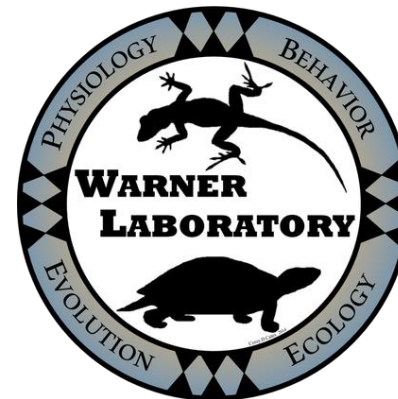
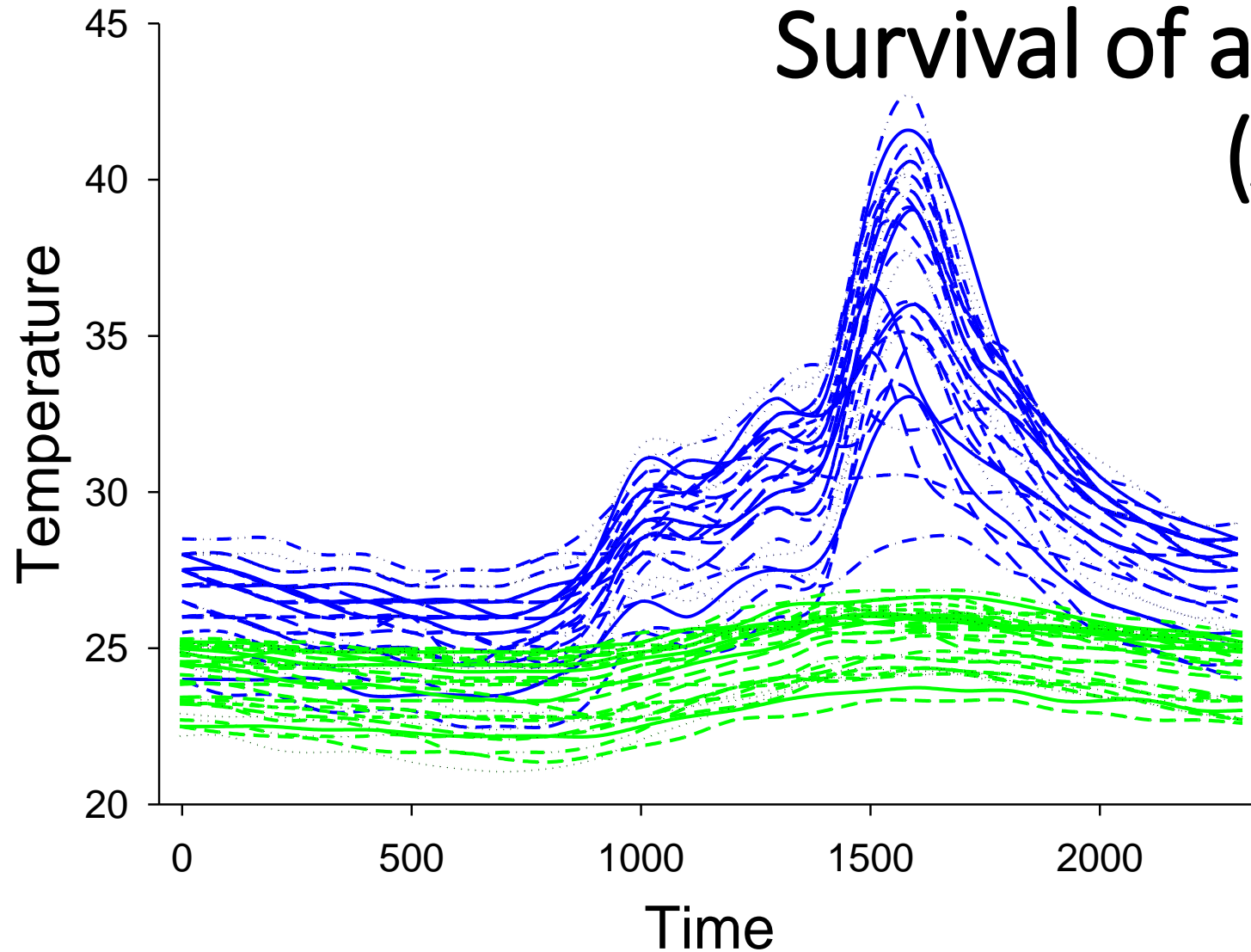


Thermal Spikes Caused by the Urban Heat Island Effect Result in Differential Egg Survival of a Non-native Lizard (*Anolis cristatellus*)

Joshua M Hall

Daniel A Warner



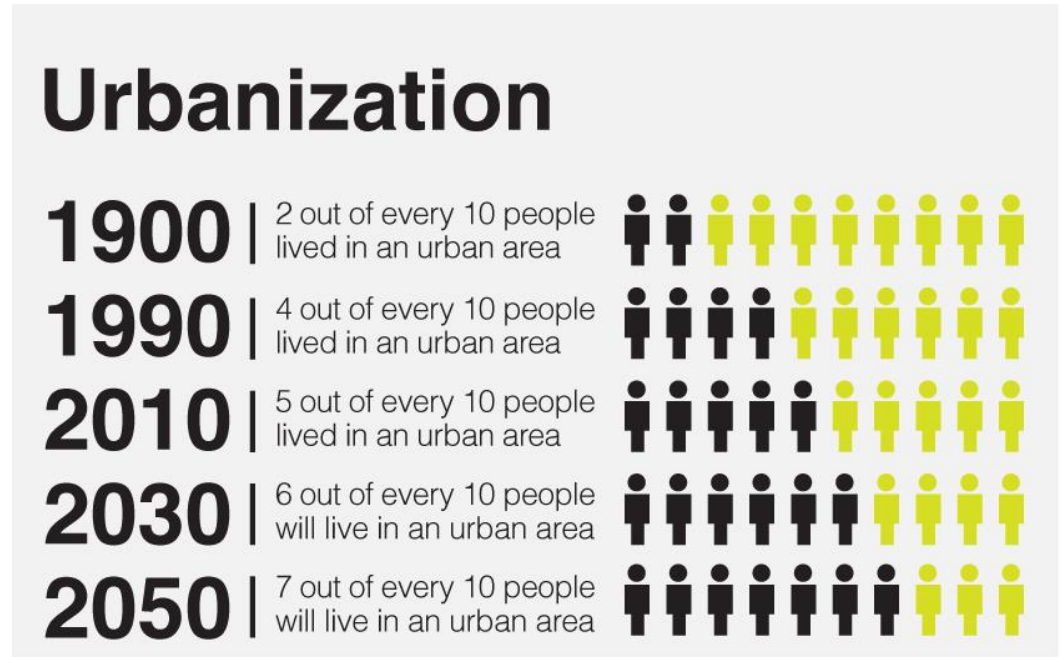
Urbanization is Global

Urbanization is Global

- Human population estimated to reach 9 billion by 2050
- Urban land area is expanding twice as fast as population
- Urban habitats create novel, conditions, i.e. Urban Heat Island Effect

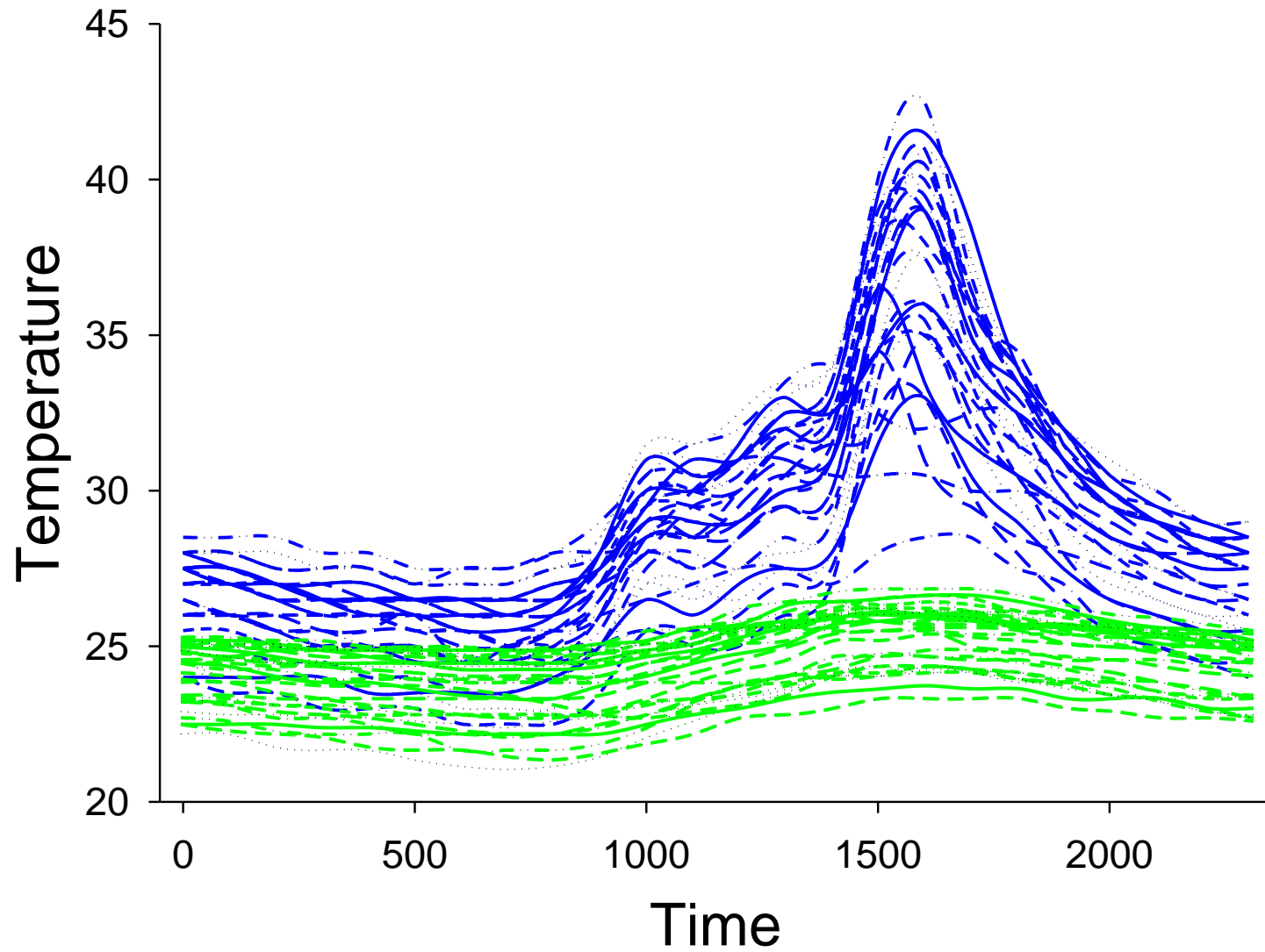
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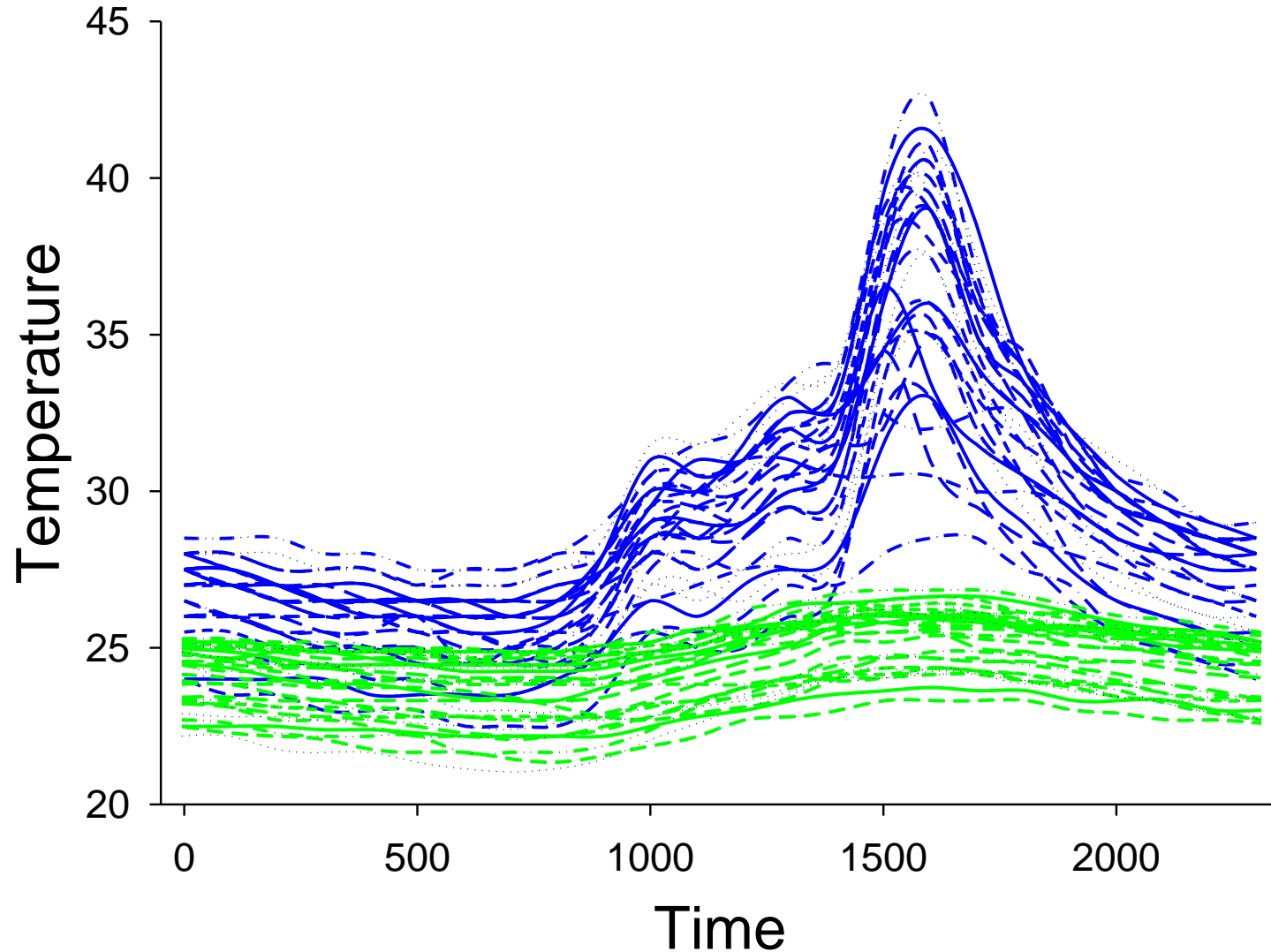


Defined by UN HABITAT as a city with a population of more than 10 million

Urban Heat Island Effect

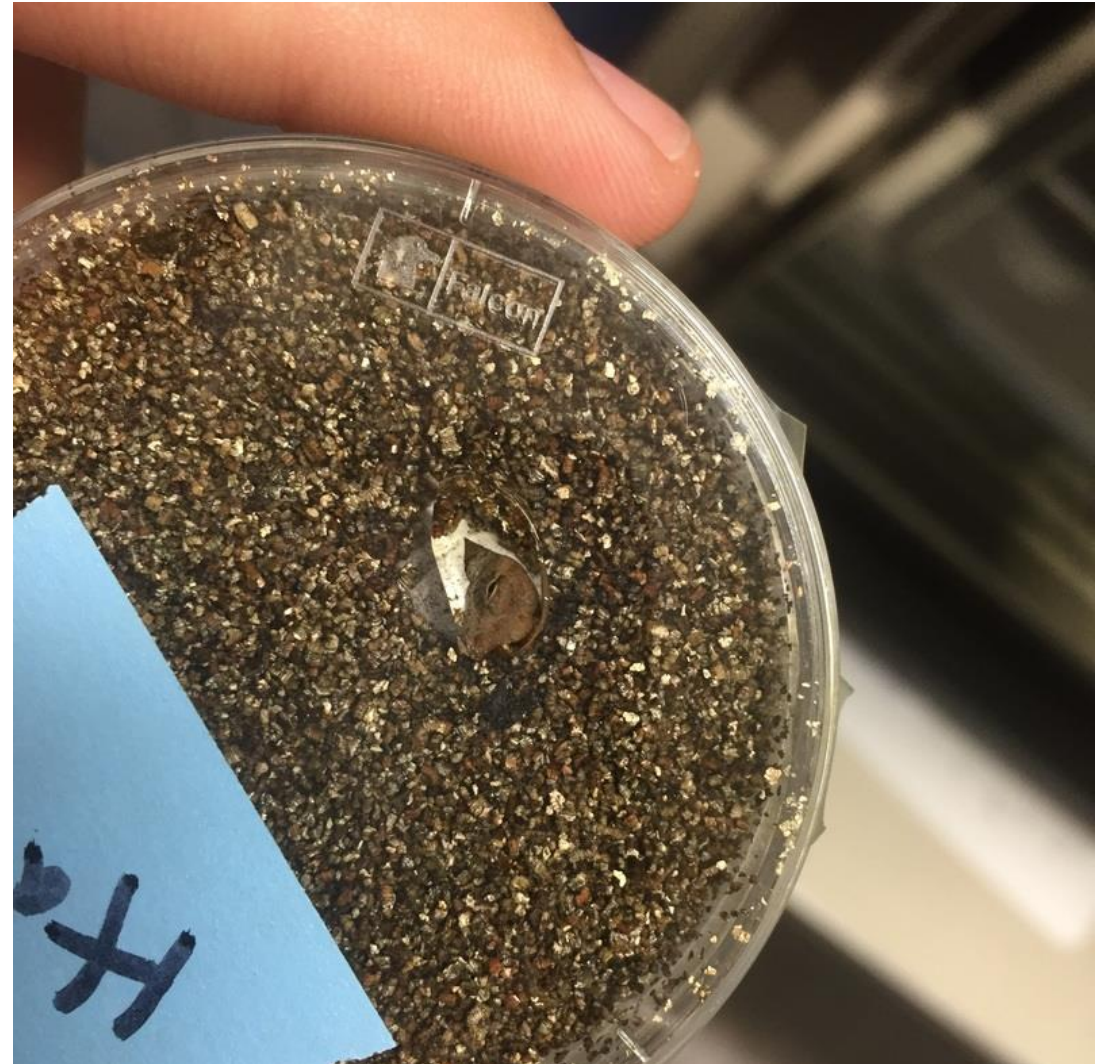


Urban Heat Island Effect



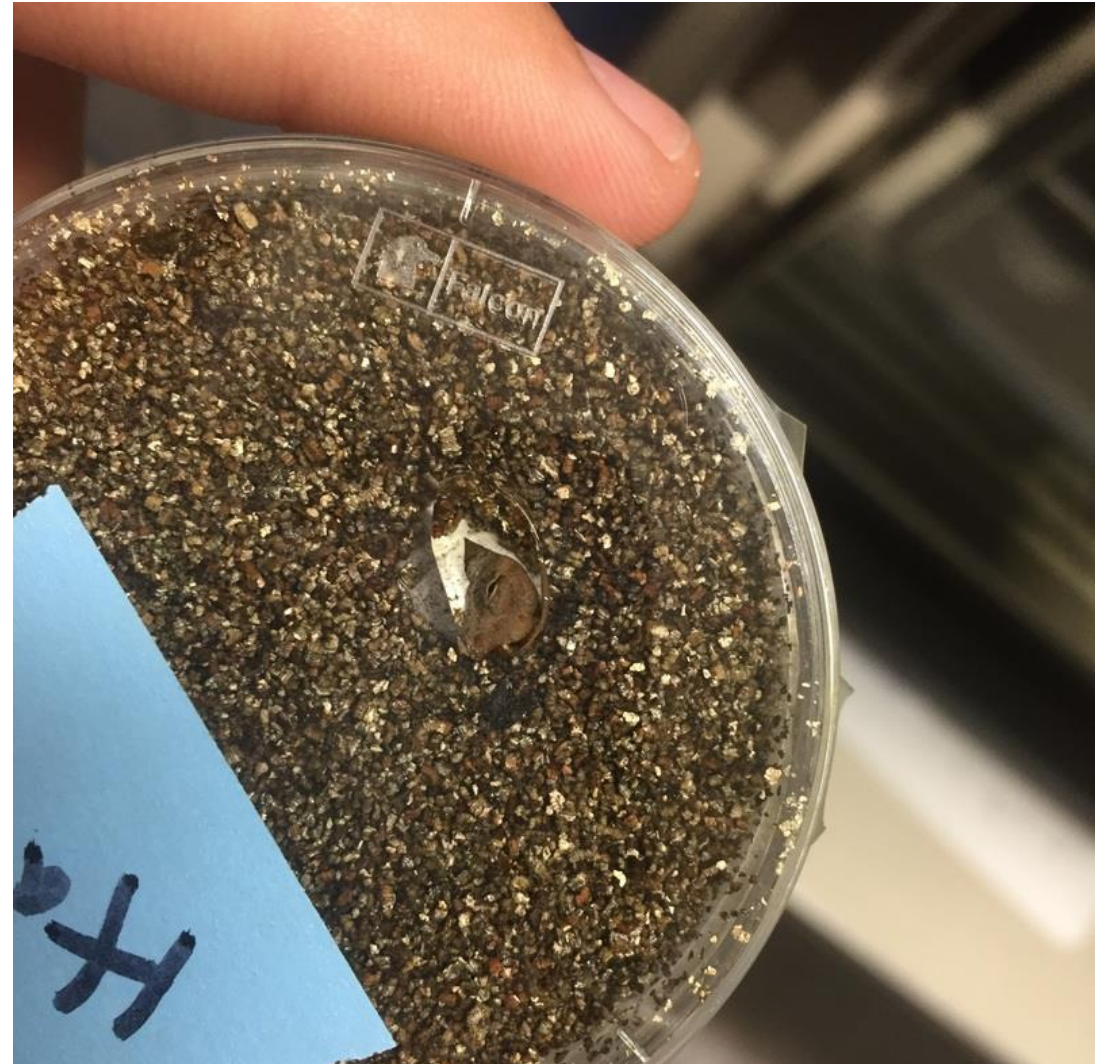
- Average temperatures higher in urban areas than natural sites
- Thermal fluctuations, thermal spikes, more extreme in urban areas
- Implications for ectotherms
 - Adults
 - Developing embryos?

