Distribution & Habitat Characteristics of Mosquito Larvae in Orange County, California

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Abstract: This preliminary study aimed to aid Orange County Mosquito and Vector Control District in identifying the risk factors of mosquito exposure. Identifying these risk factors would provide insight in how to best tailor the mosquito surveillance program to reduce the risk of a West Nile Virus outbreak in Orange County, California. This 10-week project required standardization and analysis of OCMVCD's mosquito larvae data collected between 2016 and 2018. We found that between genera there was no statistically significant difference in larval habitat preference (p = 0.21); however, between the top four most commonly sampled species in Orange County there was statistically significant differences in larval habitats (p < .001). This provides insight into what sources to target for effective West Nile Virus prevention methods.

Introduction/Background

- The mosquitoes most effective in transmitting West Nile Virus—the *Culex* genus—are seen as an endemic health threat in Orange County.[1]
- With the identification of the two invasive Aedes species in 2015, Orange County is now also under surveillance for anthroponotic arboviruses such as Zika, dengue, chikungunya, and yellow fever.[2]
- This project will determine what types of water sources harbor mosquito larvae, what the species composition is of these larval habitats, and how they are distributed across Orange County—laying a foundation for better understanding the risk of WNV transmission and *Aedes* control.

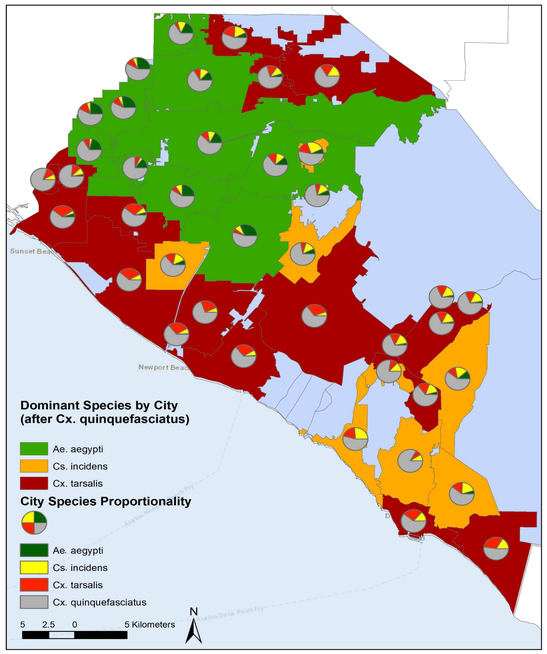
Objectives

1. To determine the spatial distribution of mosquito larvae throughout Orange County, California.
2. To identify the preferred breeding sources for mosquitoes commonly found in Orange County, CA.
3. To identify coexistence among mosquito species in larval habitats in Orange County, CA.
4. To identify changes in mosquito species' larval habitat preferences between 2016 and 2018 in Orange County, CA.

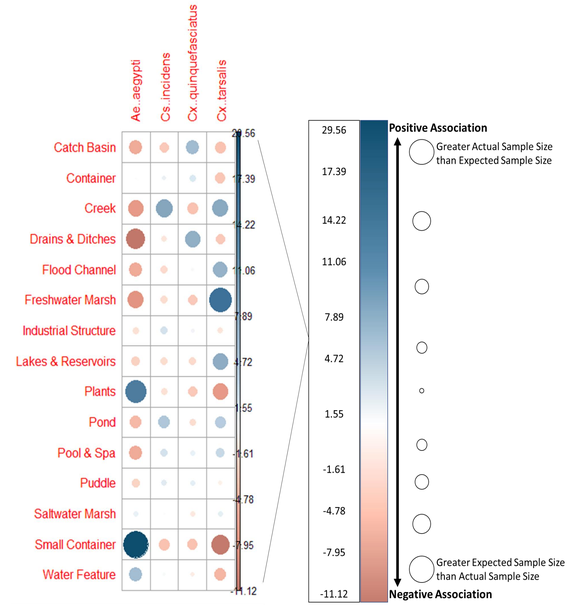
Method

- This preliminary study was a retrospective data analysis that looked at mosquito larvae data collected by OCMVCD from 2016 through 2018.
- The database was standardized to fit into one of four collection site types and one of 15 larval habitat/water source types.
- The final dataset for assessing sampling abundance and species coexistence had a total sample size (N) of 8,989; the sample size for larval habitat types was n = 5,591, and the sample size for source locations n = 4,419.
- RStudio [3.4.3] was used to conduct an NMDS analysis and a Chi Square test to determine independence in larval habitat preferences by mosquito genus and species.
- GIS mapping was used to display the geographic distribution of larvae samples to identify hotspot cities for the top four most sampled species.

