Microclimate and Mosquitos Across an Urban Gradient

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Does microclimate across an urban landscape influence mosquito emergence & population growth rate?

Microclimate and Mosquitoes

Landscape-scale studies of vector-borne disease are often based on coarse measures of climate such as weather station data, failing to incorporate fine scale heterogeneity. Urban landscapes, in particular, have heterogeneous microclimate profiles (e.g. the urban heat island effect) driven by factors such as the amount of impervious surface or housing density. Mosquitoes are especially sensitive to this fine scale variation in microclimate, particularly temperature[1]. Warmer temperatures may lead to a shorter larval development time and smaller body size[2] (a proxy for female fecundity), decreasing the population growth rate. Ultimately, these changes in mosquito population dynamics across the landscape due to microclimate will correspond to spatial changes in disease risk.

Asian Tiger Mosquito

Aedes albopictus

- Invasive in Eastern US
- Vector of chikungunya & Zika
- Anthropophilic

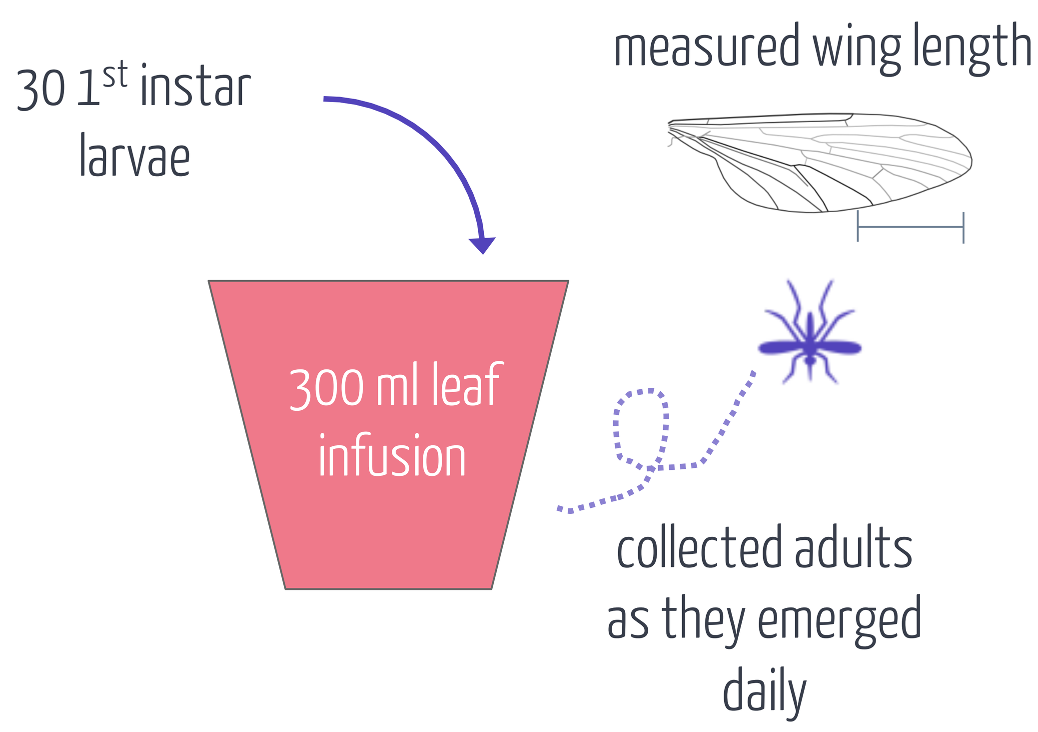
Objectives

- Characterize microclimate across an urban landscape
- Identify the influence of land-class on larval emergence
- Calculate mosquito population growth rates across land classes and their respective microclimates