Embryos Respond to Environment



Embryos Respond to Environment

- Adjust physiology
 - Alter metabolism
 - Acclimate
- Influence exposure
 - Hatch early
 - Initiate diapause



Questions



Questions

- Do thermal spikes caused by urban heat island effect reduce egg survival?
- Are there interactions between thermal background regimes and thermal spikes?
- Does survival depend upon the magnitude of spikes?

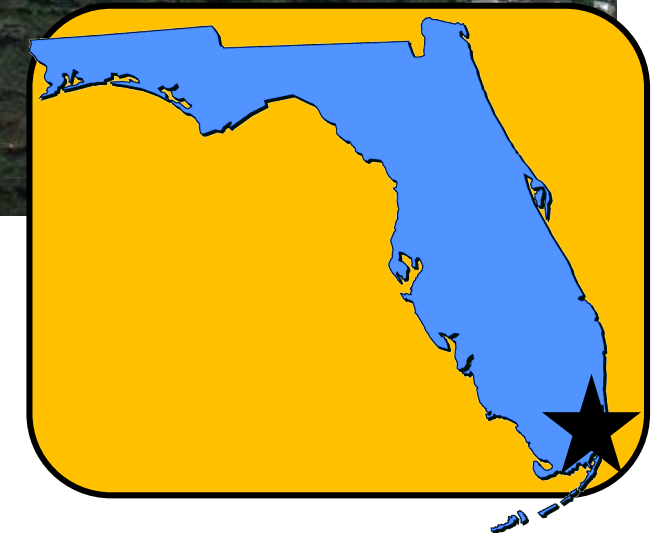




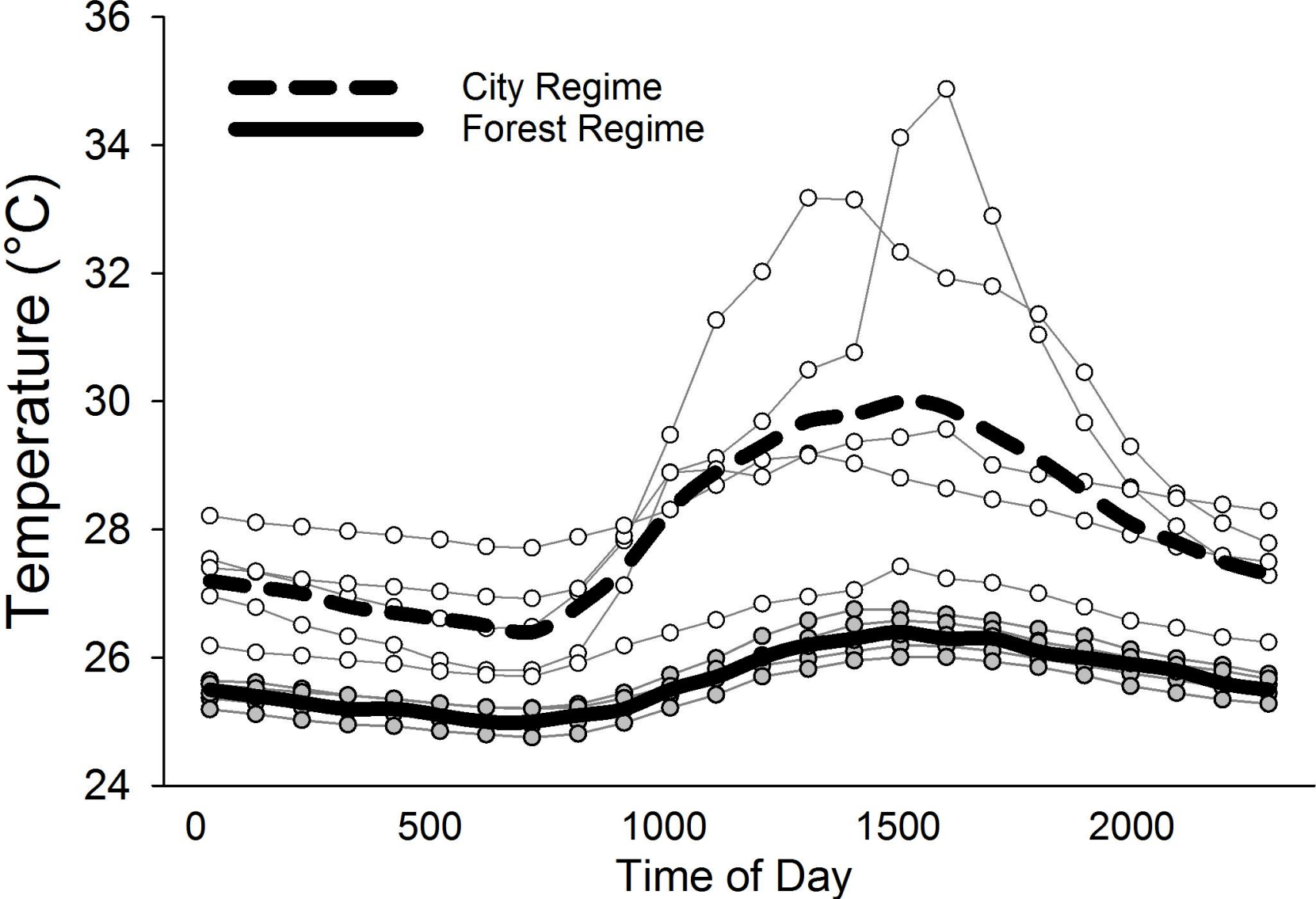


Questions

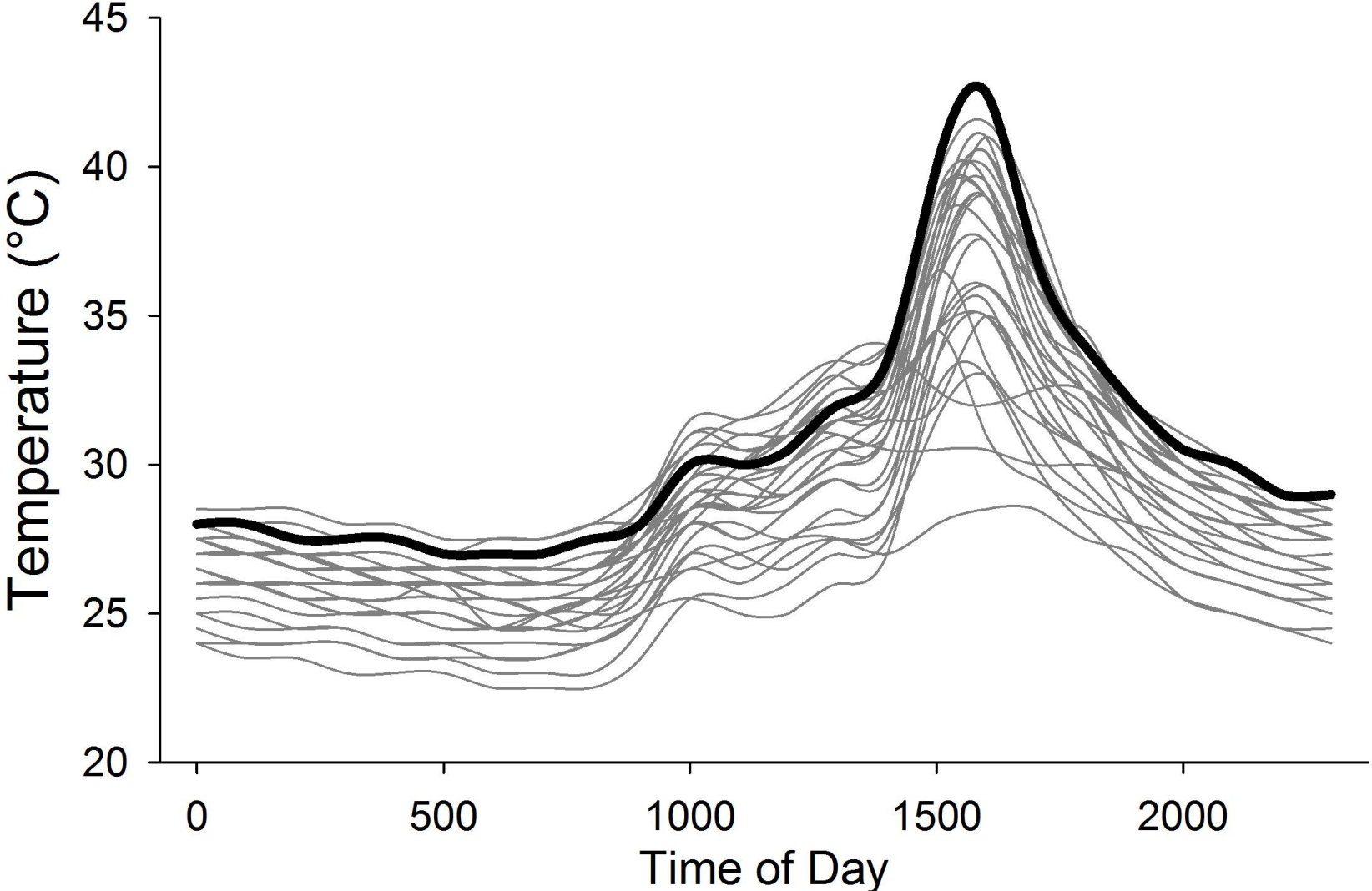
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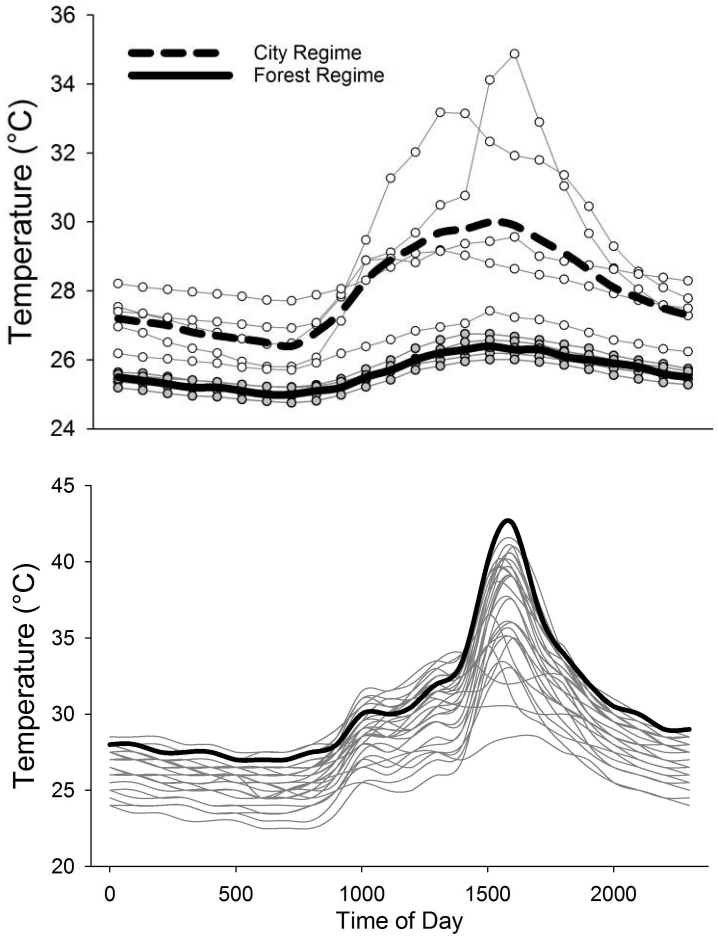
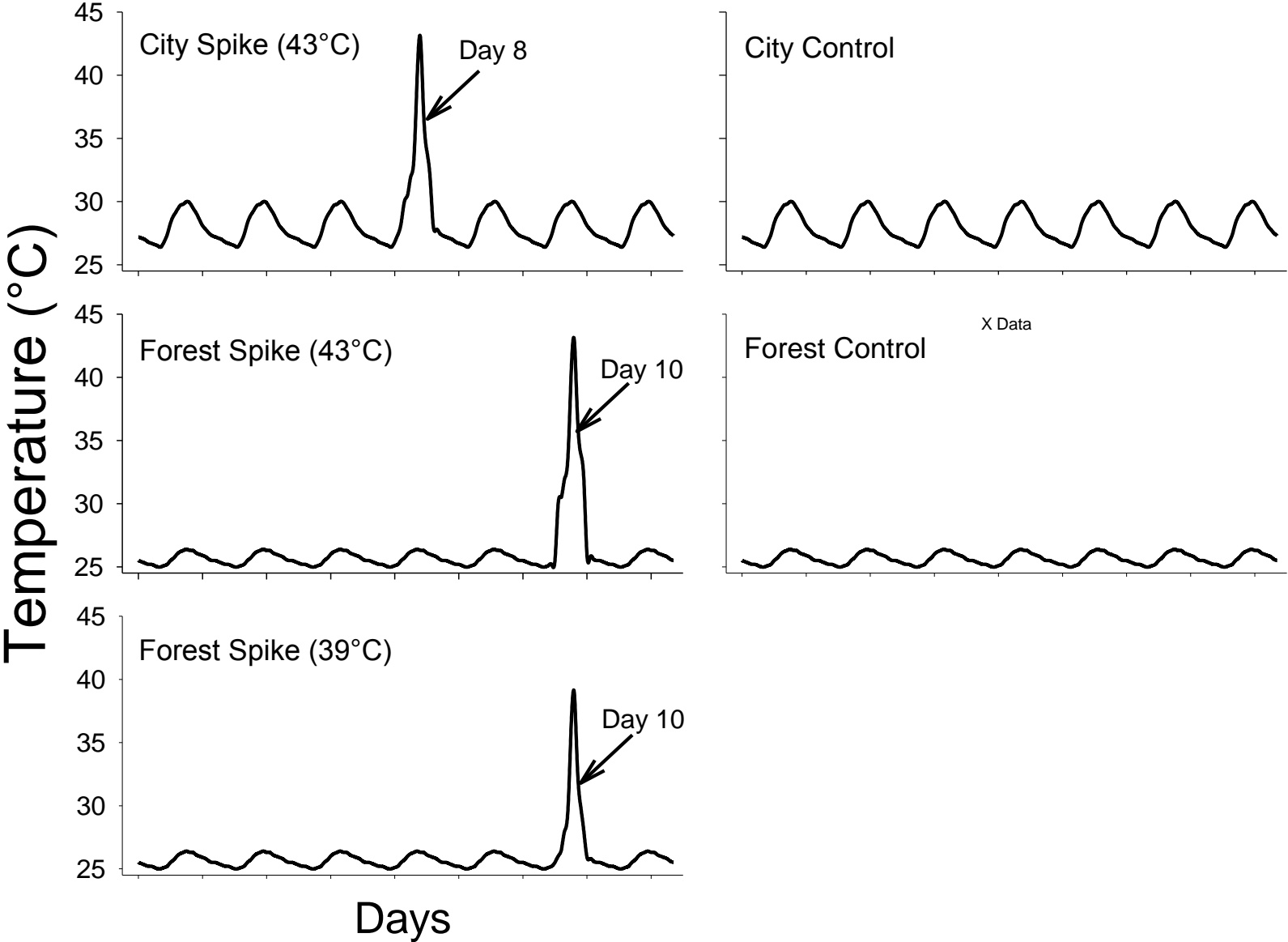
Thermal Profiles



