Evaluating the Impact of Roads on Insectivorous Bats: An Australian Perspective

Manisha Bhardwaj

Rodney van der Ree, Lindy Lumsden,
Kylie Soanes, and José Lahoz-Monfort

What to expect:

1. Road effect zone
2. Use of underpasses
3. Impact of light on the use of underpass

Study Area Information

- 3 highways in Victoria, Australia (southern most points approximately 200 km from Melbourne, Victoria)
- Predominately agricultural landscape with patches of forest
- Supports 12 species of bats: *Austronomus australis, Chalinolobus gouldii, C. morio, Nyctophilus-Myotis* complex (*Nyctophilus geoffroyi*, *Nyctophilus gouldi* and *Myotis macropus*), *Mormopterus ridei, M. planiceps, Scotorepens balstoni, Vespadelus darlingtoni, V. regulus,* and *V. vulturnus*

Q1. What is the road effect zone for the bats in this region?

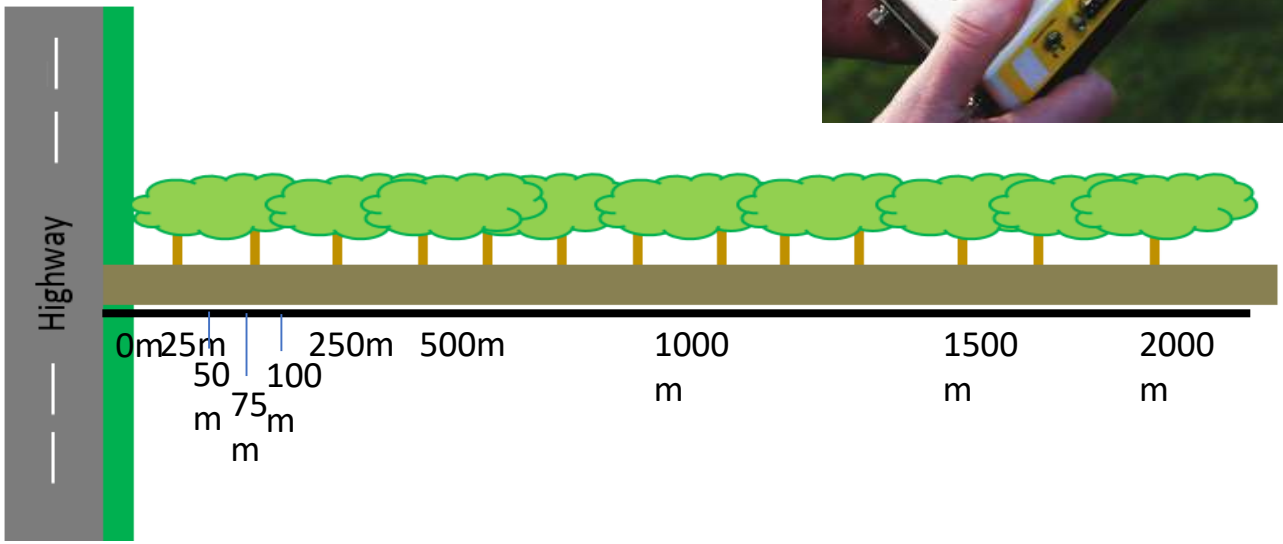
- Ecological impacts of roads tend to extend into the habitat surrounding a road – this distance is known as the '**road effect zone**'
- Asked: Does the activity of bats (number of calls per night) change with distance from the road?