Experimental Set-Up

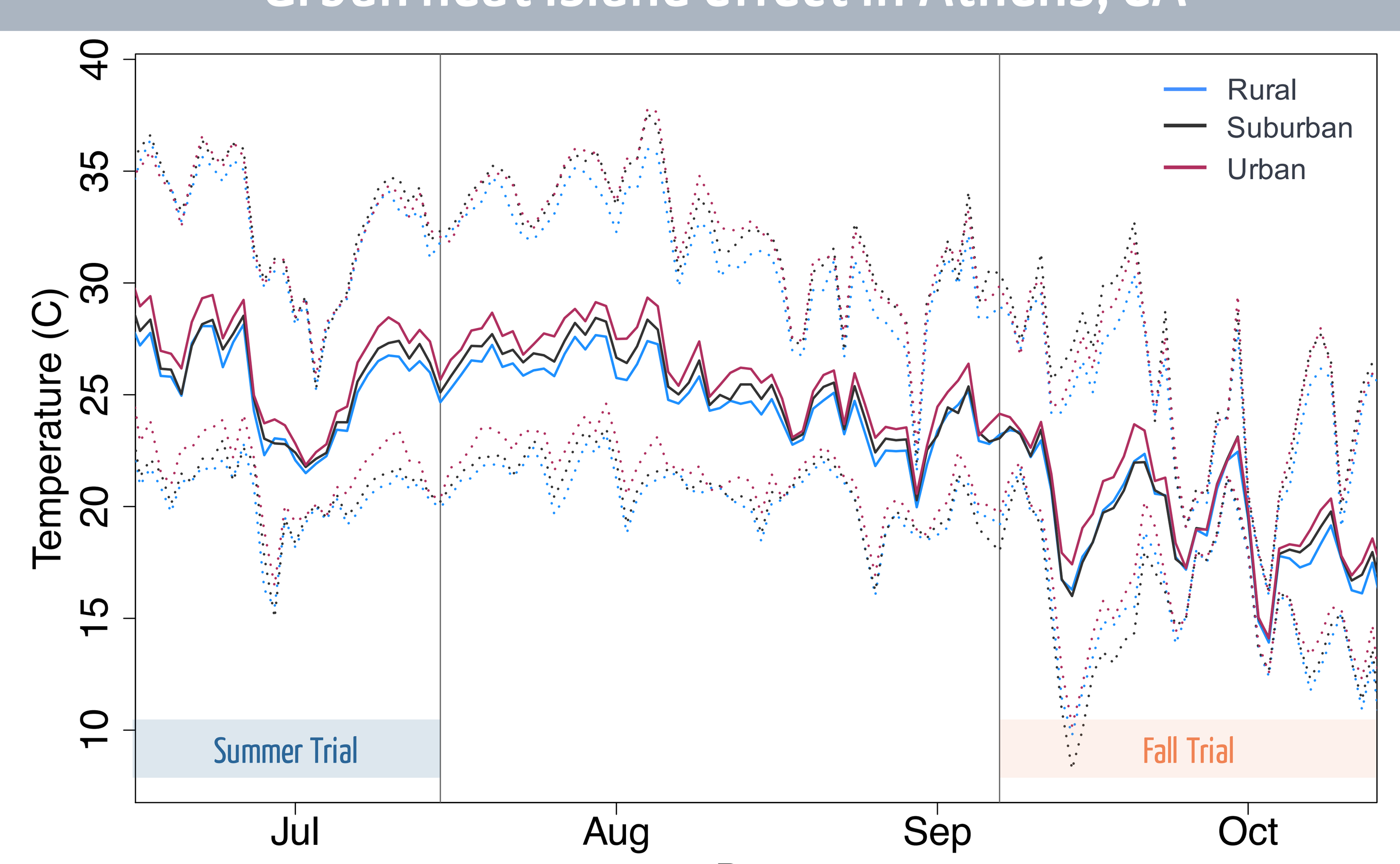
9 sites

- Rural, suburban, and urban sites were chosen based on their percentage of impervious surface
- Placed six pots in a 30 x 30 m area at each site
- Replicated in the summer and fall of 2015
- Collected fine-scale adult and larval temperature and relative humidity data of each pots' microclimate



Urban heat island effect in Athens, GA

Scan the QR code to interactively explore the data on your phone or tablet.