Thermal Profiles

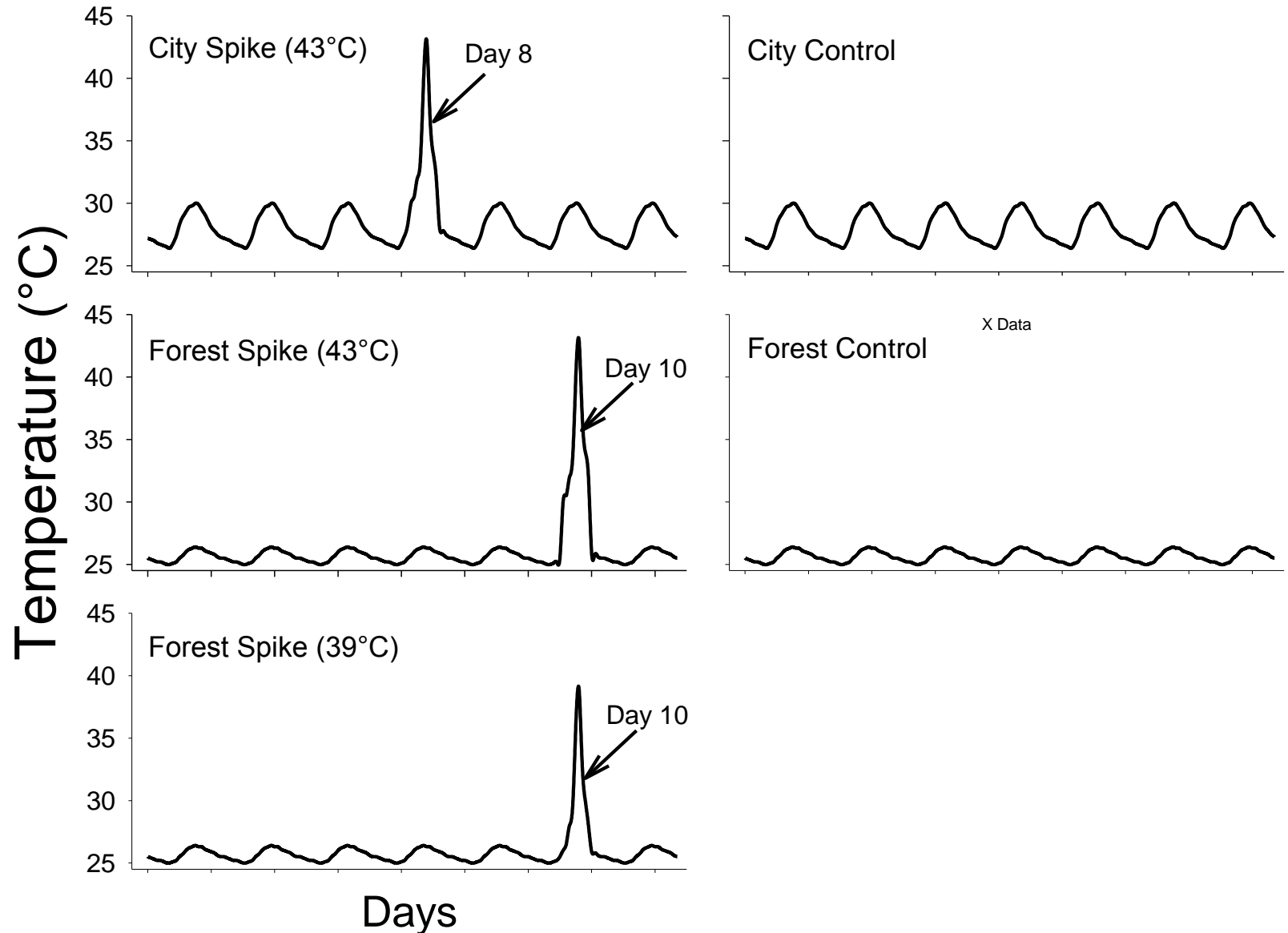


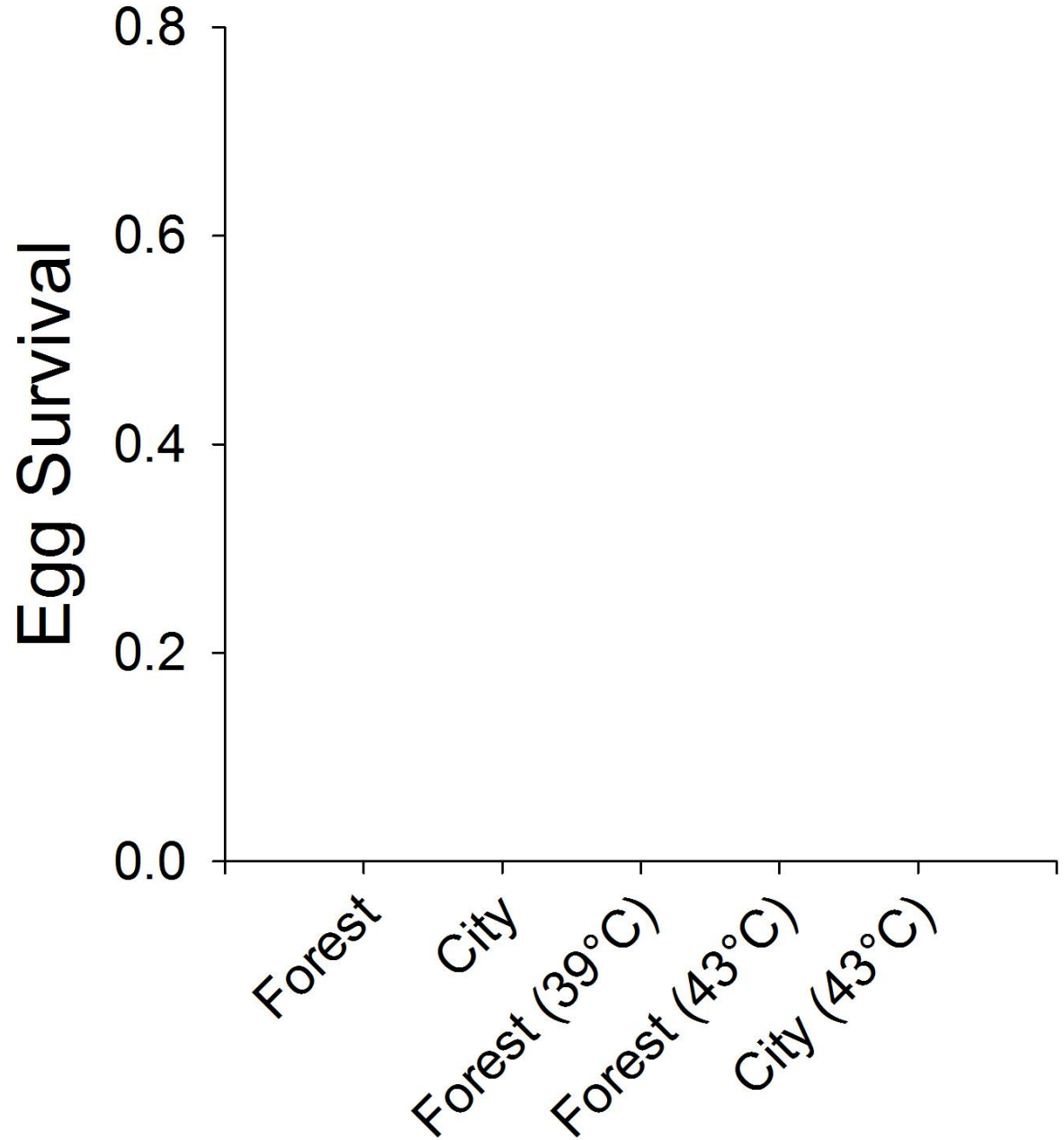
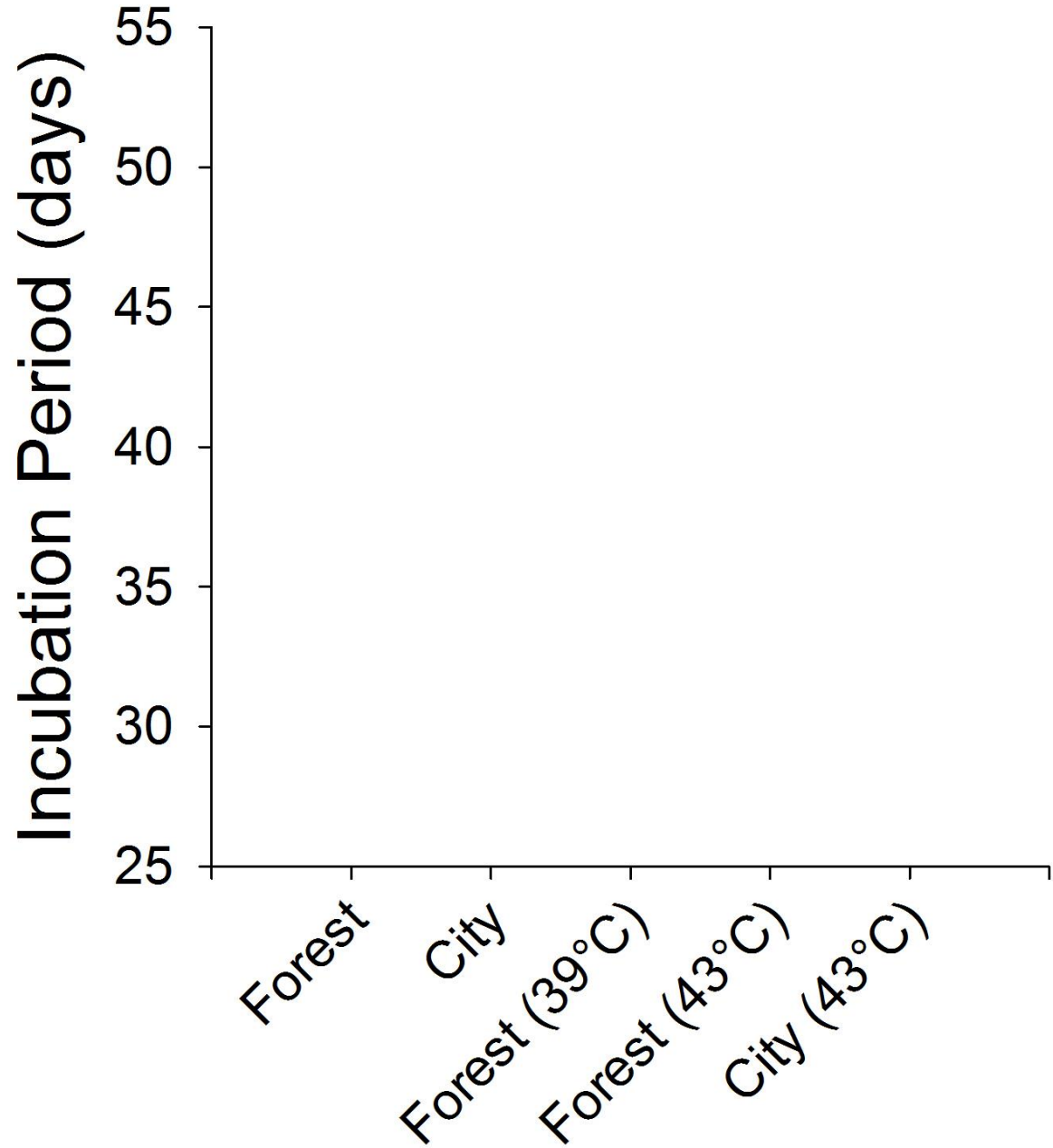
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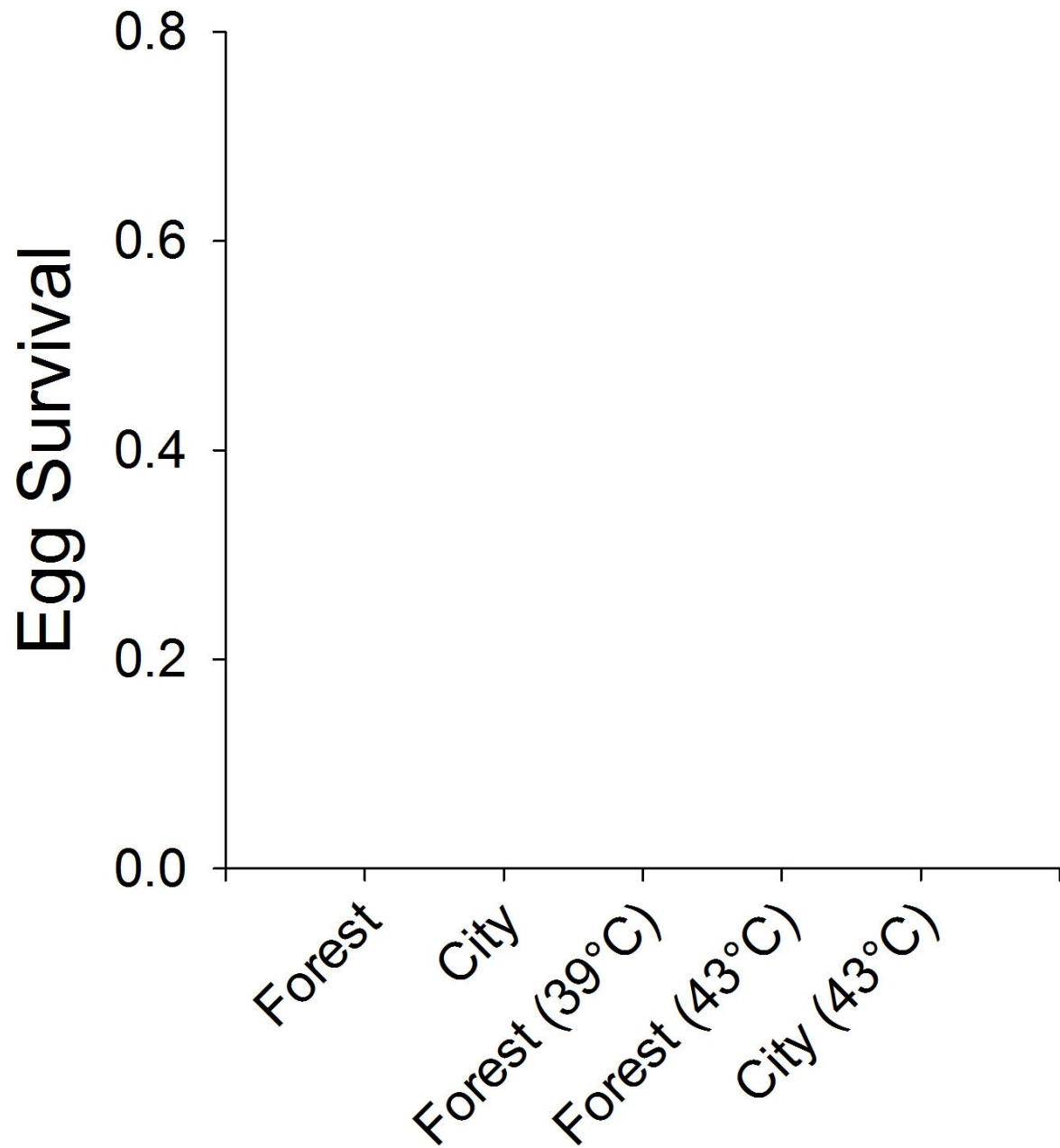
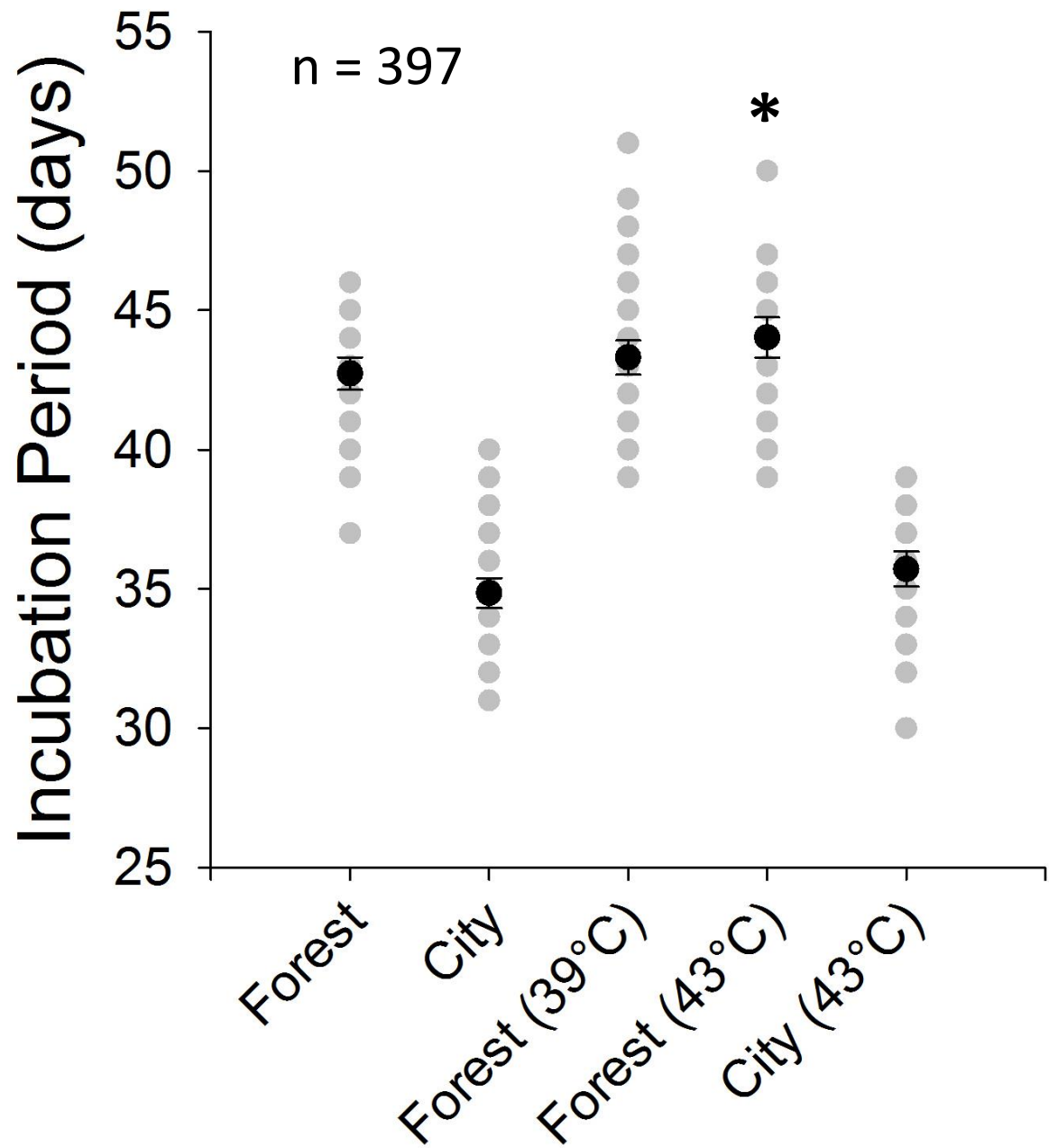


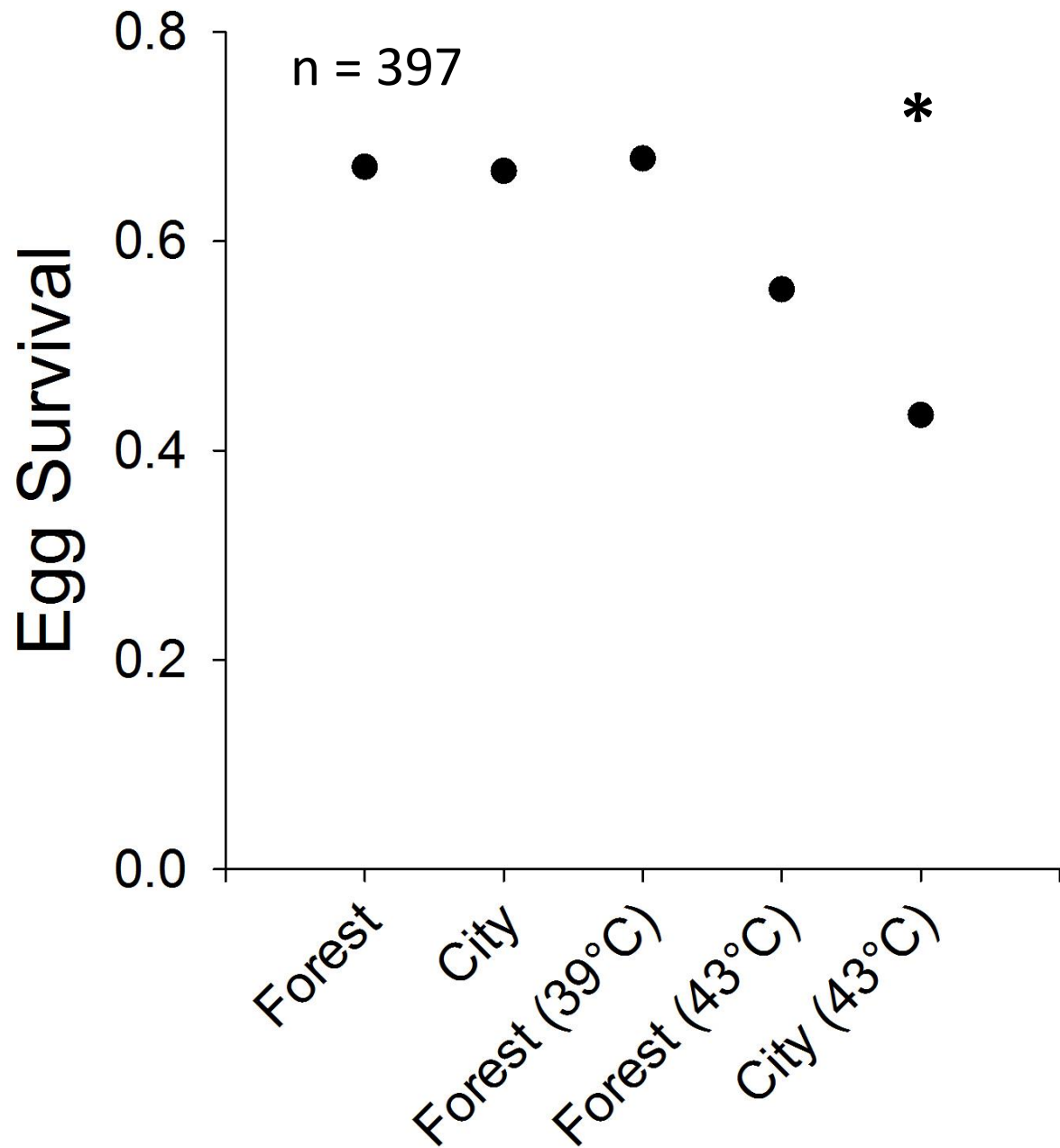
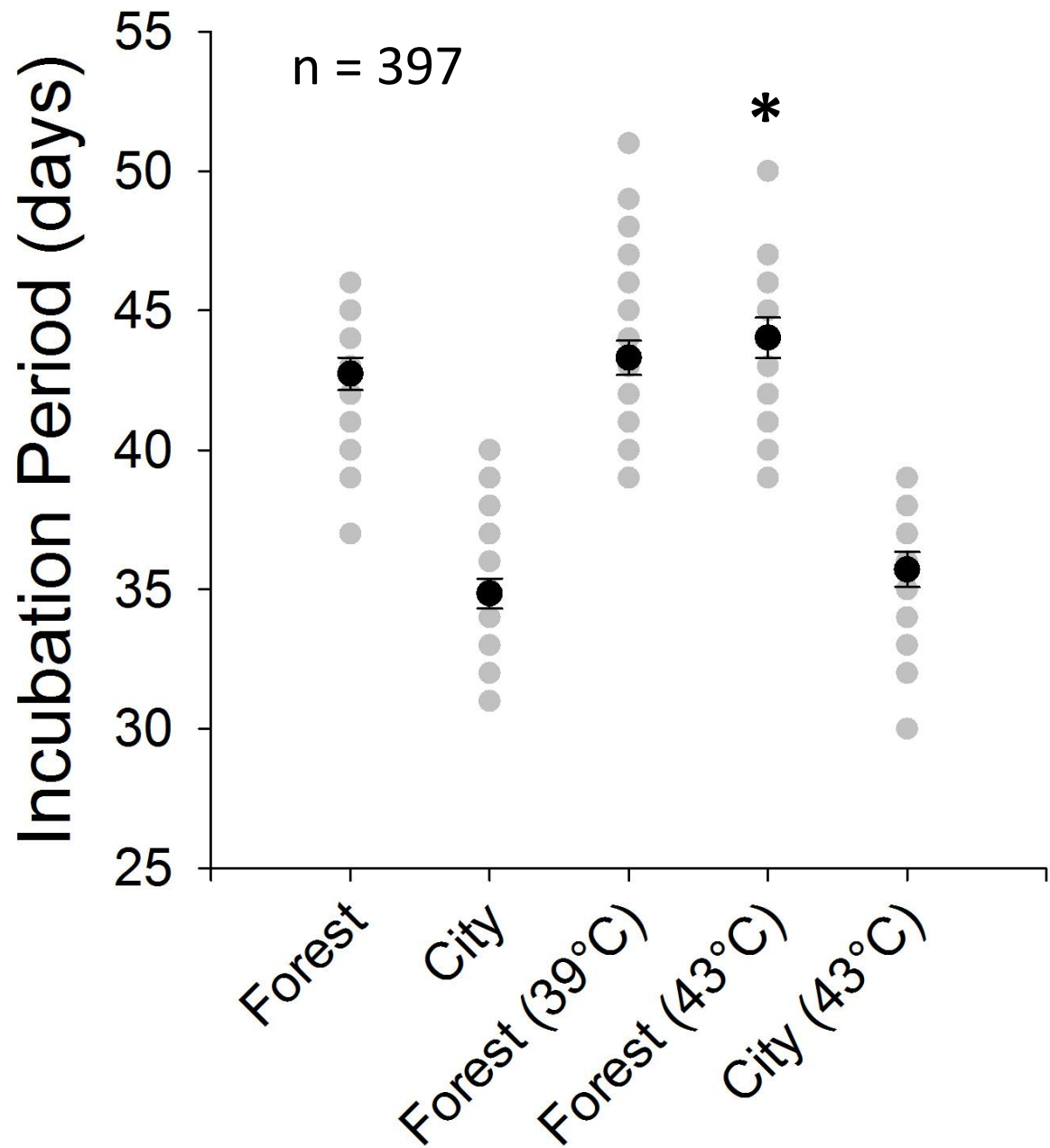
Experimental Design

- Do thermal spikes caused by urban heat island effect reduce egg survival?
- Are there interactions between thermal background regimes and thermal spikes?
- Does survival depend upon the magnitude of spikes?