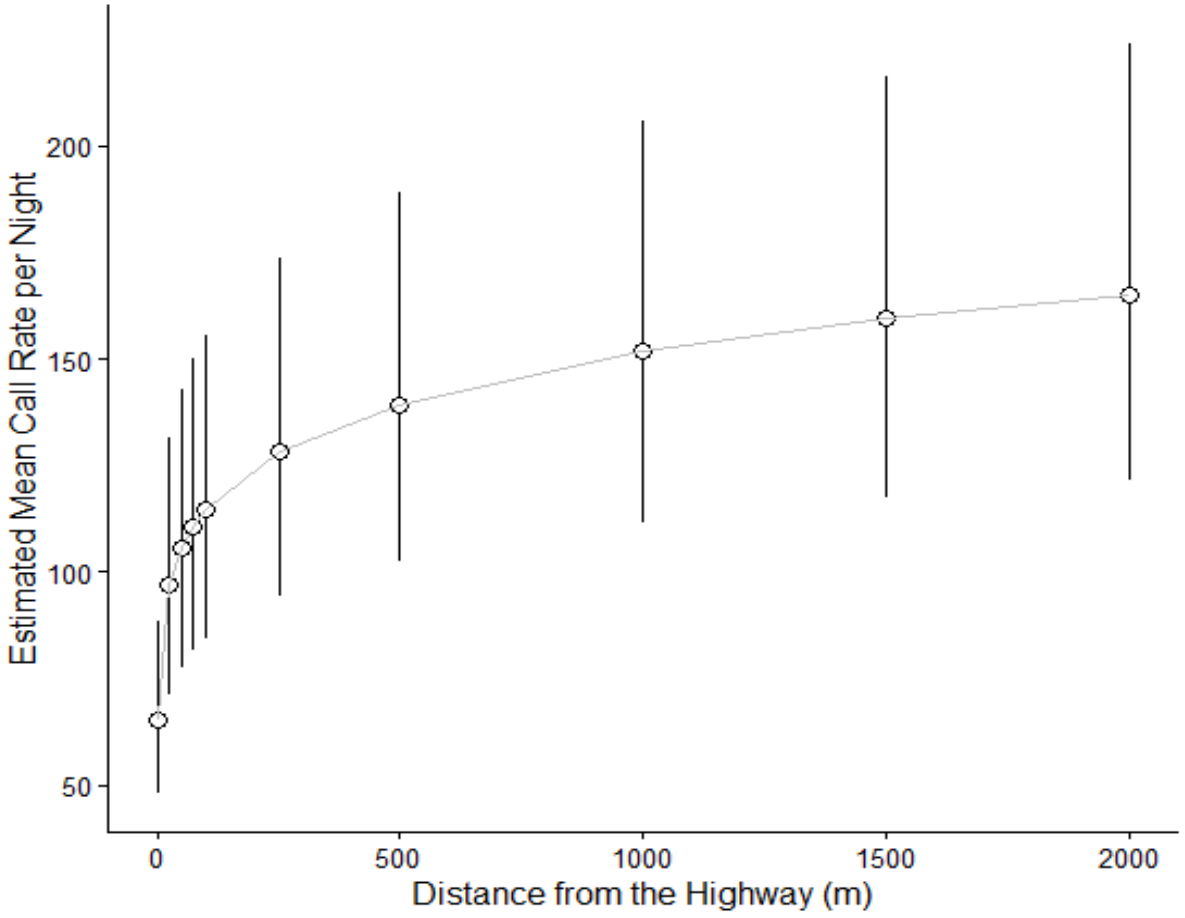
Road Effect Zone for Bats

Methods

- Surveyed 18 transects (small, rural roads that met each highway perpendicularly) using Anabat detectors (Calder Freeway (n=5), Goulburn Valley Freeway (n=6), and Hume Freeway (n=7))
- Transects were tree lined on both sides, and often adjacent to cleared agricultural lands.
- Place 10 detectors at different intervals from the road
- Sampled for 2 consecutive nights at each transect (at each distance)

- Analysis:
  - Identified 43, 355 calls to species/species complex
  - Poisson Regression Model
    - Response: nightly call rate
    - Predictors: distance, temperature, canopy cover, number of large trees
    - Random effect: transect





Results

- Overall call activity (for all species combined) decreases with distance from the highway. Greatest rate of change within 200 m, deemed the road effect zone