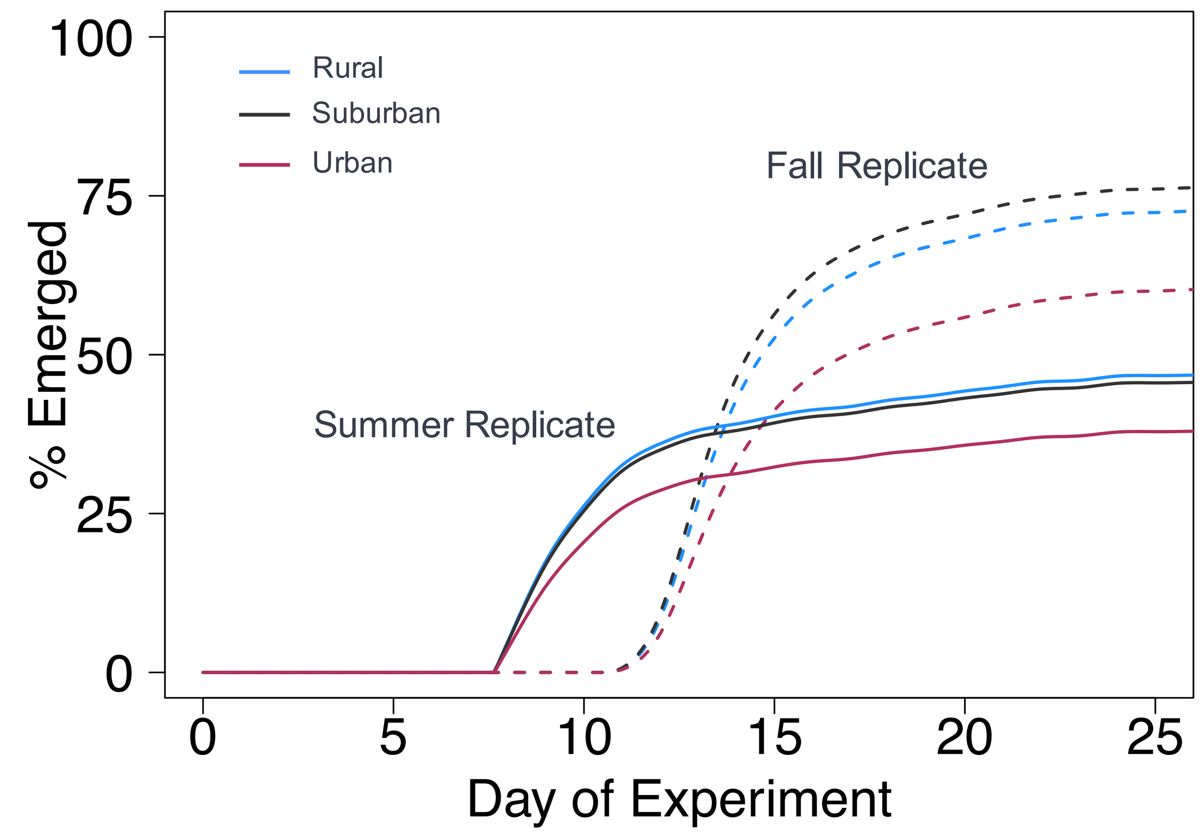


Plot of mosquito adult environmental temperature (i.e. ambient) in Athens, GA in 2015. Bolded line represents the daily mean temperature by land class, and dotted lines are the daily minimum and maximum. The urban sites have warmer mean and minimum temperatures over the whole season.

Mosquito Emergence & Growth

Or go to the following url:

https://tinyurl.com/jatjspy



Emergence rates were higher in the fall

Adults began emerging earlier in the summer

Rural and suburban sites had similar emergence rates

Mosquito emergence rates were analyzed using a Cox Proportional Hazard model, clustering by pot replicate to control for variation. Models were fit to minimize AIC using a multidirectional stepwise algorithm.