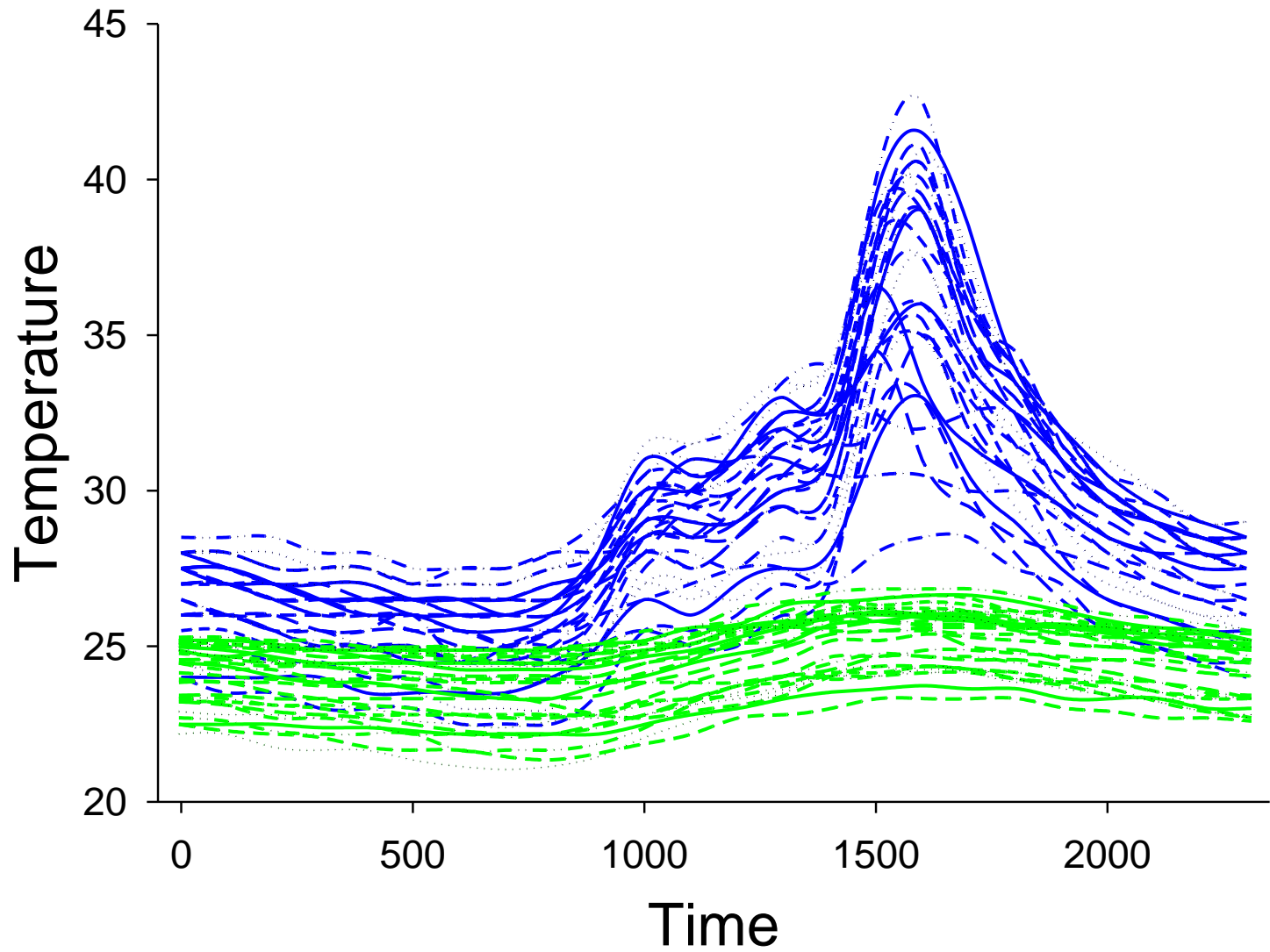




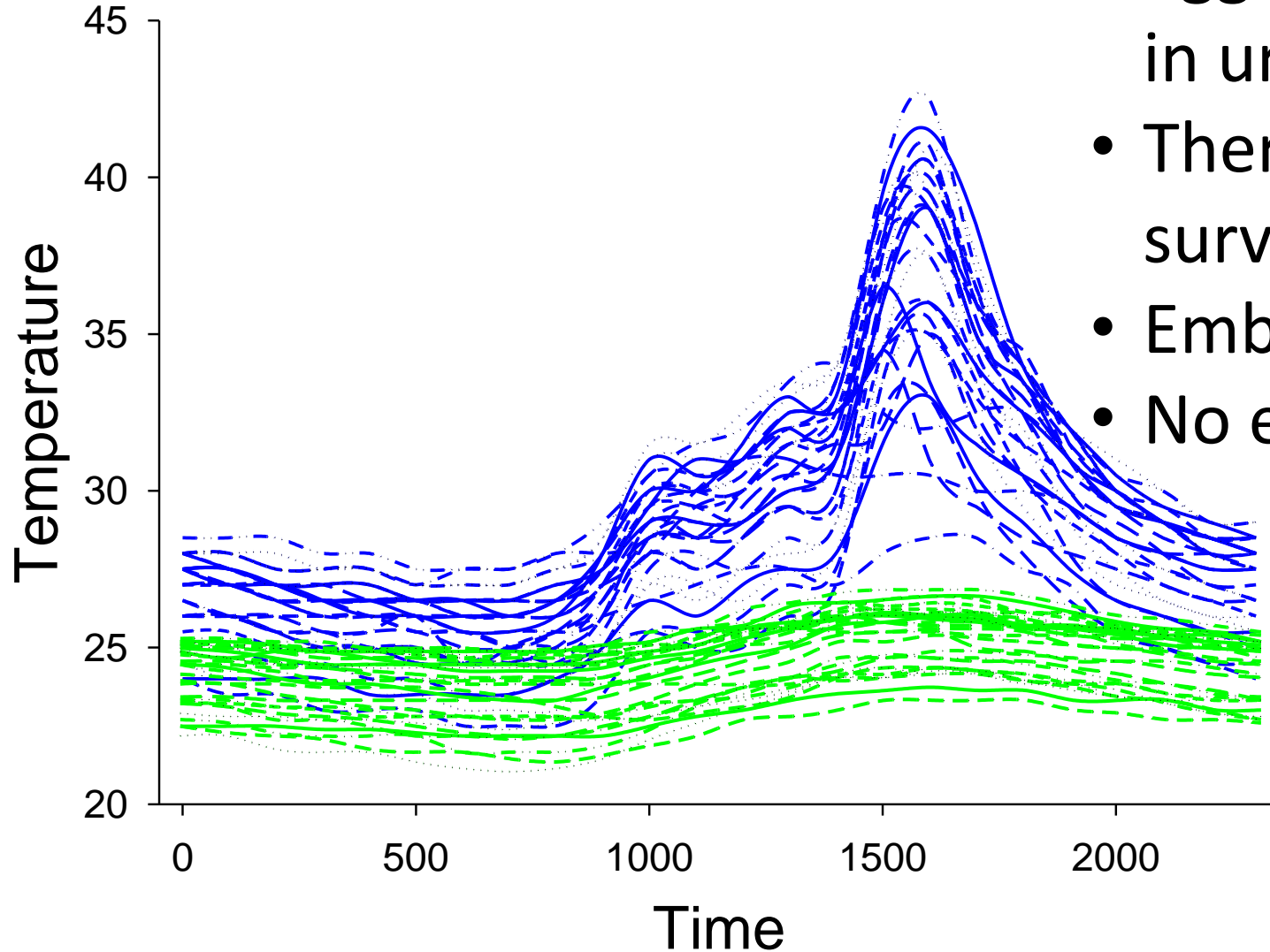




Results

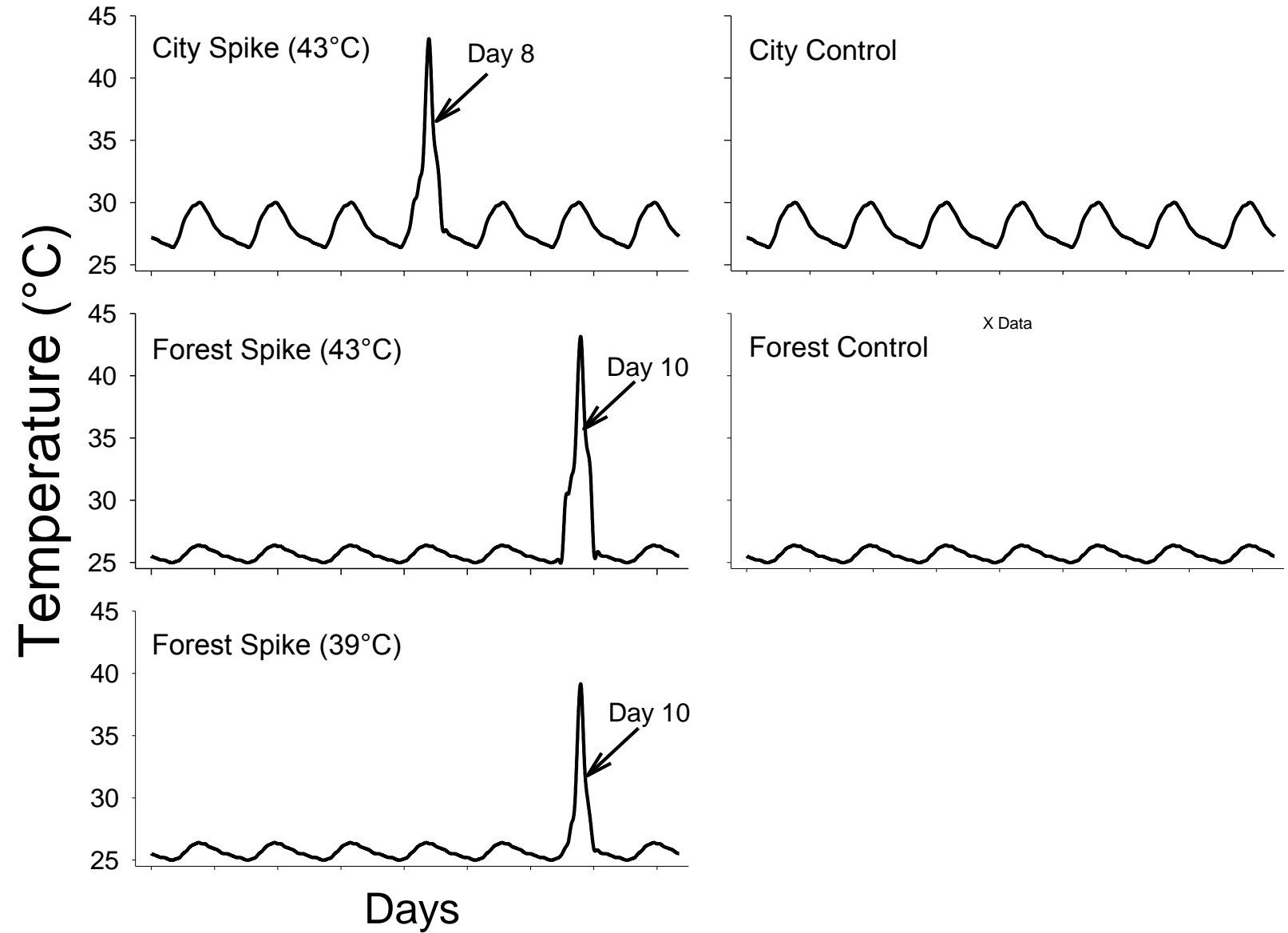


Results



- Eggs hatch earlier in the season in urban environments
- Thermal spikes can reduce survival; but not by much
- Embryos are relatively robust
- No evidence of acclimation