Next step: Identify the cause of the road effect zone

One hypothesis is that there may be fewer insects (prey for bats) near the road, and therefore bats are less active near the road. Therefore, we aimed to identify the road effect zone for nocturnal flying insects

Road Effect Zone for Nocturnal Flying Insects – Methods

Methods

- Collected insect samples using light traps
- Same transects, but different nights, 2 nights of sampling as well
- Sorted samples to order, dried and weighed each order for a measure of biomass

Analysis

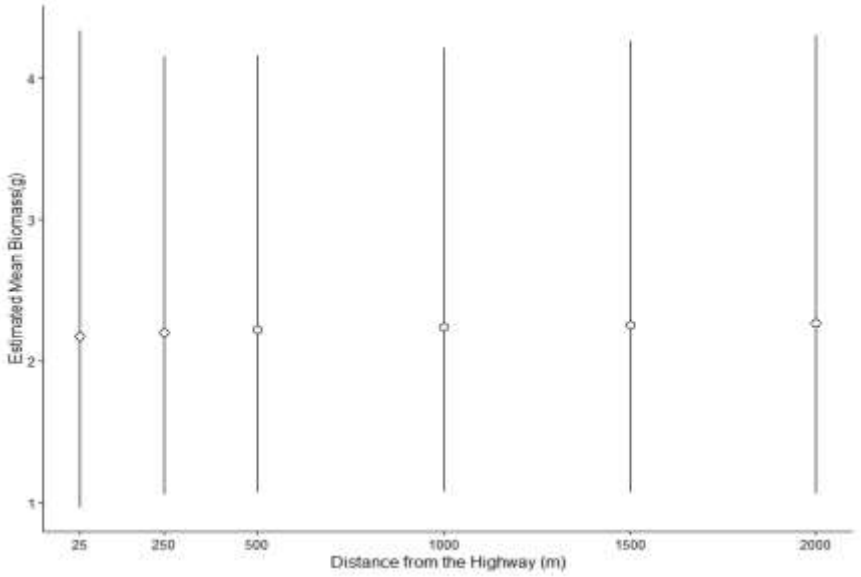
- Collected, on average, 8.94 g of insects per trap from 10 orders
    - Normal Distribution Model
        - Response: nightly biomass per trap
        - Predictors: distance, temperature, canopy cover, number of large trees
        - Random effect: transect

Results

- Order richness or biomass of each order did not change with distance from the highway

Watch this space: study is in press at Ecology and Evolution

Next step: Need to continue to explore the causes of the road effect zone
Recommended to vehicle presence (including light and traffic noise effects) as the next possible cause.



Q1 summary:

- Road effect zone of 200 m for bats
- Not caused by lack of prey

- Need to consider and compensate for additional habitat loss
- Need to identify cause of Road Effect Zone

Q2. Will bats in this region use underpasses?

- Evidence of crossing structure (underpass) use by bats in other parts of the world
- Asked: What is that activity of bats above and under two types of crossing structures in this region?

Q2. Will bats in this region use underpasses?

Methods

- Compared the activity of bats above and under 2 types of underpasses that were installed with terrestrial species (e.g. kangaroos, koalas, wallabies) in mind.
- 'Bridges' were 3 – 15 m tall and 20 – 30 m wide, vegetated throughout
- 'Culverts' were 3 m tall and 3 m wide, concrete throughout
- Also sampled at sections of the highway with no crossing structure ('unmitigated')
- Collected calls under and above the structures for 2 consecutive nights