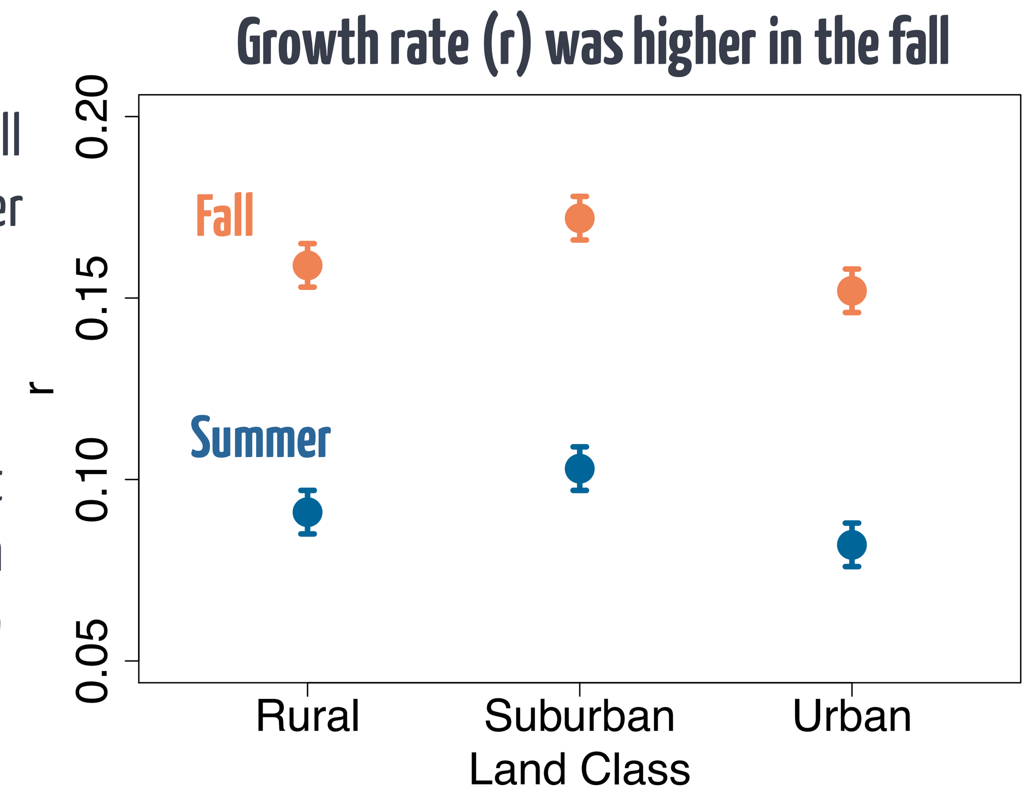
- **40%** decrease in likelihood of emergence at urban sites (β_{summer}=-0.42, β_{fall} = -0.62, p-value <0.01)
- **28%** increase in likelihood of emergence with each 1˚C increase in fall maximum temperature (β=0.25, p-value<0.05)
- **18%** decrease in likelihood of emergence with each 1˚C increase in summer minimum temperature (β=-0.19, p-value<0.05)

- Effect of temperature differed by season, with warmer temperatures decreasing emergence in the summer and increasing emergence in the fall
- Higher temperatures at urban sites may decrease emergence through increased larval mortality

2x higher in the fall than the summer

Temperature has a significant negative relationship with growth rate

Growth rate (r) was higher in the fall



Per-capita growth curves were calculated from the emergence rate and wing size of females from each pot using the composite index[3]. We analyzed the effect of land-use, season, and microclimate on *r* with a mixed-effects model, treating pot as a random factor. Error bars represent standard error.

Microclimate influences mosquito dynamics, with warmer temperatures in urban areas leading to lower emergence and growth rates.

Future Directions

- Rectify mismatching of scale between weather station data and microclimate
- Survey land classes for measures of *Ae. albopictus* growth rates in the field
- Quantify effects of land class and microclimate on vector competence

References

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