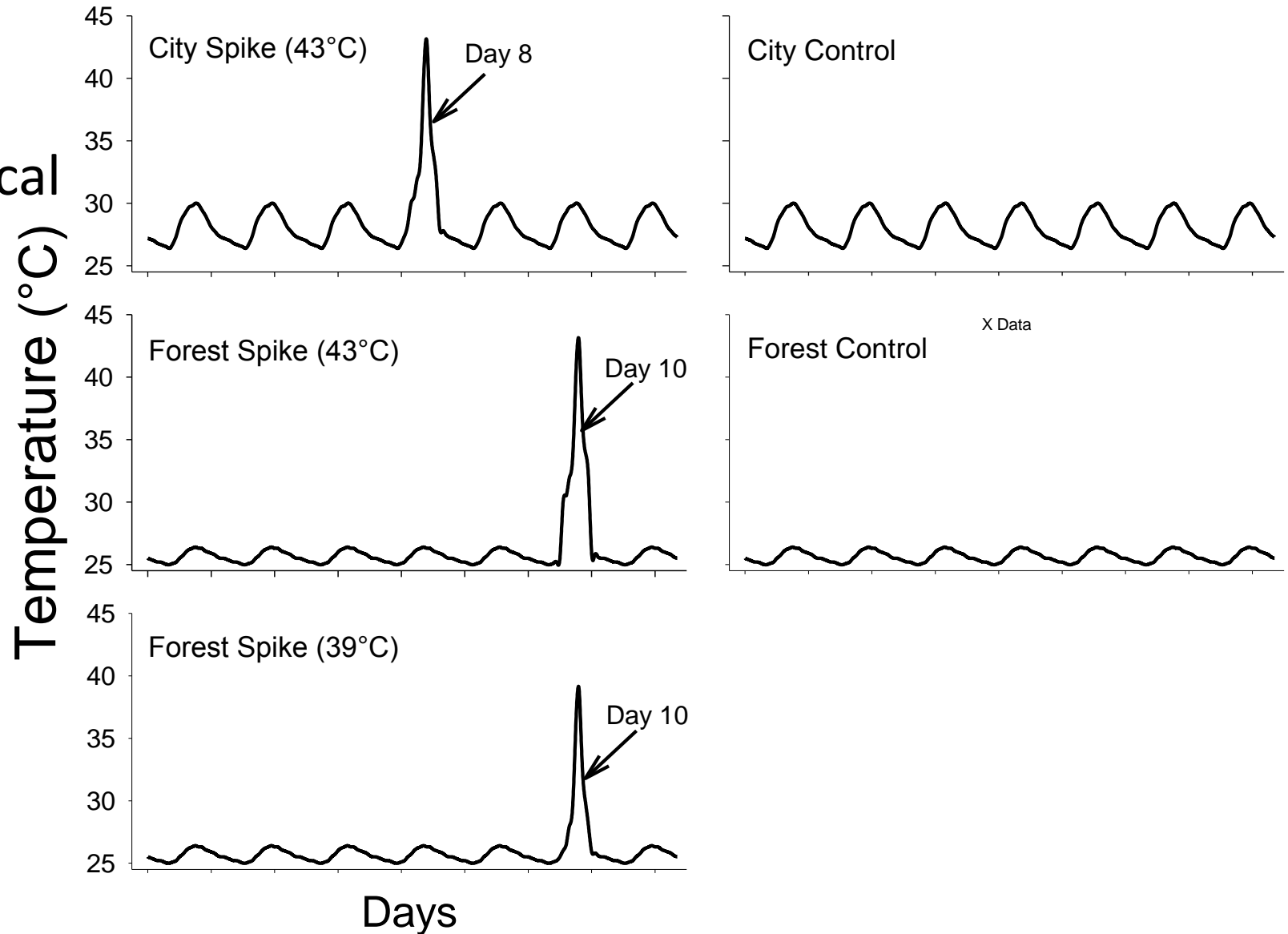
Ecophysiology



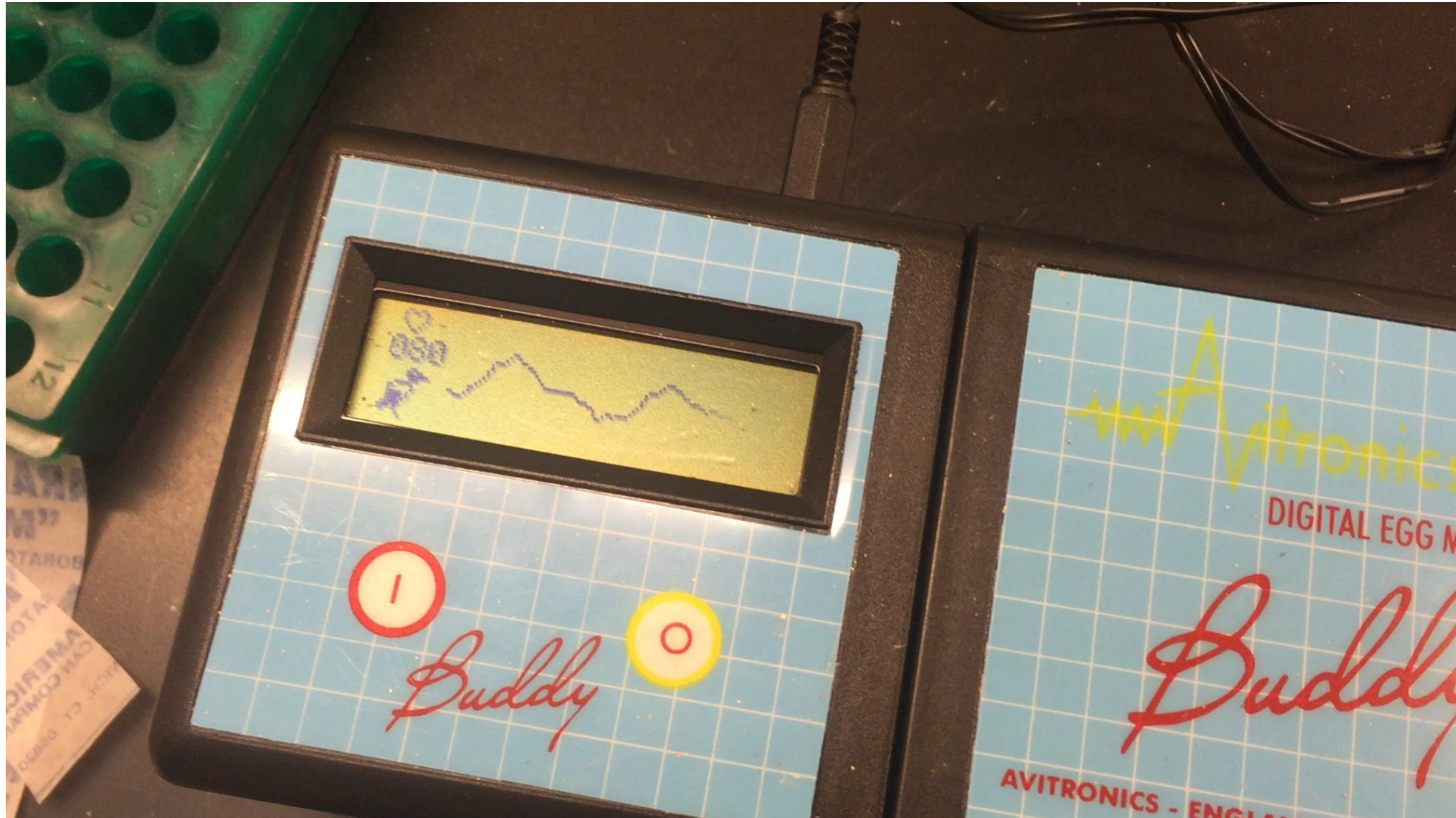
Ecophysiology

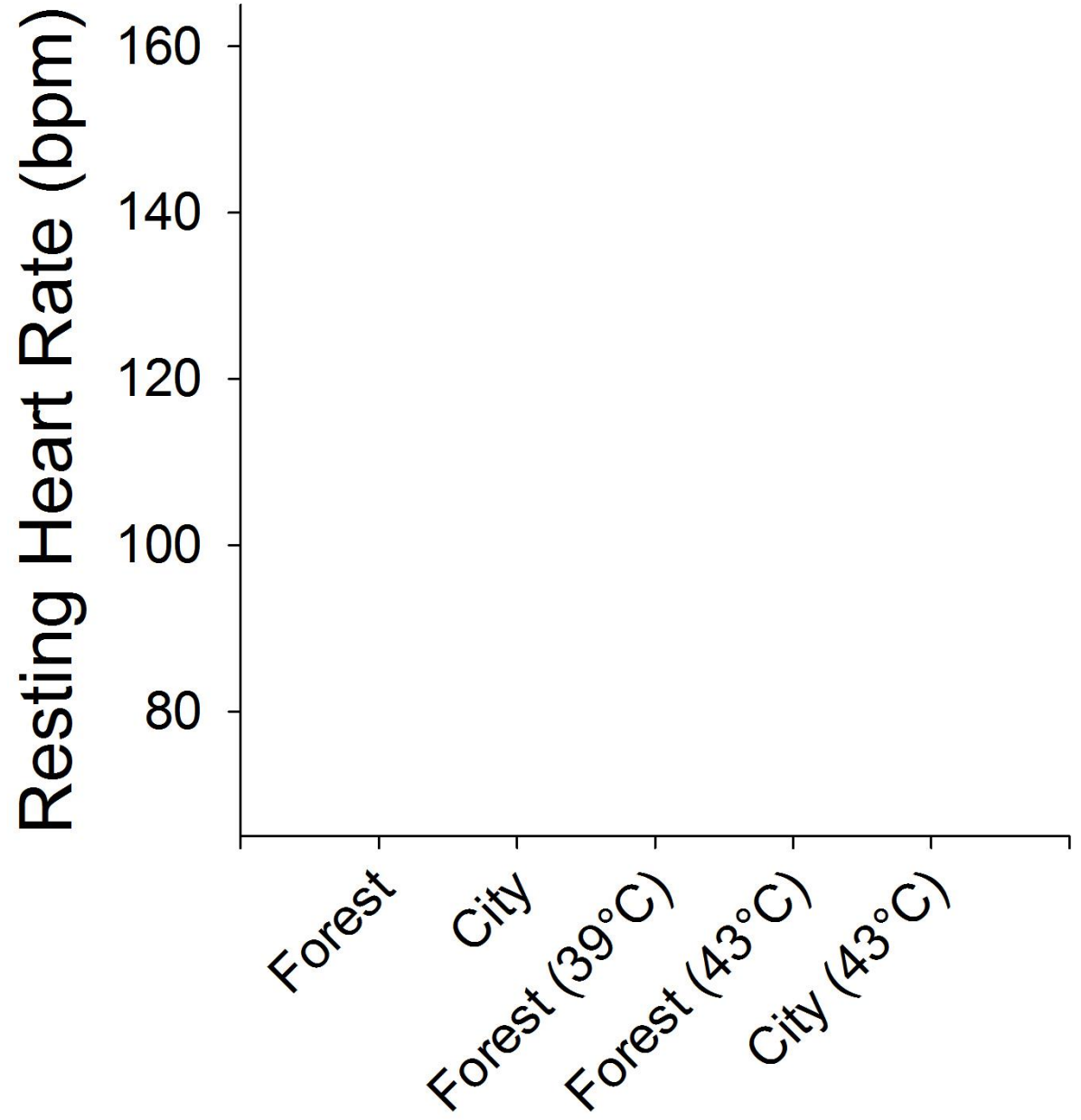
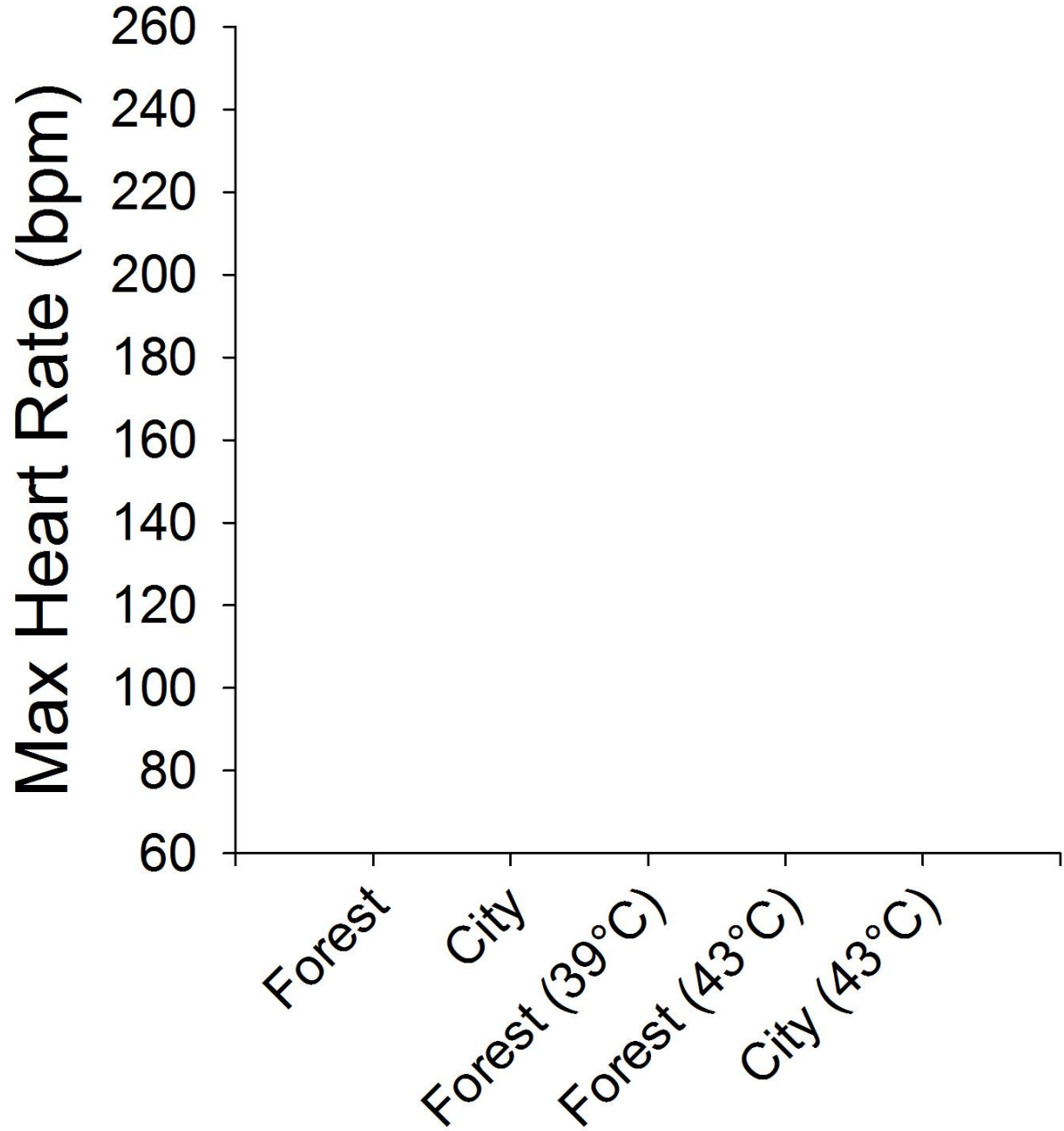
Questions

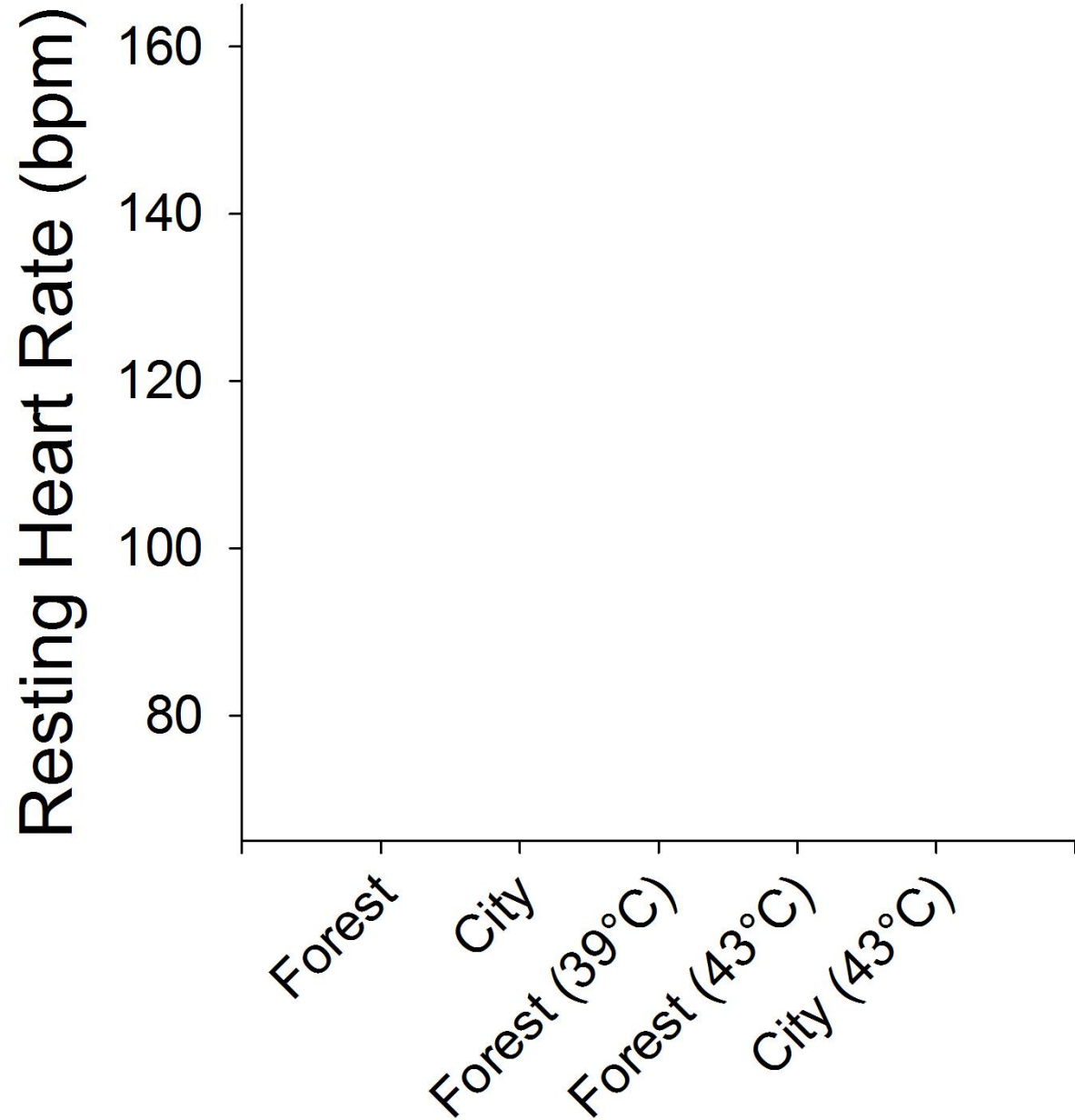
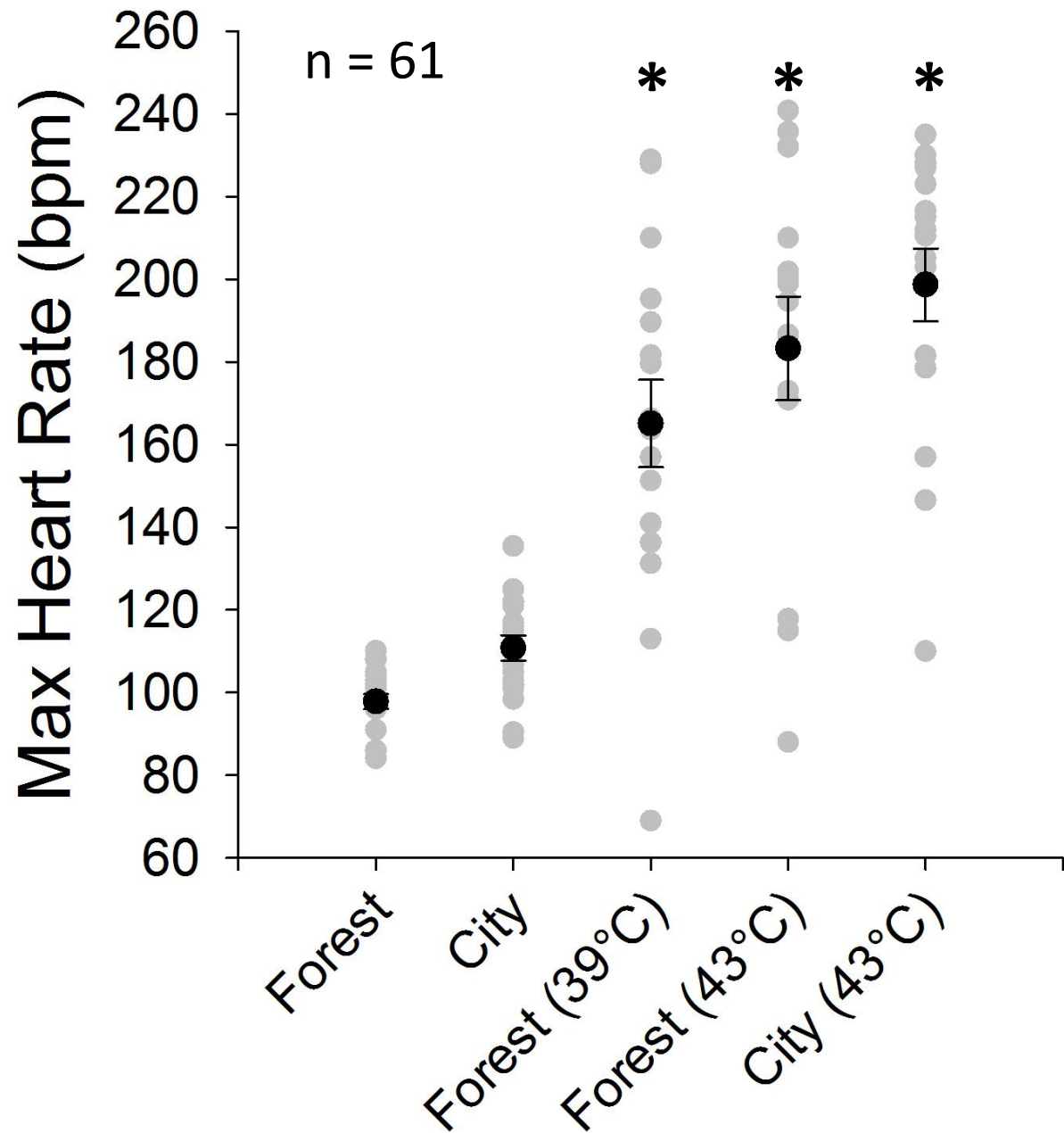
- What are the physiological responses to thermal spikes?
- Are responses or effects persistent?
 - In embryological development?
 - Post-hatching?

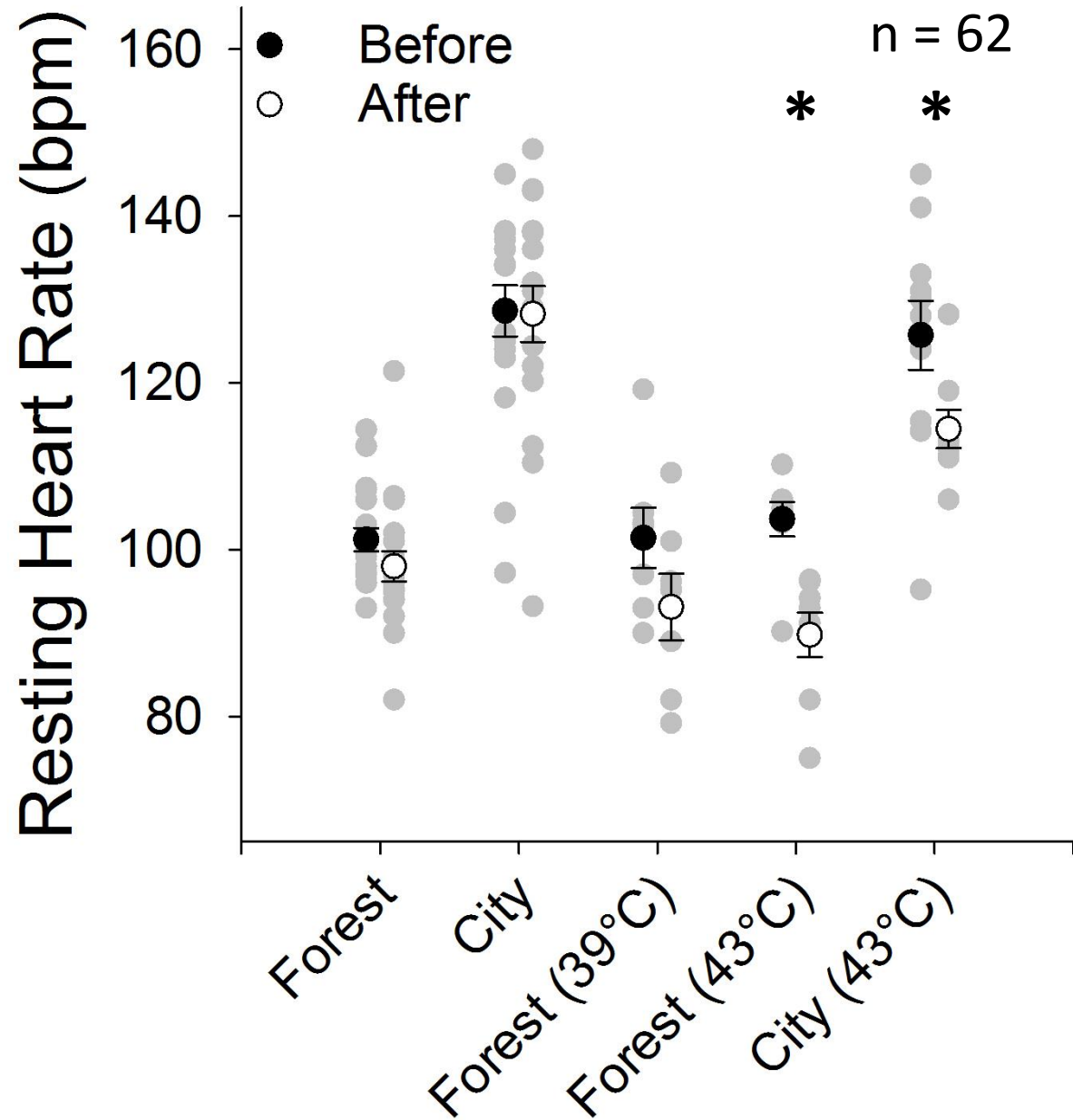
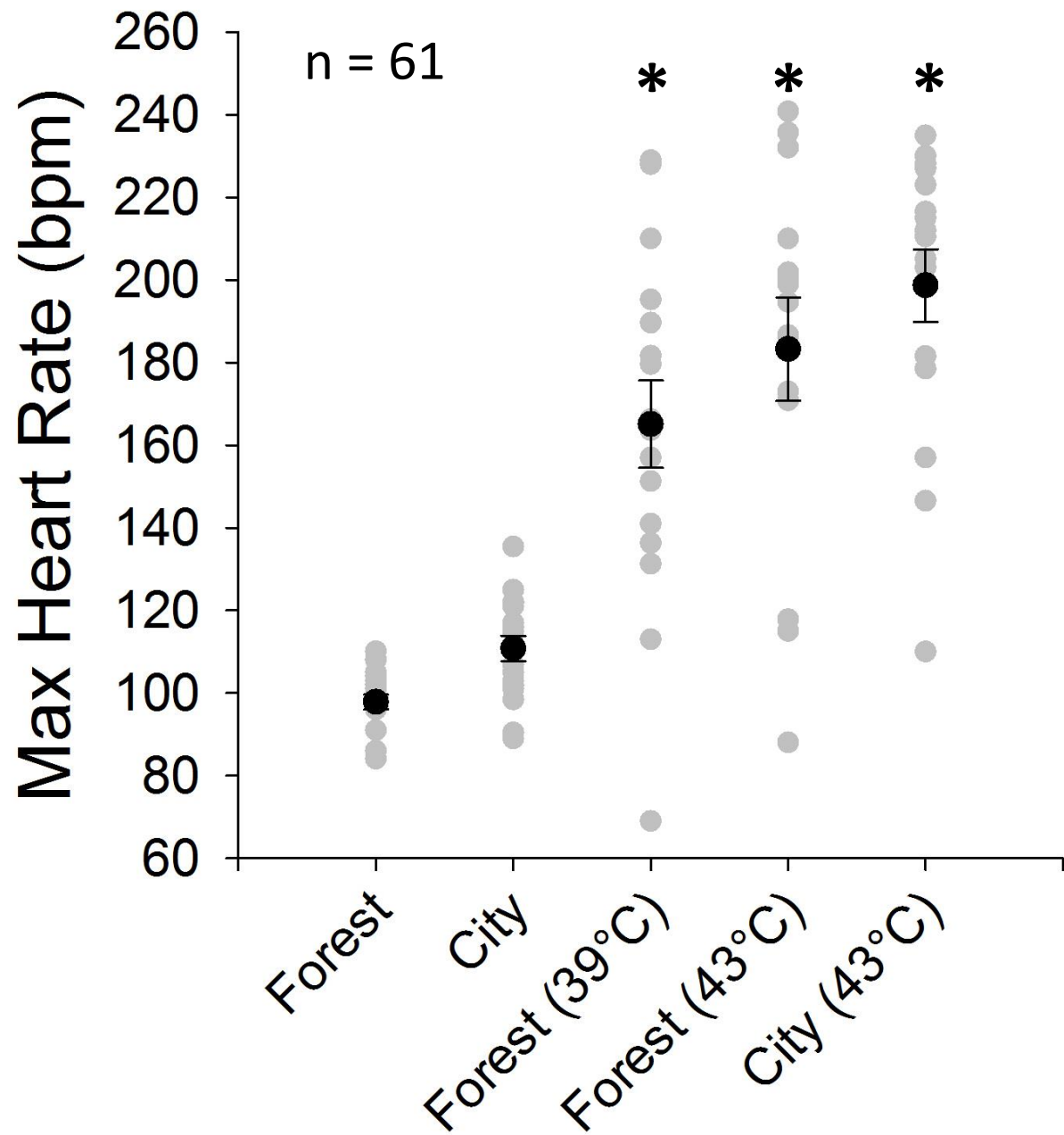