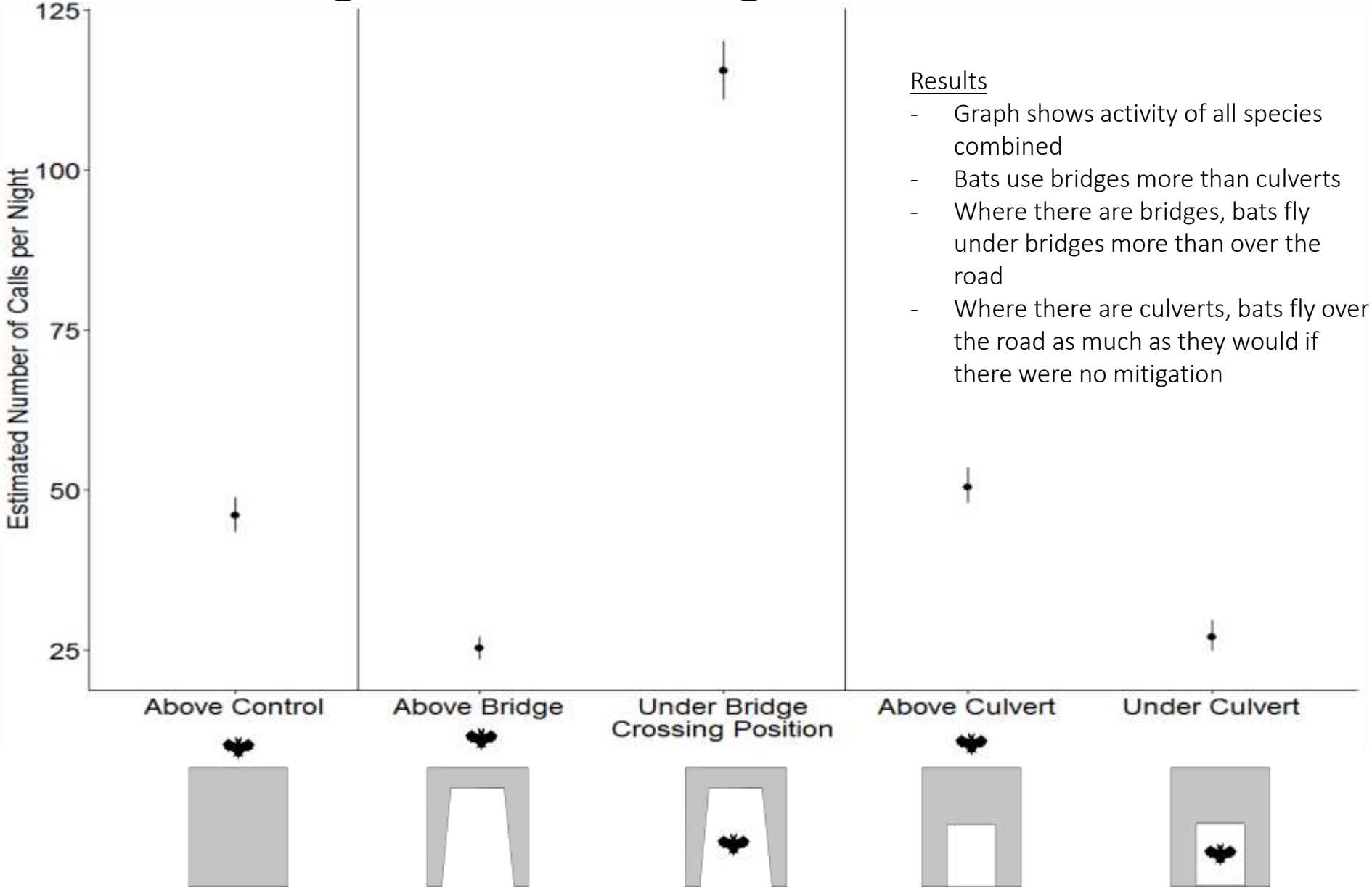
Analysis

- Identified 23, 760 calls to species/species complex
- Poisson Regression Model
  - Response: nightly call rate
  - Predictors: position, number of calls in surrounding area, temperature and moon phase

Bridges

Culverts

Crossing Rate in Bridges and Culverts



Results

- Graph shows activity of all species combined
- Bats use bridges more than culverts
- Where there are bridges, bats fly under bridges more than over the road
- Where there are culverts, bats fly over the road as much as they would if there were no mitigation

Bhardwaj M, Soanes K, Straka T, Lahoz-Monfort J. J, Lumsden, L. F, van der Ree, R. (2017). Differential use of highway underpasses by bats. *Biological Conservation,* **212**, 22-28. doi: 10.1016/j.biocon.2017.05.022

Q2 summary:

- Bats will use underpass crossing structures
- Bridges more than culverts
  - Vegetated, bigger

- Where possible: Install bridges!!!!!

