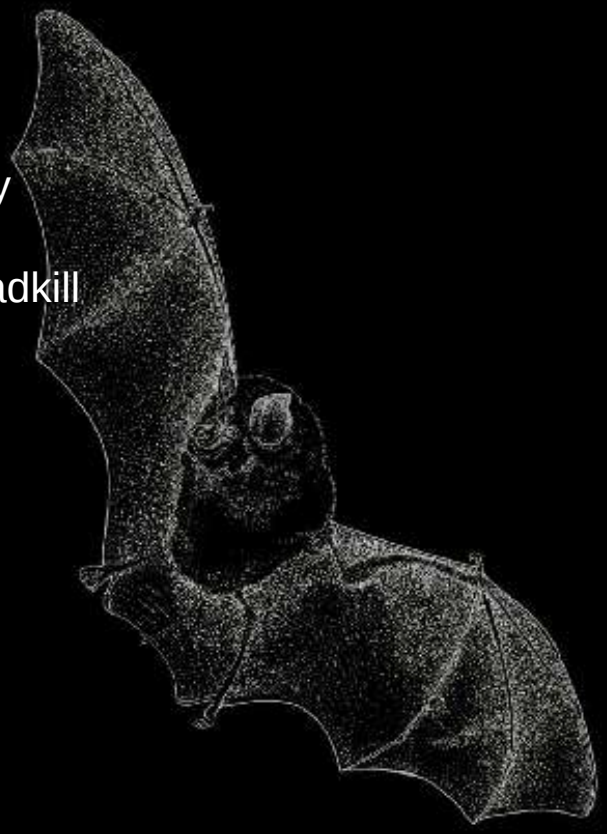
Roads can have a profound effect on bat abundance and diversity

Primary causes: habitat loss, fragmentation (degradation) and roadkill

Mitigation is therefore essential

Current European practices are inadequate:

- Goals are ill-defined
- Monitoring is badly designed and often not done
- Mitigation effectiveness untested or shown to be failing



Where next?

A more evidence-based approach to mitigation

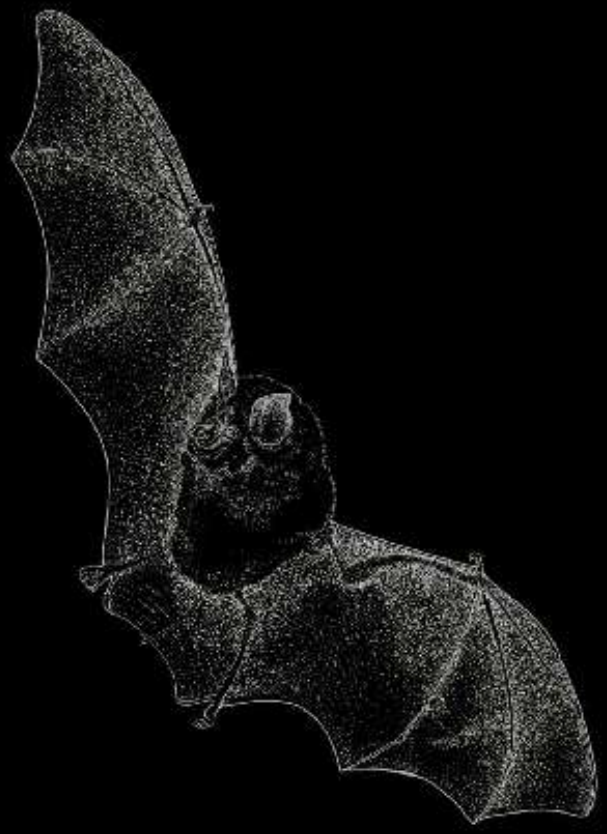
Some of the work done may not even be necessary

Some is clearly ineffective

Monitoring is seen as expensive,
but large sums are spent on untested mitigation

The consequences: wasted resources, ineffective mitigation

It's not rocket science and it need not be expensive



Is this scenario unique to bats?

Several European studies suggest not:

Poor design, target setting, implementation, reporting, enforcement……

Rundcrantz K. (2006) Environmental compensation in Swedish road planning. *European Environment*, **16**, 350-367.

Tischew S, Baasch A, Conrad MK & Kirmer A. 2010. Evaluating restoration success of frequently implemented compensation measures: results and demands for control procedures. *Restoration Ecology*, **18**, 467-480.

Villarroya A & Puig J. 2013. A proposal to improve ecological compensation practice in road and railway projects in Spain. *Environmental Impact Assessment Review*, **42**, 87-94.

Do you recognise these problems or are you doing things better?