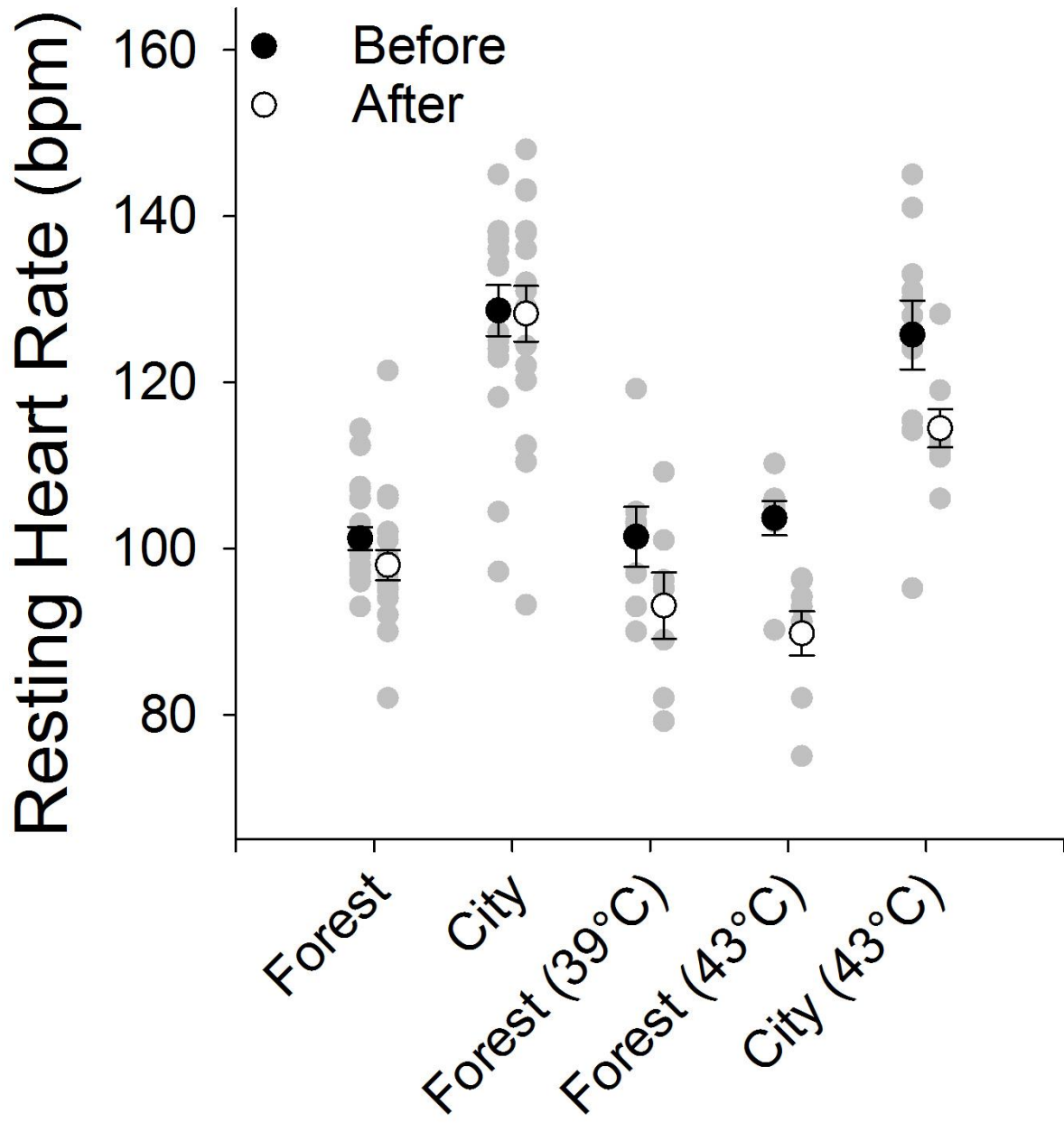
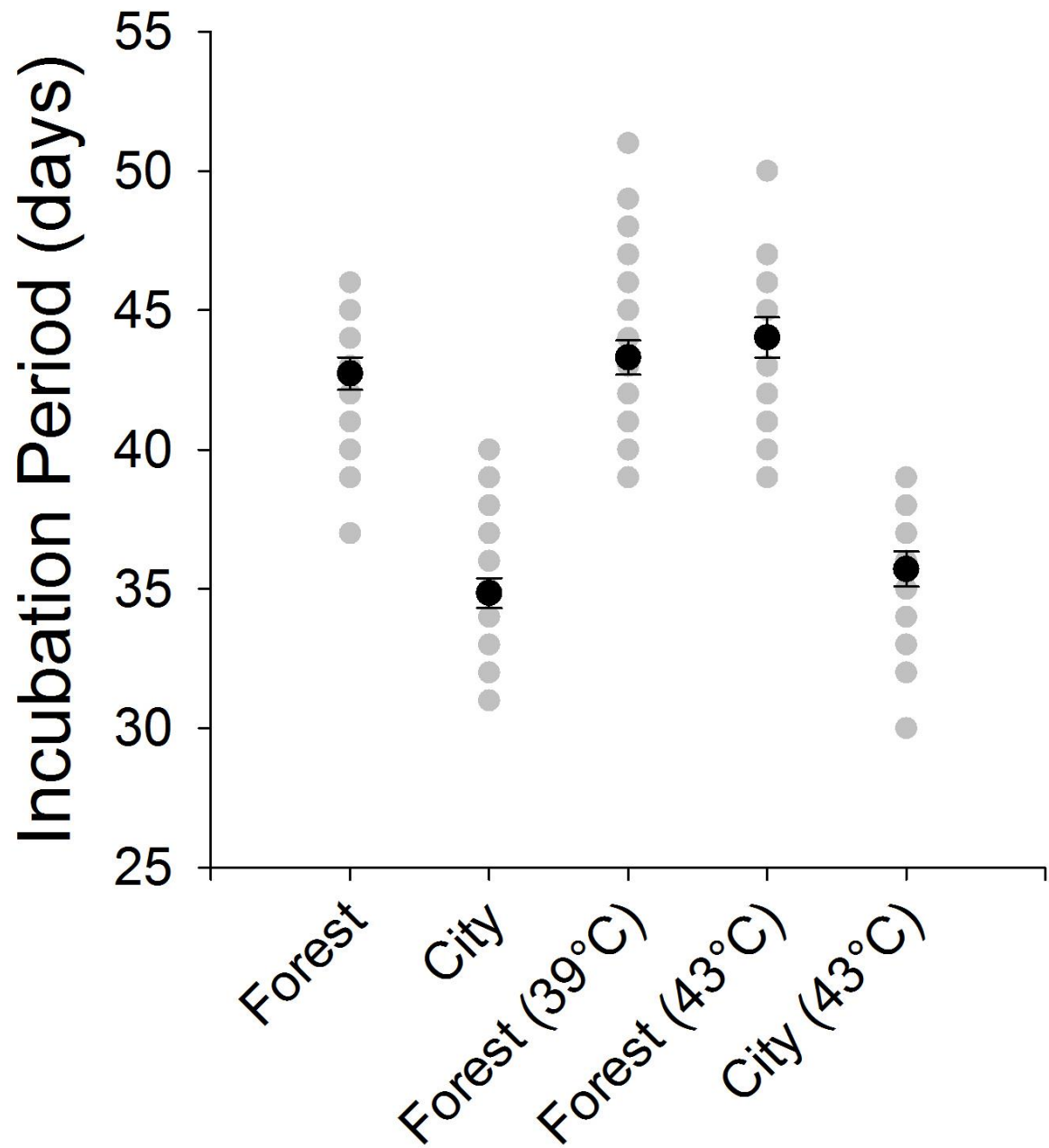
Non-invasive Measure of Heart Rate

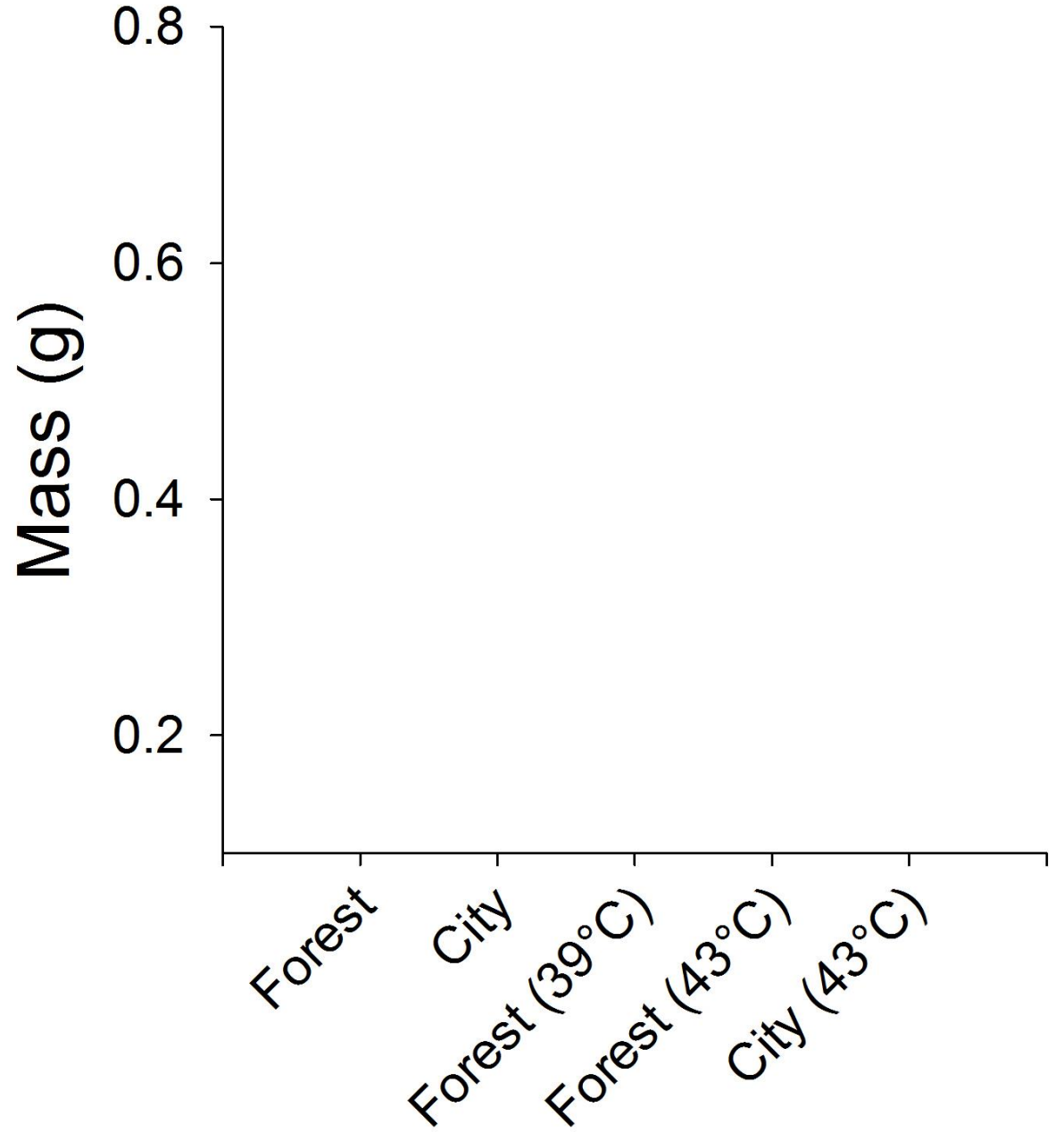
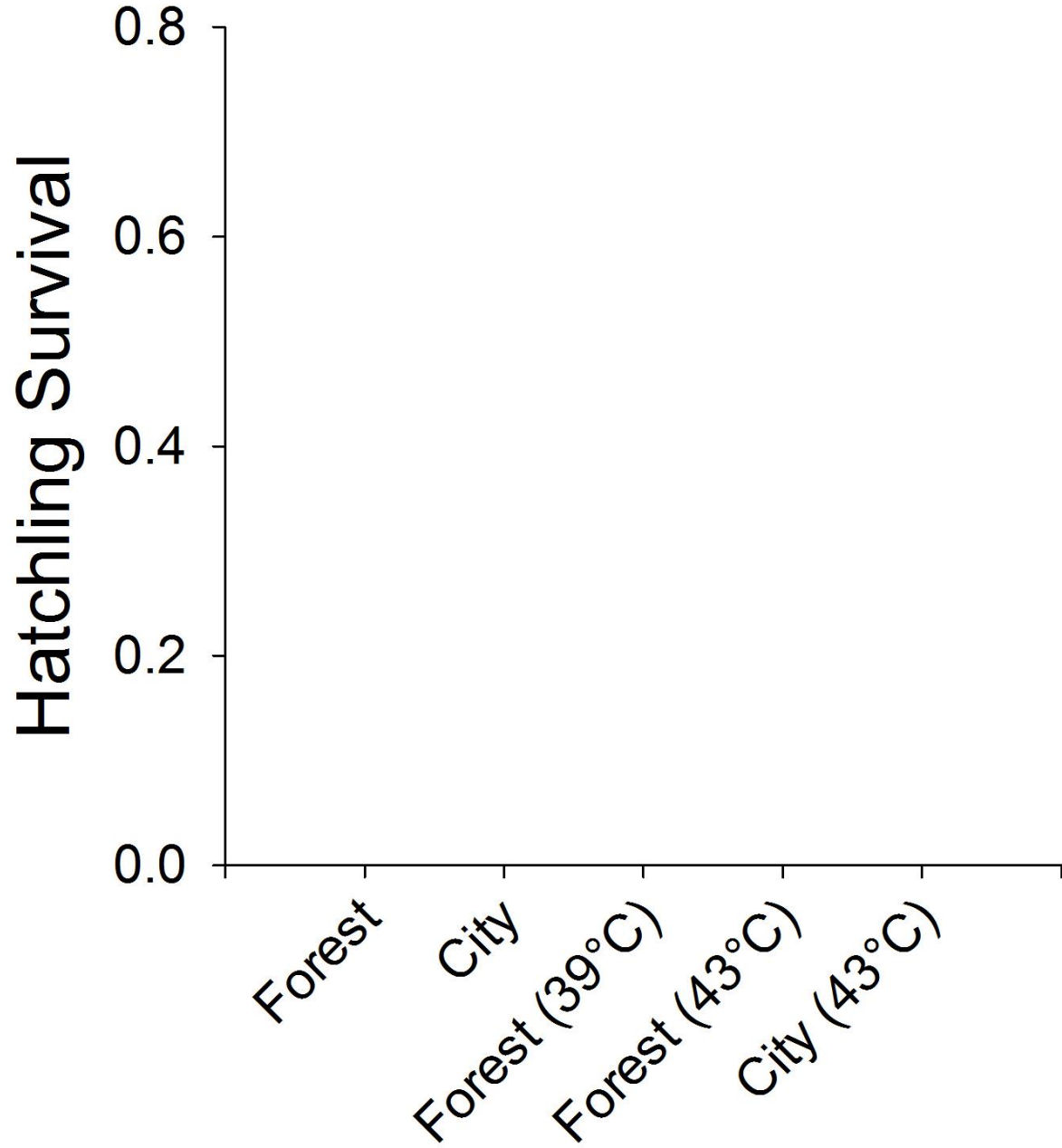


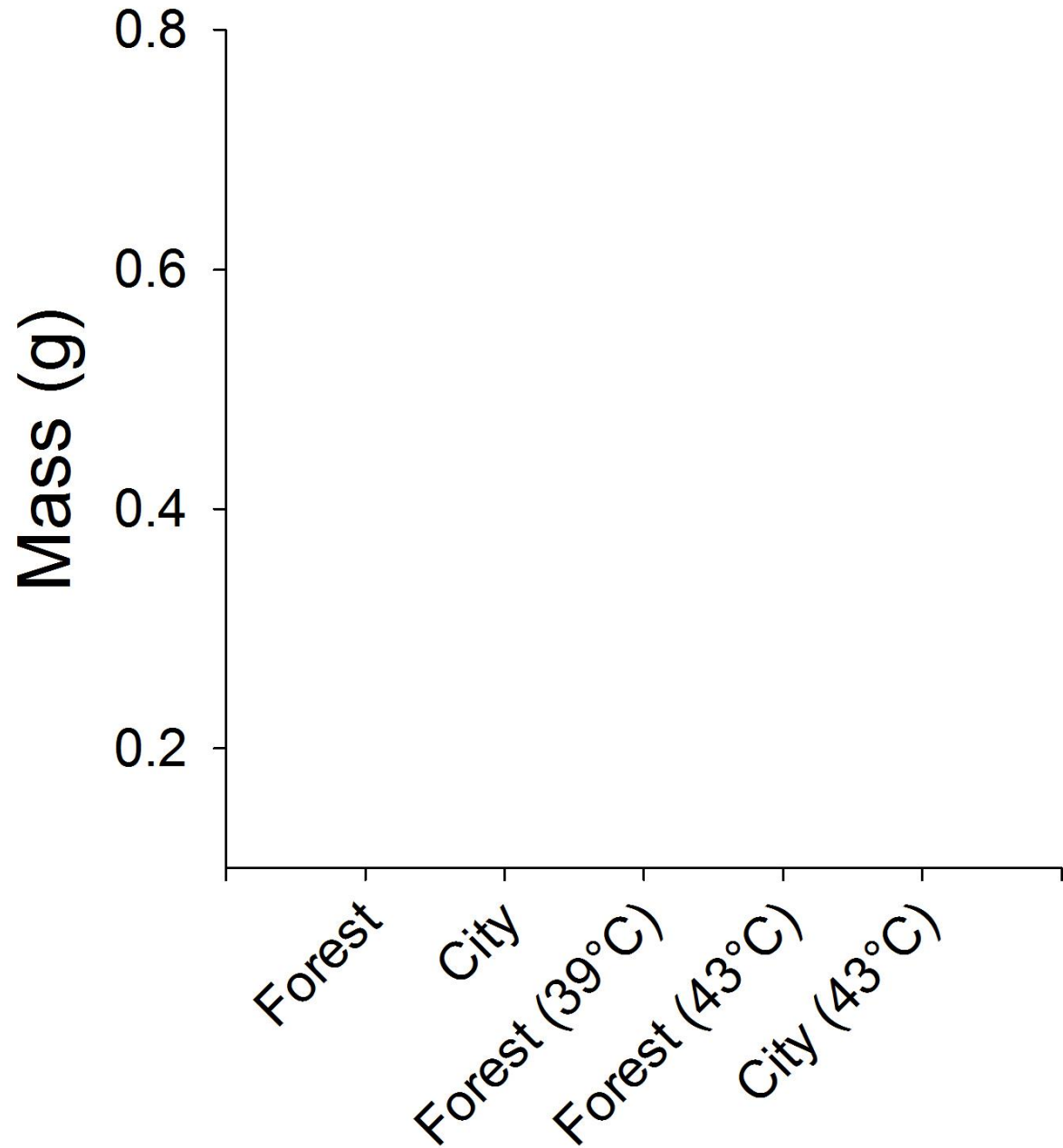
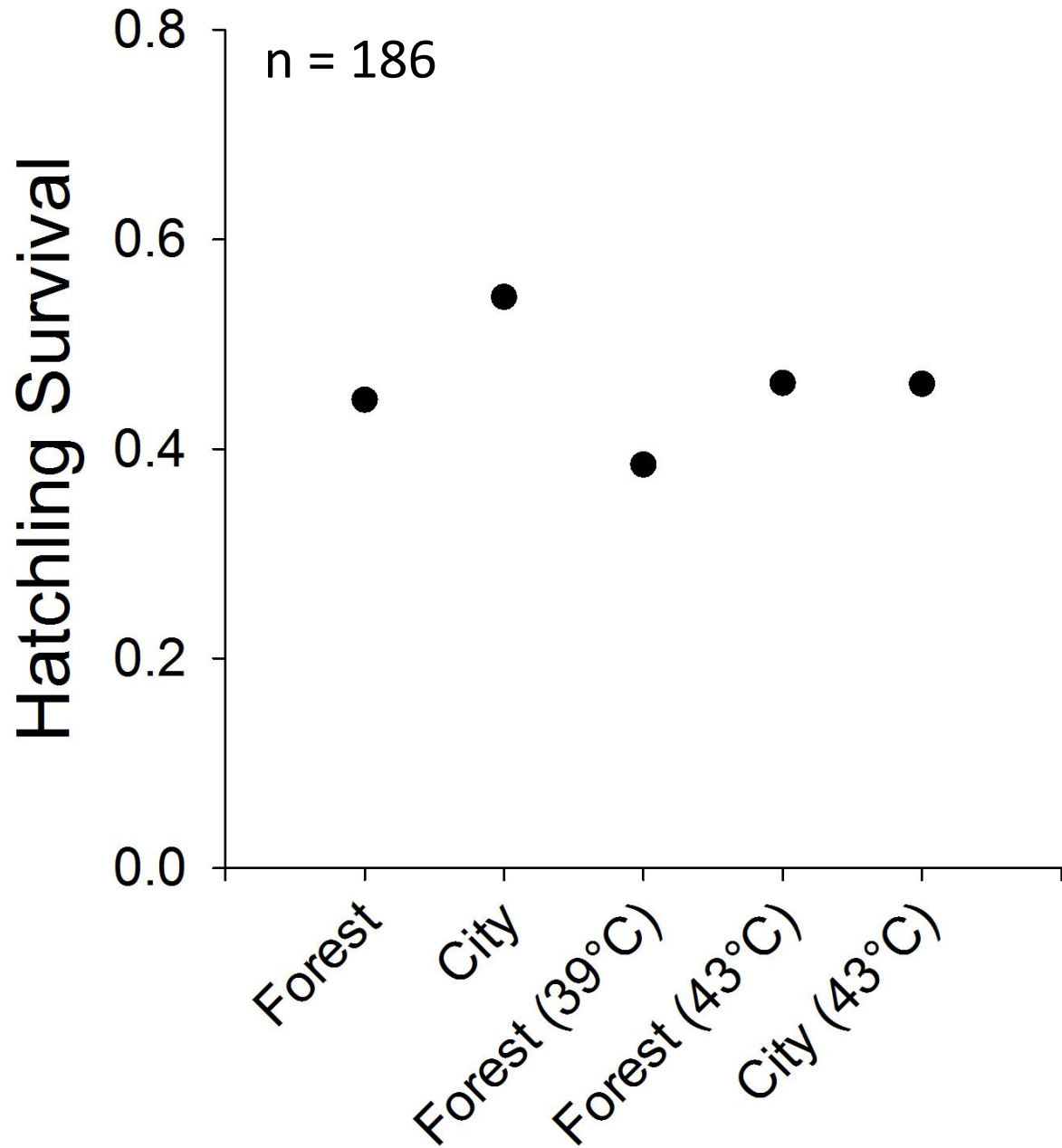