Q3. How does lighting influence the use of crossing structures by bats?

- Road agencies may want to light structures at night for human co-use but this can influence their use by bats
- Asked: How does the activity of bats above and under structures change when they are lit?

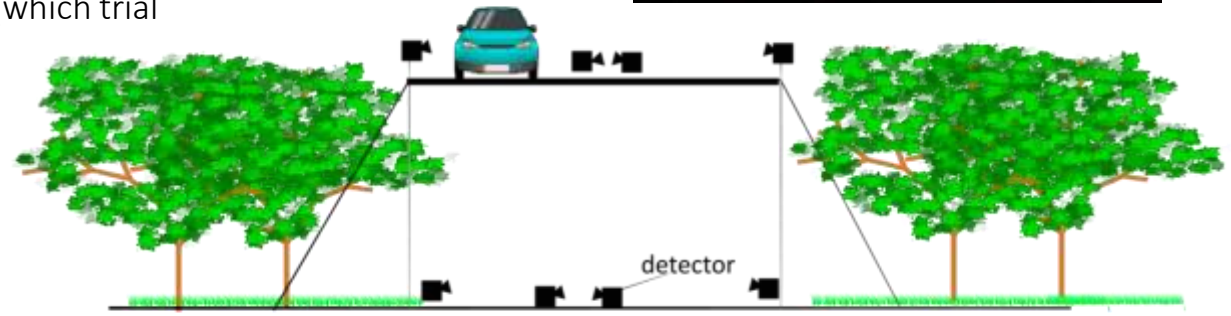
Q3. How does lighting influence the use of crossing structures by bats?

Methods

- Used a Before-During-After-Control-Impact design to compare the activity of bats above and underpasses when they are lit
- Completed 4 trials
  - In each trial, simultaneously monitored 2 bridges and 2 culverts for 16 nights
  - At 1 bridge and 1 culvert, monitored activity for 4 nights before lighting, 8 nights during lighting, and 4 nights after lighting
  - At the other bridge and culvert, monitored for the same 16 nights with no lights.

