What's The Buzz?

An investigation on how urbanization impacts mosquito species distribution

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Background

Impervious surfaces, mainly paved areas, can affect local climate by heating the air and decreasing humidity. This is known as the **Urban Heat Island** effect. Variation in microclimate can impact mosquito population dynamics and increased temperatures are known to decrease *Aedes albopictus* larval survival. With the effects of Urban Island Heating, it will be interesting to see how mosquito community composition is impacted by impervious surface coverage.

For this study, sites were categorized into rural, suburban and urban sites with 0-5%, 5-55%, and 55-100% impervious surface coverage respectively. Spatial analysis data from 2011 as used to determine impervious surface coverage of each site.

It is especially important to understand how climate impacts *Aedes albopictus* distribution. This species is both prominent in Athens and has potential vectoral capacity for Zika, Dengue, and Chikungunya. Understanding how climate impacts this species can aid disease prevention if an outbreak occurs.

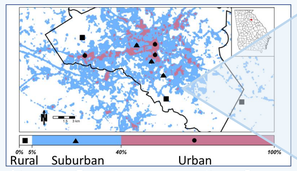
The **Shannon diversity index (H)** is a quantitative measure of relative diversity that can be used to compare multiple sites and communities. It measures the total number of species in a community (**S**), and the proportion of S made up by each species ($\mathbf{p_i}$).

$$H = -\sum_{i=1}^{S} p_i ln(p_i)$$

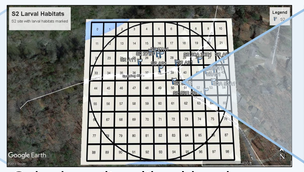
Hypothesis

Urban climates are known to increase *Ae albopictus* mortality. It is expected that in urban areas with high impervious surface coverage, there will be lower proportions of habitats occupied by *Ae. albopictus*. It is also expected that rural areas with low impervious surface coverage will have higher mosquito species diversity.

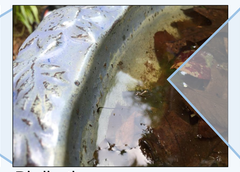
Methods



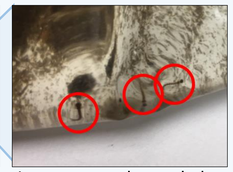
Athens, Ga with survey sites. 3 rural, 3 suburban, and 3 urban sites were surveyed



Suburban site with grid and identified larval habitats

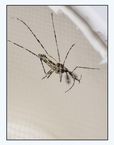


Birdbath, a common habitat for mosquito larvae



Larvae are subsampled from positive habitats

Larvae are reared in the lab until they emerge as adults. Adults are identified to species



Toxorhynchites spp.

Aedes albopictus

Aedes triseriatus

Results

Fig 1: The mid-June and early July larval surveys show *Ae. albopictus* occuping significantly more larval habitats than any other species in suburban sites. The early June survey showed the same in urban sites.

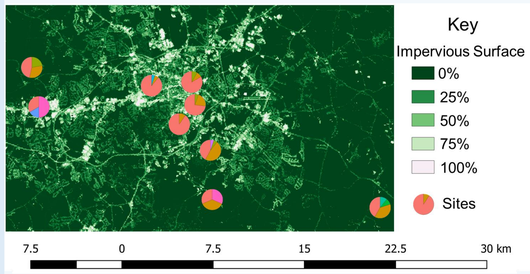


Fig 2: An impervious surface map of Athens, Ga. Areas with lower impervious surface coverage (rural and suburban sites) tend to have higher species richness and a more even spread of species presence.

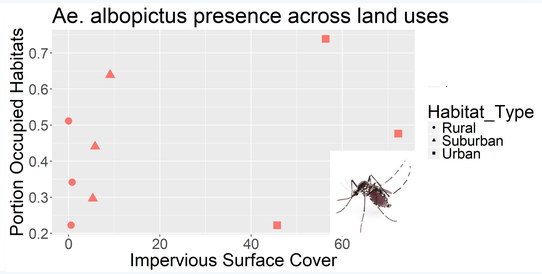


Fig 3: Proportion of *Ae. albopictus* occupied habitats in each habitat type. There seems to be no correlation with impervious surface coverage and *Ae. albopictus* presence.

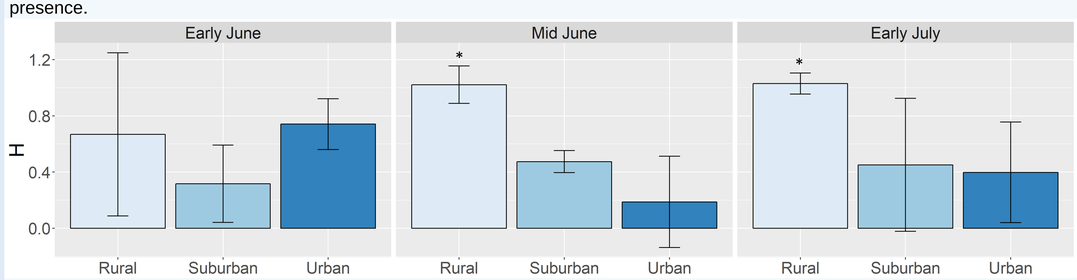


Fig. 4: The Shannon Diversity Index (H) was calculated for each site and averaged across land uses for each larval survey. In the Mid-June and Early July surveys, rural sites had significantly higher H values than suburban and rural.

Conclusion

Although the presence of *Ae. albopictus* doesn't significantly change across land uses, the overall mosquito species diversity decreases with higher impervious surface coverage. *Ae. albopictus* appears to be more adaptive to urbanization than other species. They may not be as sensitive to temperature change, larval habitat type, or larvicides as other species. It would be beneficial to investigate what factors limit other mosquito species larval distribution.

These results have interesting implications for disease research. Since there are less species for potential competition does *Ae. albopictus* have higher vectoral capacity in urban sites? Or, would urbanization not have an impact on disease spread since the presence of *Ae. albopictus* is similar across land uses? These questions would be interesting to investigate in future studies.

Acknowledgments

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Sources

Murdock CC, Evans MV, McClanahan TD, Miazgowicz KL, Tesla B (2017) Fine-scale variation in microclimate across an urban landscape shapes variation in mosquito population dynamics and the potential of *Aedes albopictus* to transmit arboviraldisease. PLoS Negl Trop Dis 11(5): e0005640. https://doi.org/10.1371/journal.pntd.0005640.

Xian, G., Homer, C., Dewitz, J., Fry, J., Hossain, N., and Wickham, J., 2011. The change of impervious surface area between 2001 and 2006 in the conterminous United States. *Photogrammetric Engineering and Remote Sensing*, Vol. 77(8): 758-762.