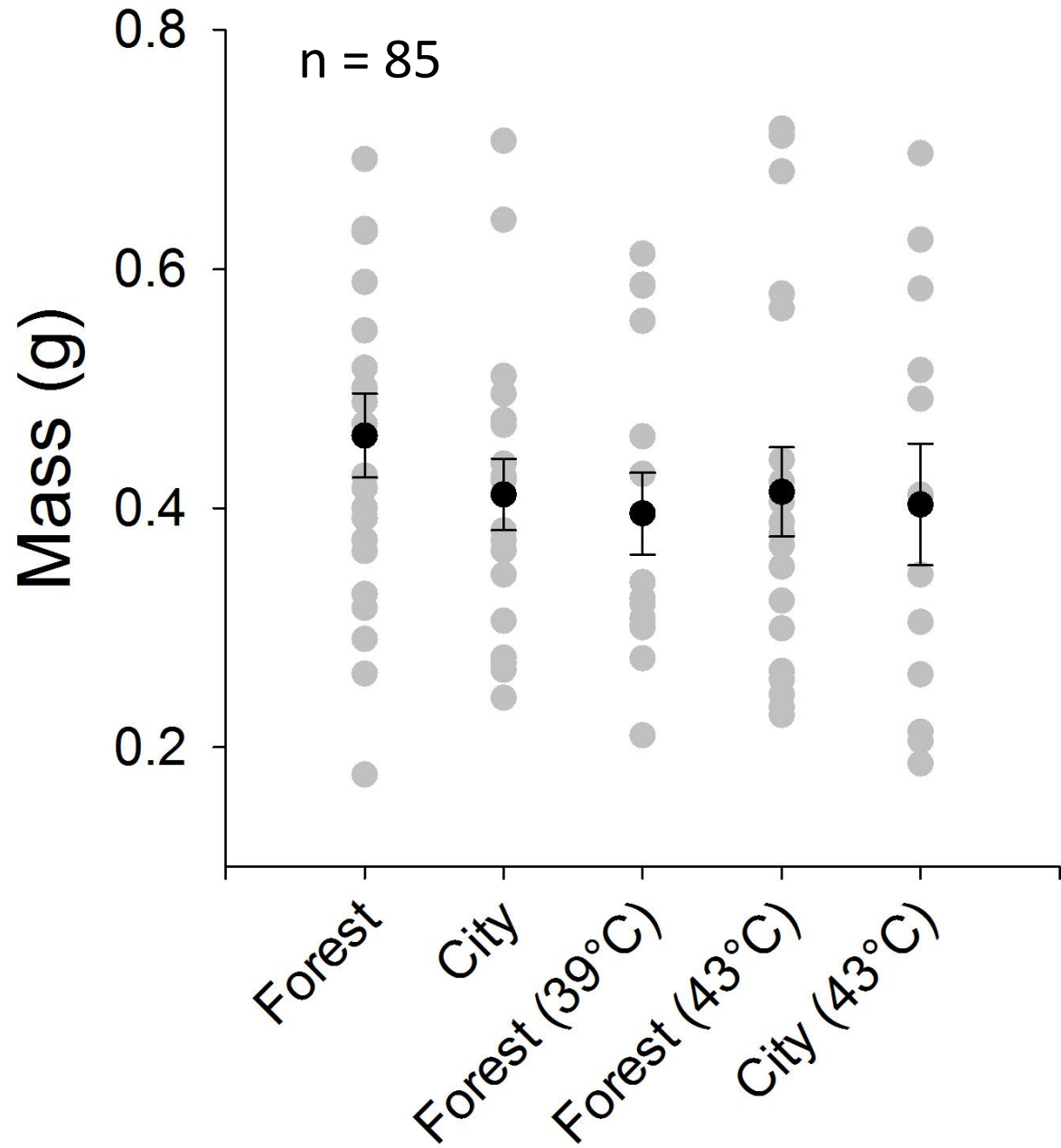
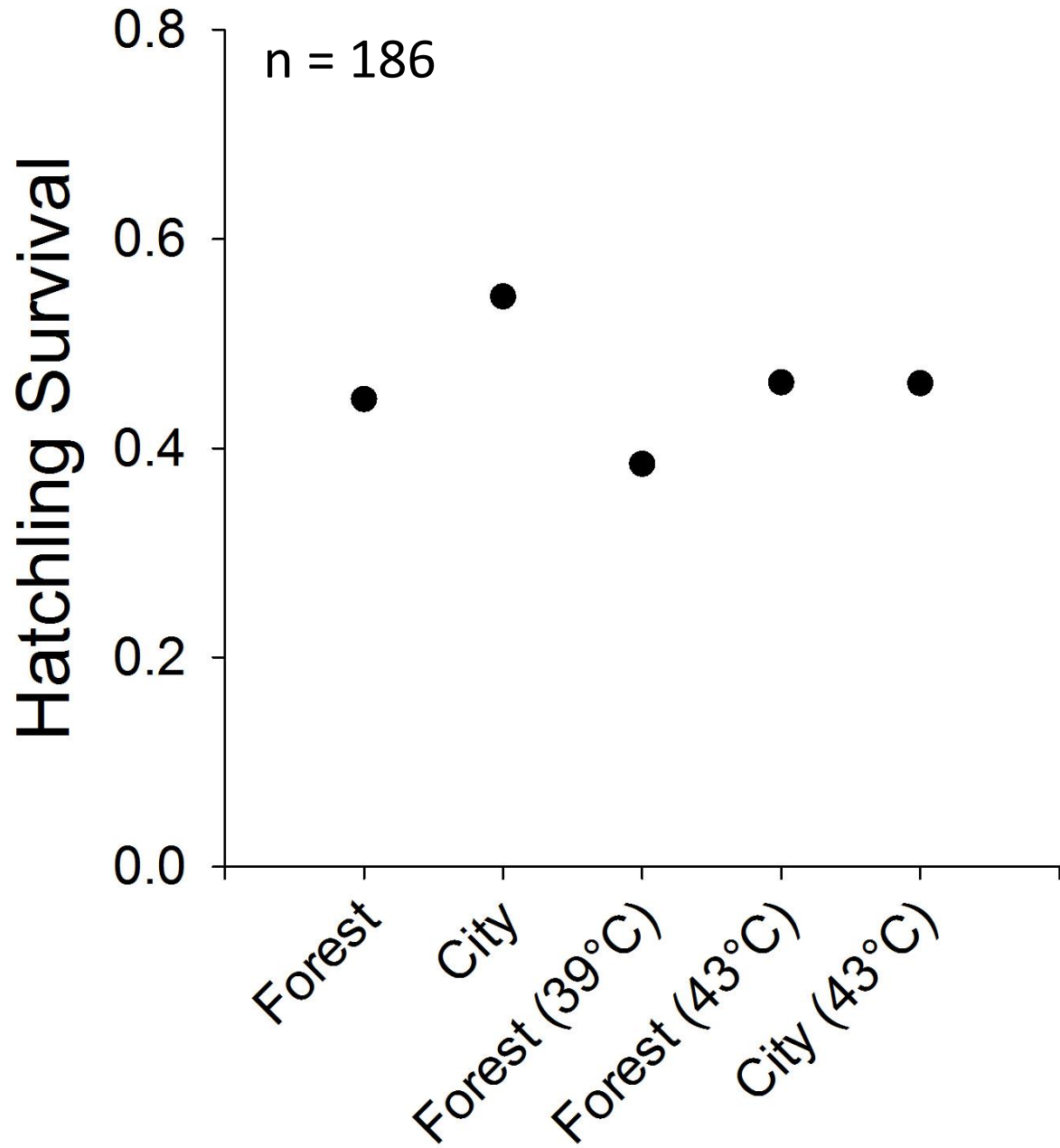




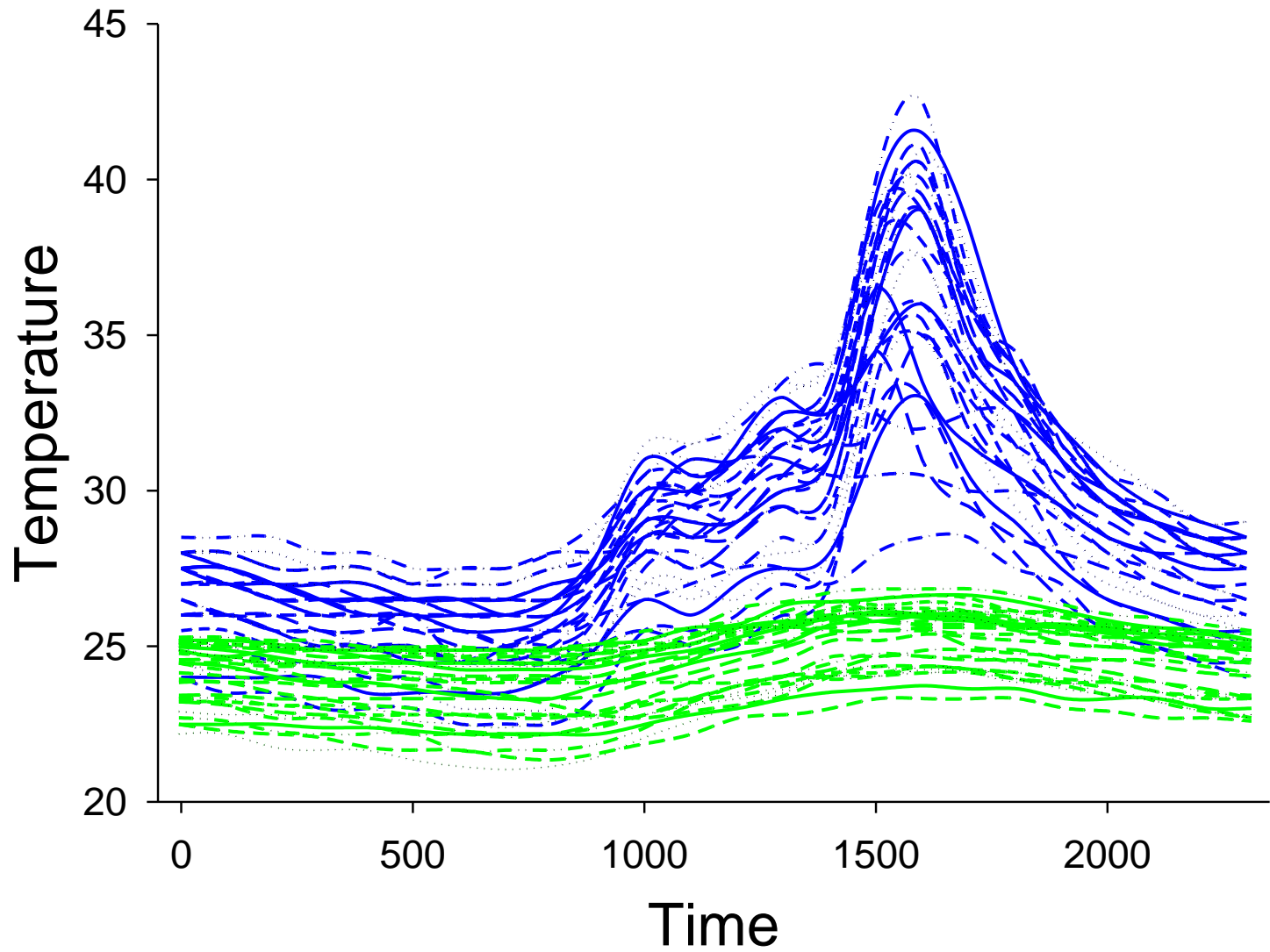






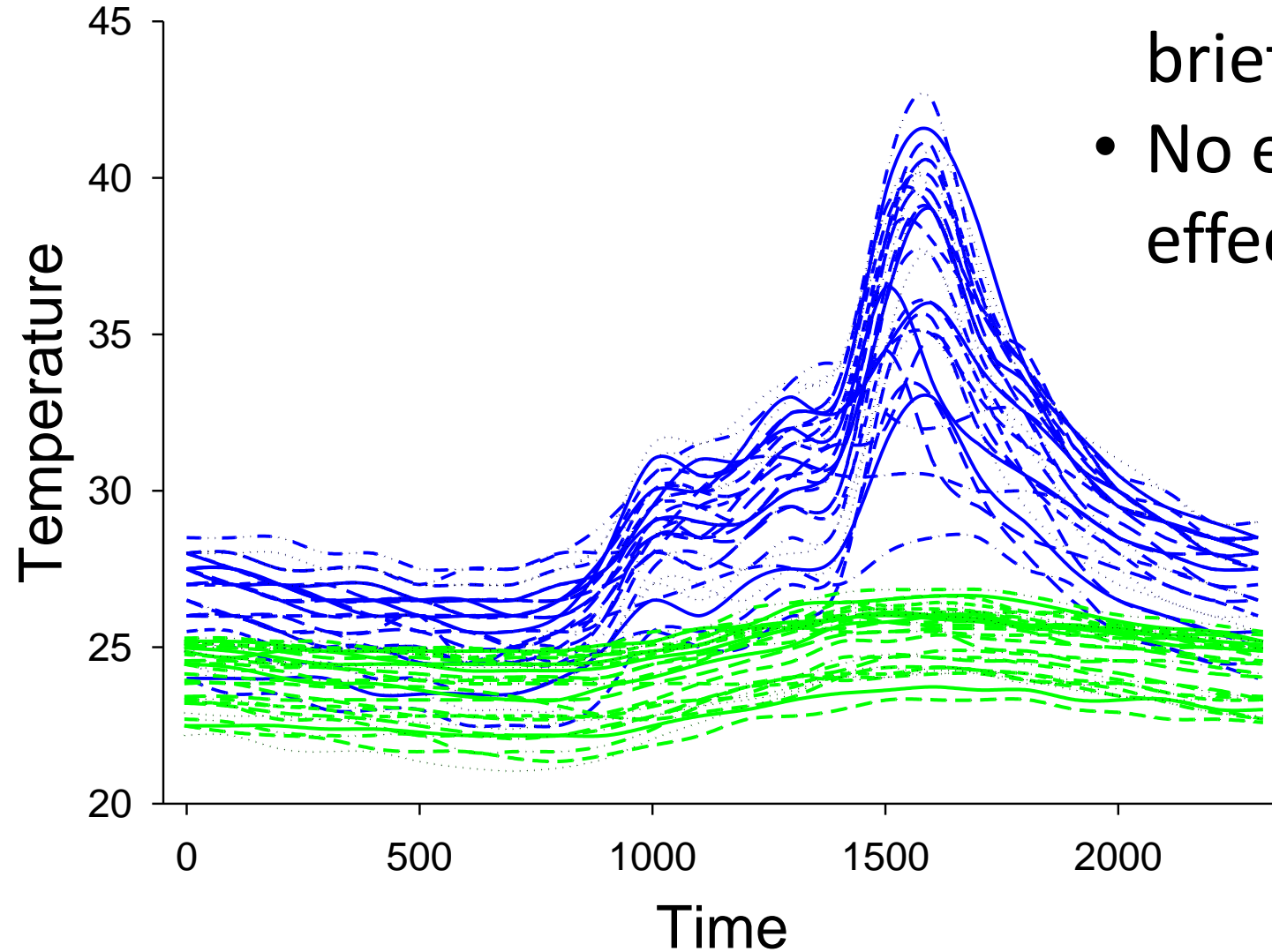


Results

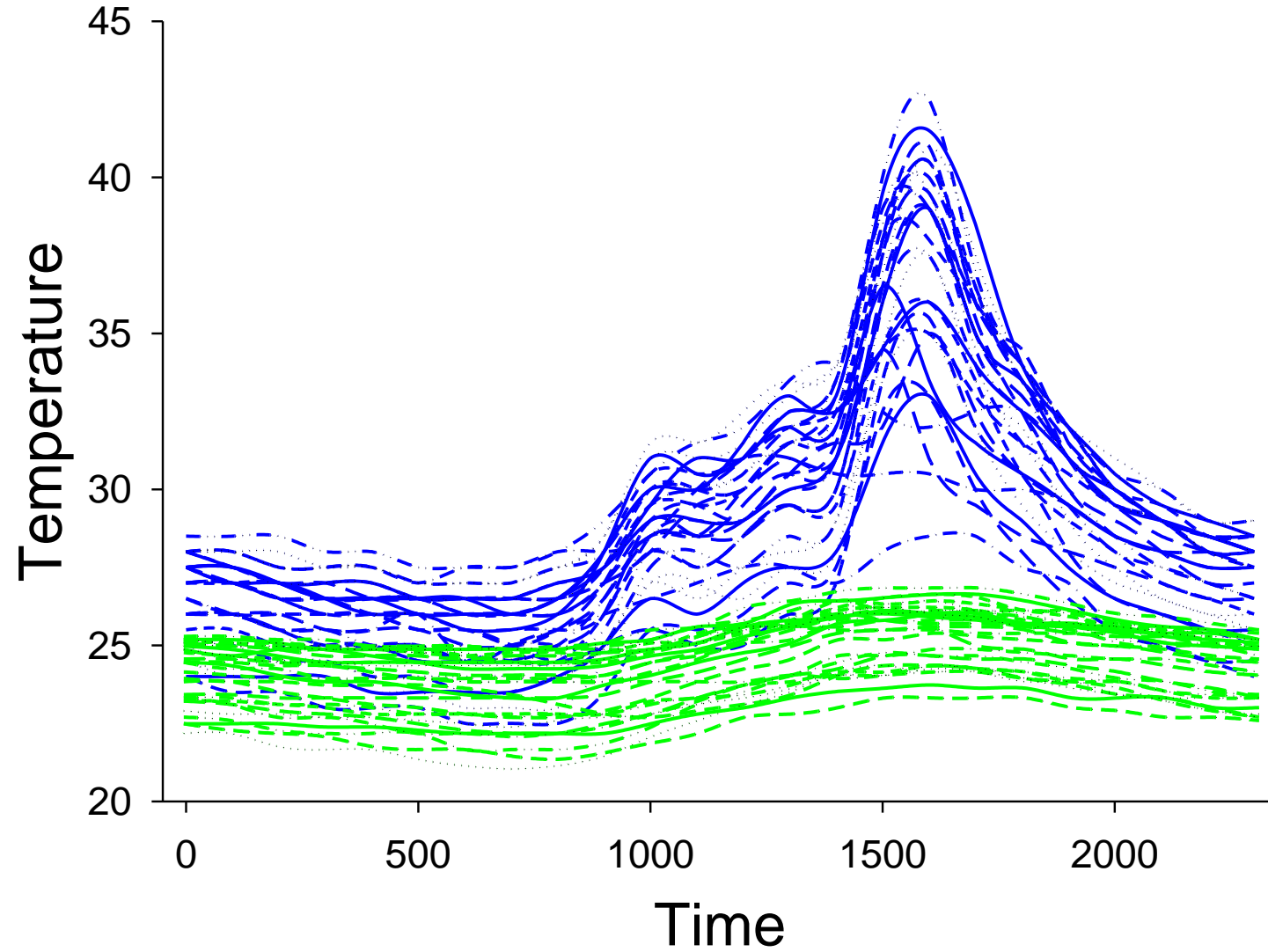


Results

- Effects persist in development; brief metabolic depression
- No evidence of post-hatching effects