Analysis

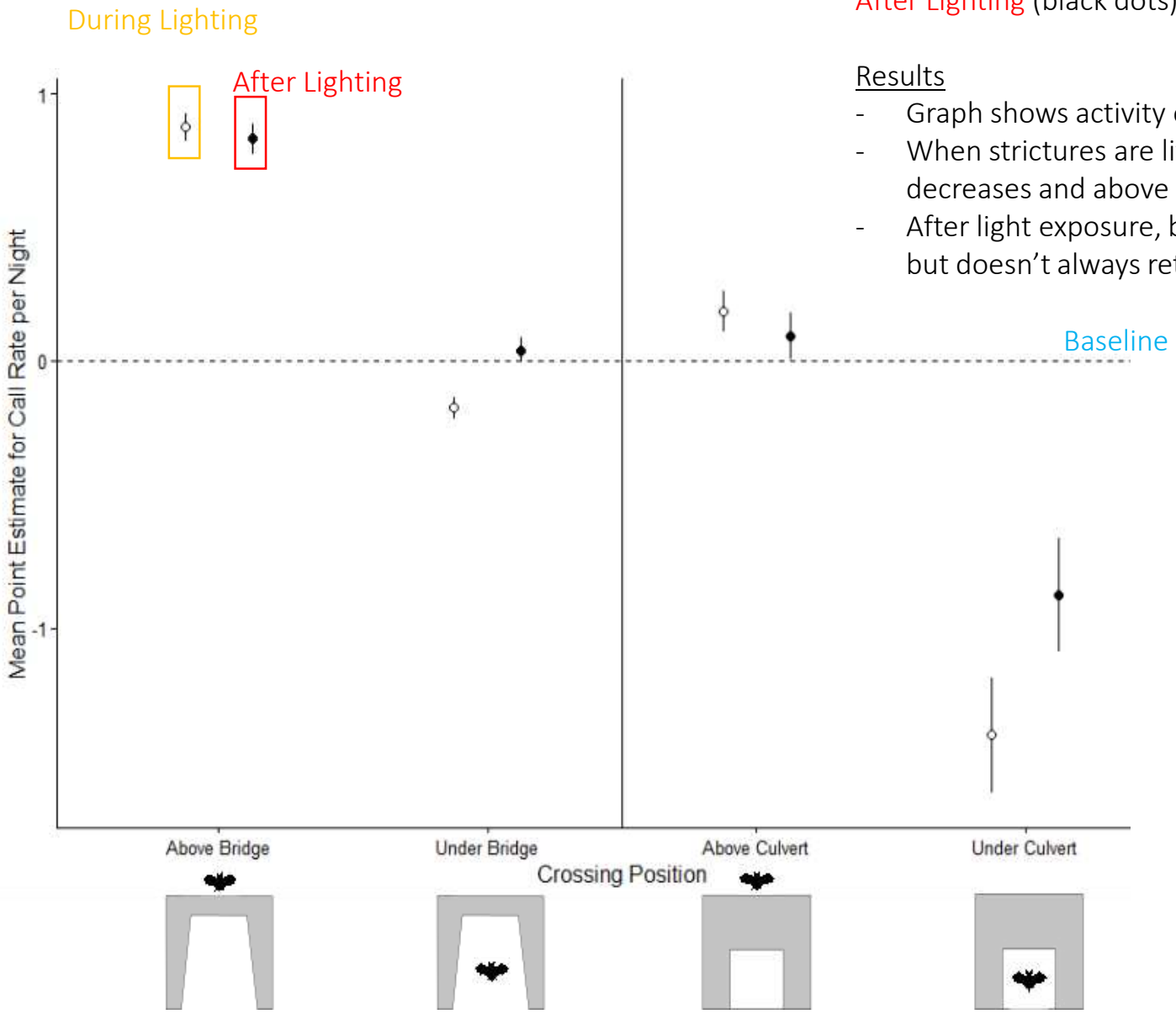
- Identified 212, 504 calls to species/species complex
- Poisson Regression Model
  - Response: nightly call rate
  - Predictors: position, treatment phase, temperature, moon phase, trial (which trial data came from)
  - Random Effect: site



Baseline (dotted line) = activity in each position before light exposure
During Lighting (white dots) = activity when structures are lit underneath
After Lighting (black dots) = activity after structures are lit

Results

- Graph shows activity of all species combined
- When strictures are lit, bat activity under structures decreases and above structure increases
- After light exposure, bat activity approaches baseline, but doesn't always return



Q3 summary:

- When structures are lit, crossing increases above the structure and decreases under the structure
  - *Crossing structures no longer serving their purpose*

- Do not light underpasses
- IF YOU MUST, use culverts for ‘co-use’

Main Conclusions

- Roads act as a filter to the movement of bats
- Bats not as active in the 200 m closest to the road
  - Should be compensated for in planning
- Road effect zone not because of vegetation, streetlighting or prey availability
  - Next Step: Noise and Vehicle Presence

Main Conclusions

- Bats use underpass bridges more than culverts
  - Bridges should be installed where possible
- Lighting underpasses reduces their use by bats
  - Don’t light underpasses!
  - *OR use culverts for co-use if necessary*

Thank you ☺

Manisha Bhardwaj
manisha.bhardwaj@live.ca

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