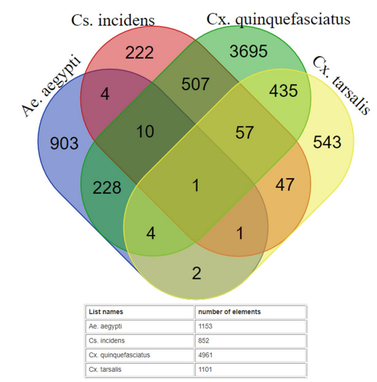
Results



[Obj. 1] GIS map showing distribution of the top four mosquito species collected at a larval life stage throughout Orange County, CA.

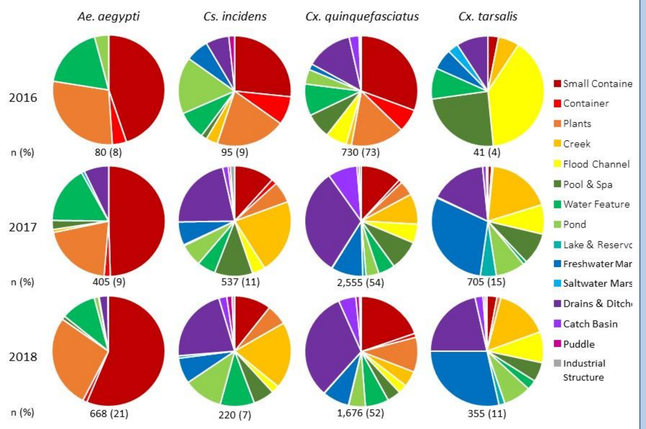


[Obj. 2] X^2 residuals showing strength of association between several mosquito species and larval habitats; positive displays preference and negative displays deterrent/less preferred.



List names	number of elements
Ae. aegypti	1153
Cs. incidens	852
Cx. quinquefasciatus	4961
Cx. tarsalis	1101

[Obj. 3] Coexistence within larval habitats among the top four most commonly sampled mosquito species.



[Obj. 4] Proportionality of sampling from various larval habitats by species from 2016 through 2018.

Discussion

- We found that there was no significant difference (p = 0.21) in larval habitat preferences between genera, supporting the hypothesis that among the 16 species within 4 genera, there is not one distinguishable, preferred larval habitat for *Aedes*, *Anopheles*, *Culiseta*, or *Culex* mosquitoes.
- We found distinct larval habitat preferences between the four most sampled species—*Ae. aegypti*, *Cs. incidens*, *Cx. quinquefasciatus*, and *Cx. tarsalis* (p < .001).
- Our findings were in line with mosquito sampling trends in the 1990s,[3] with *Cx. quinquefasciatus*, *Cx. tarsalis*, *Cx. stigmatasoma*, and *Cs. incidens* among the most sampled species. *Ae. aegypti* has since been introduced and has become the 2nd most sampled species as of 2018.
- Many species displayed cohabitation with *Cx. quinquefasciatus*, which has been show in the past to develop more quickly and successfully in the presence of other mosquito species.[4]

Conclusions

- *Ae. aegypti* preferred small containers, *Cs. incidens* preferred creeks, *Cx. quinqefasciatus* preferred drains and ditches, and *Cx. tarsalis* preferred freshwater marshes.
- We found that *Cs. incidens*, *Cx. quinquefasciatus*, and *Cx. tarsalis* often coexisted within the same larval habitats, while *Ae. aegypti* rarely shared larval habitats with any species but *Cx. quinquefasciatus*.
- *Cx. quinquefasciatus*—the most ubiquitous mosquito in Orange County—has shifted away from backyard sources since 2016, while *Ae. aegypti* has steadily increased its presence in backyard sources.

Acknowledgments and Permissions

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Literature Cited

[1] California Department of Public Health. Latest West Nile Virus activity in California. California West Nile Virus Website. Retrieved from http://westnile.ca.gov/. Accessed May 14, 2019.
[2] Orange County Mosquito & Vector Control [OCMVCD]. First indication of West Nile Virus activity in Orange County for 2018. *News and Press Releases 2018.* https://www.ocvector.org/files/cb59a80d8/PR_FirstWNV_2018.pdf . Accessed May 14, 2019.
[3] Reisen WK, Meyer RP, Tempelis CH, Spoehel JJ. Mosquito Abundance and Bionomics in Residential Communities in Orange and Los Angeles Counties, California. *Journal of Medical Entomology.* 1990;27(3):356-367. doi:10.1093/jmedent/27.3.356
[4] Smith PT, Reisen WK, Cowles DA. Interspecific Competition Between Culex tarsalis and Culex quinquefasciatus. *Journal of Vector Ecology.* 1995;20(2):139-146.