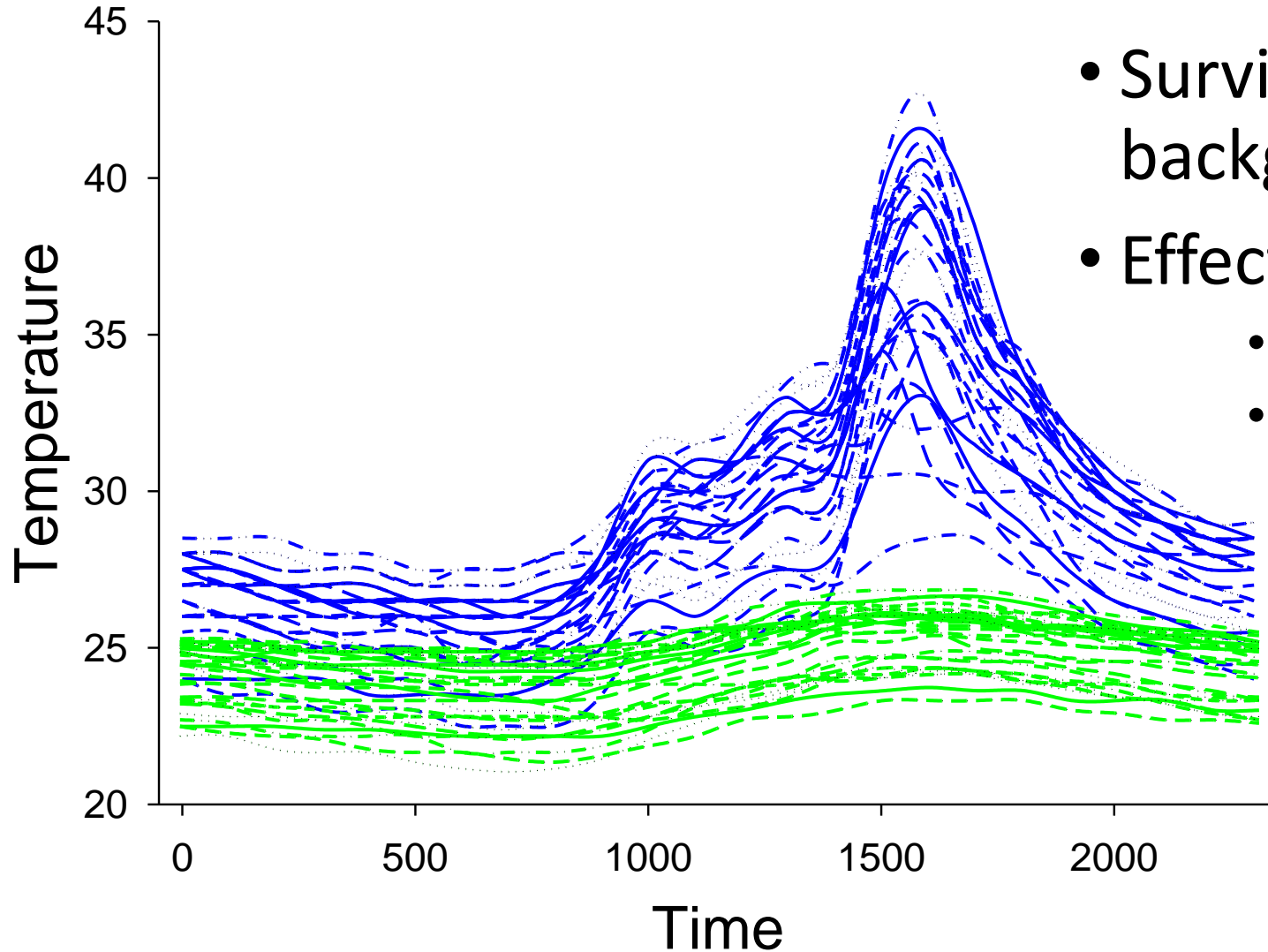


Conclusions

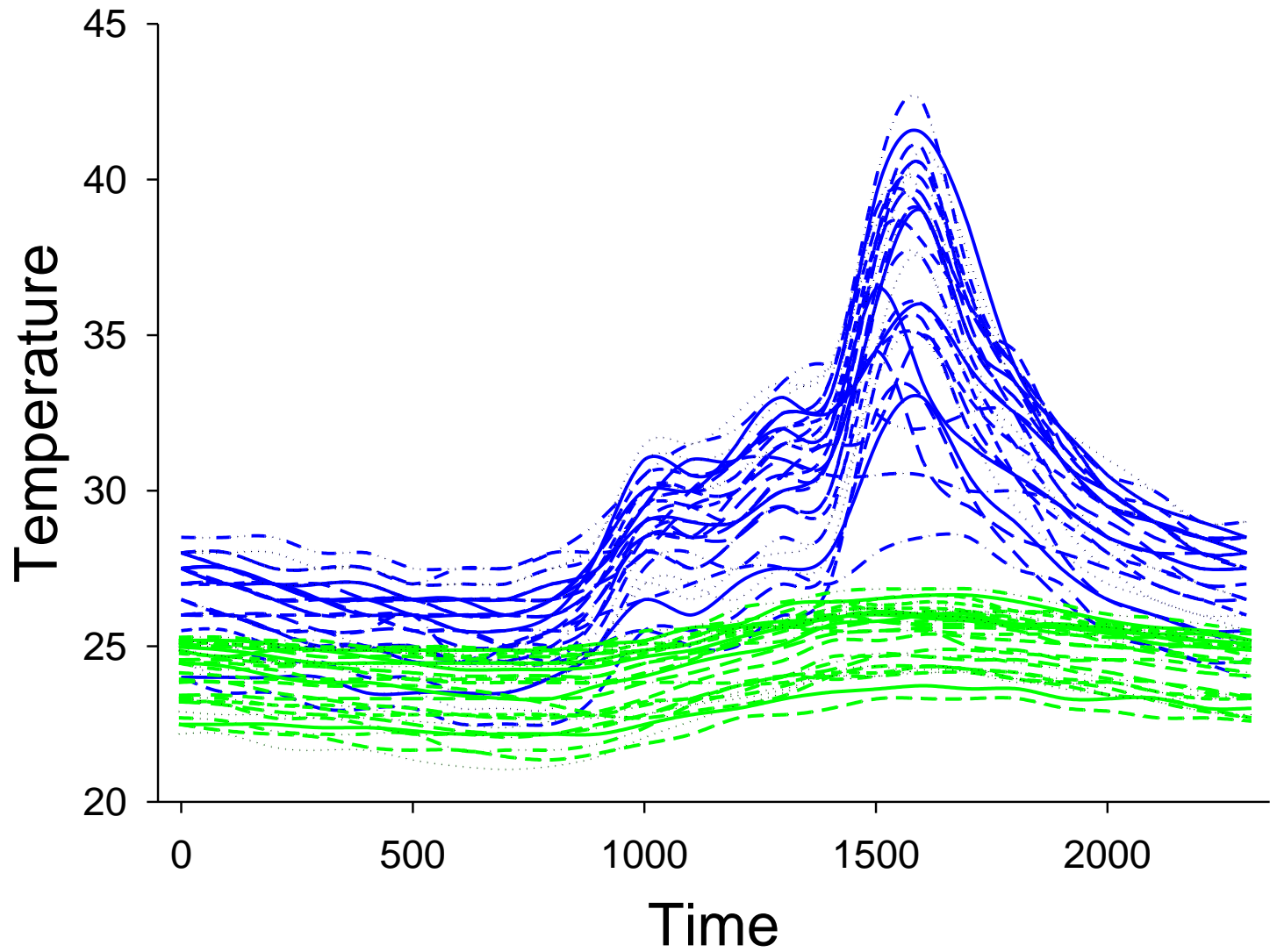


Conclusions

- Embryos appear to be robust to urban thermal environment
- Survival dependent on thermal background and magnitude
- Effects of thermal spikes can persist
 - Through embryonic development
 - But not post-hatching

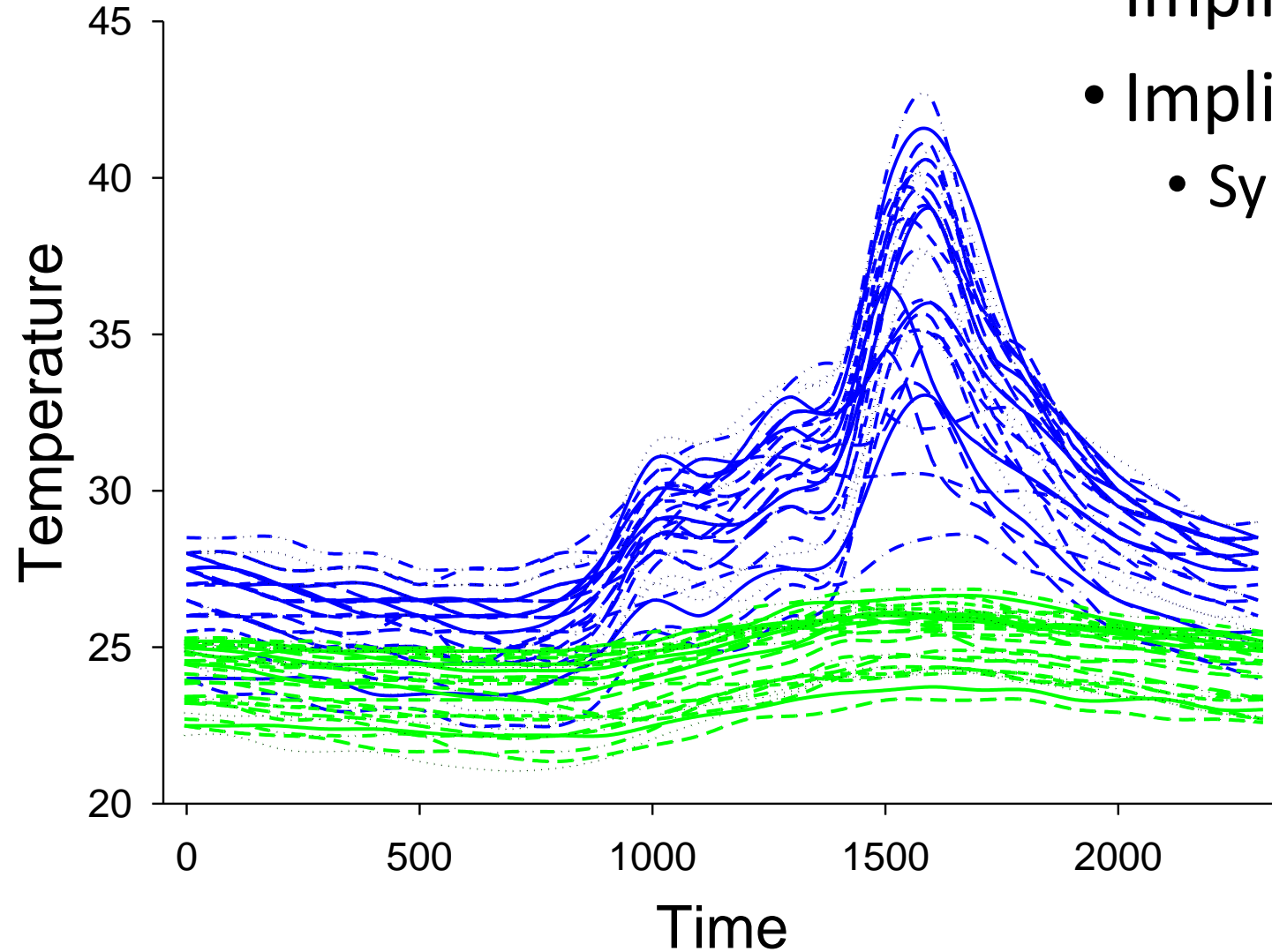


Discussion

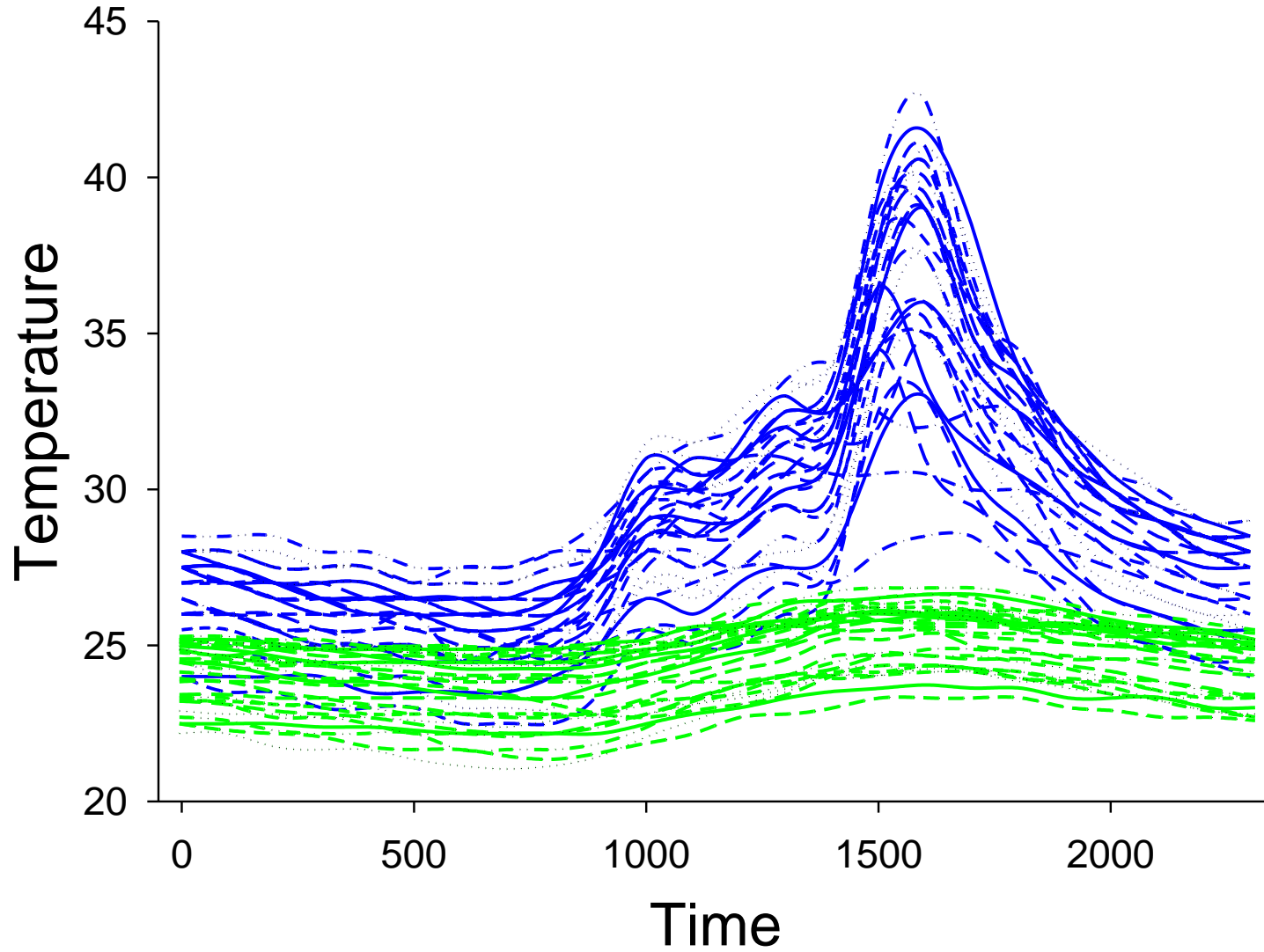


Discussion

- Invasion/naturalization
- Implications for Urbanization
- Implications for Climate Change
 - Synergistic effects

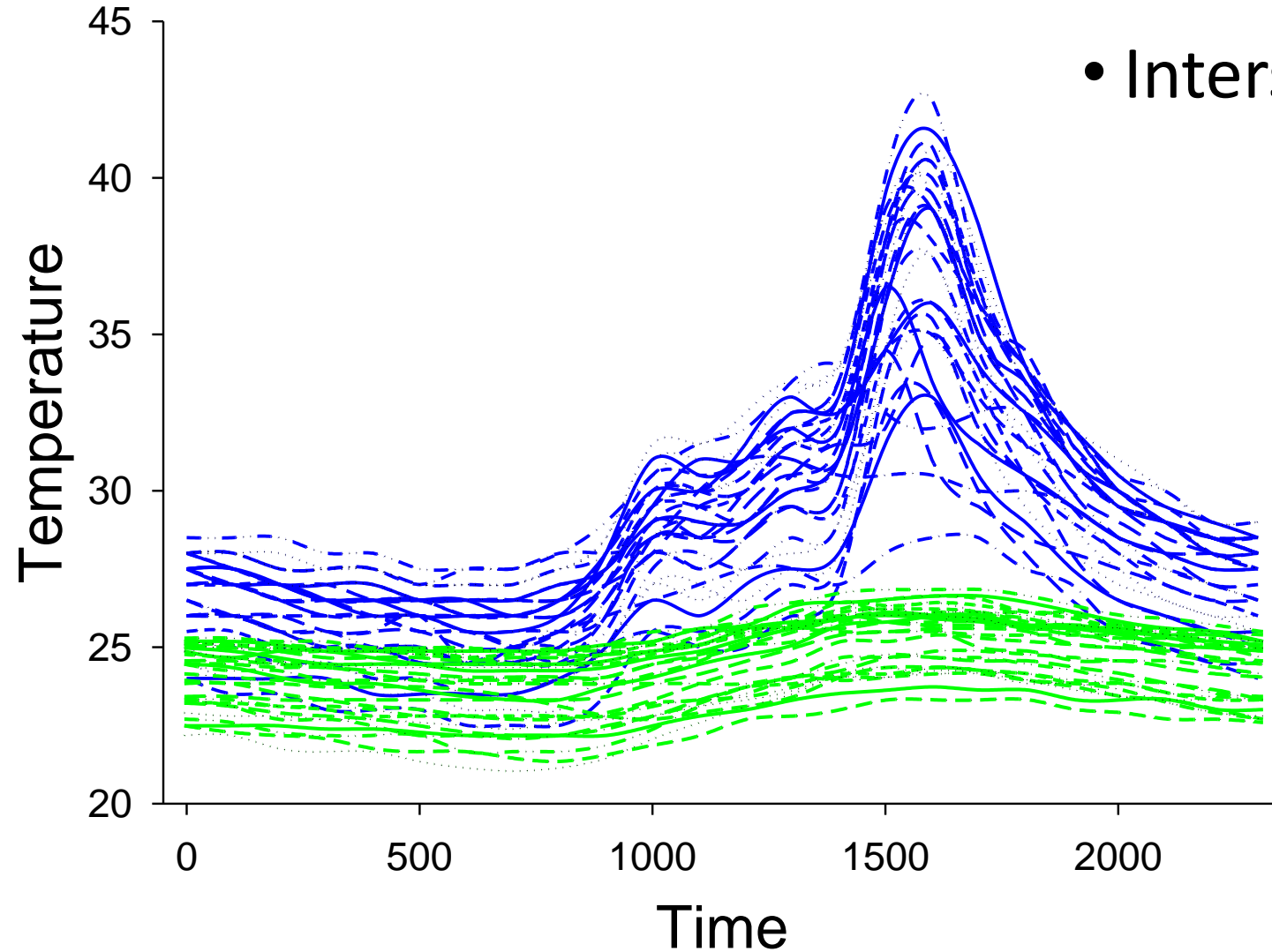


Future Directions



Future Directions

- Quantify the metabolic costs of the urban heat island effect in embryos
- Interspecific comparisons



Acknowledgements

Mentors

Dan Warner
Tim Mitchell
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Collaborators

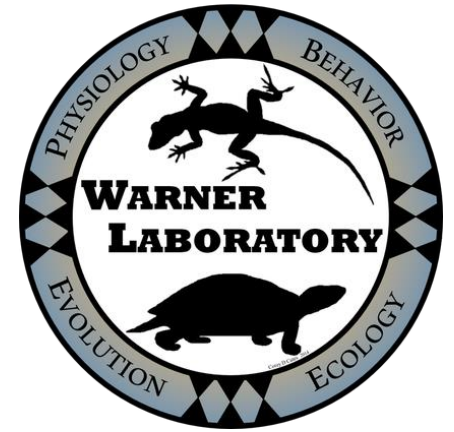
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Potential Site x Treatment Interaction

