The Effect of Garden Plant Diversity on Mosquito Species that Act as Infectious Disease Vectors in Central Illinois

ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

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Introduction

- Central Illinois is home to mosquito species that are primary vectors of diseases such as West Nile virus, dengue fever, yellow fever, and the Zika virus
- Mosquito oviposition is dictated by how mosquitoes utilize physical and chemical environmental cues to choose sites at which to lay their eggs
- All mosquitoes require sugar to survive; when blood meals are unavailable, females utilize plant sugars to survive, so the distribution of plant nectar sources can greatly influence mosquito reproduction and abundance
- Studies have shown that urban gardens can provide habitat and resources (including food) to a wide range of organisms including mosquitoes (Gardner et al., 2014)
- However, to what extent sugar sources from plants found in residential areas could impact mosquito diversity, including mosquitoes carrying infectious diseases, is not well understood

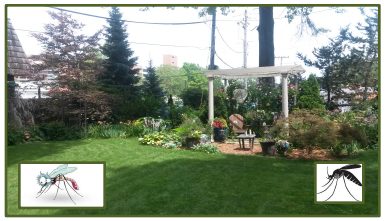
Culex pipiens–*West Nile virus vector*

Aedes albopictus–*dengue/Zika virus vector*

Anopheles punctipennis–*malaria vector*

Objective

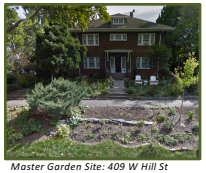
- This study was designed to characterize the species richness of common garden plants and mosquito abundance and diversity in the Champaign-Urbana area of Central Illinois in order to evaluate the following hypothesis: **1) local sites with high plant diversity will contain higher quantities of mosquitoes due to providing more sugar resources**
- To our knowledge, this is one of the first studies examining flowering plant and mosquito interactions, focusing on species carrying diseases such as *Culex pipiens* and *Culex restuans*



Methods

- Twelve residential sites in Champaign-Urbana were selected with high and low plant diversity; the six high plant diversity sites (> 10 plants species of varying abundance) were selected from the UI Extensions Master Gardener program
- Two trap types (i.e., gravid and light) were used to collect mosquitoes
- Traps were placed at each site from August (2015) until the end of mosquito season (mid-October, 2015)
- Mosquitoes were identified at the genera and species level
- At each site plant species richness, mosquito richness, mosquito abundance, and mosquito biodiversity (i.e., Shannon-Wiener Index [H] and the Simpson's Index [D]) were determined

Control Site: 604 W Hill St

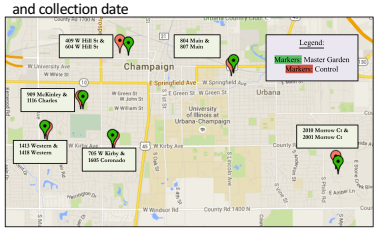


Master Garden Site: 409 W Hill St

Gravid Mosquito Trap

Light Mosquito Trap

- Two-way ANOVA performed to examine differences in mosquito abundance due to site plant diversity, trap type with which mosquitoes were captured, or their interaction
- T-tests conducted to examine differences between high and low plant diversity sites for plant species richness, mosquito Shannon-Wiener index, mosquito Simpson's index, total mosquito abundance, and mosquito richness
- T-tests performed to examine differences between high and low plant diversity sites for *Culex*, *Aedes*, and *Anopheles* mosquitoes (three most abundant genera collected) and at the species level
- Linear regressions were conducted for eight mosquito species to test for significant relationships between mosquito species and collection date



Map showing the location of mosquito collection sites in Champaign & Urbana, IL USA

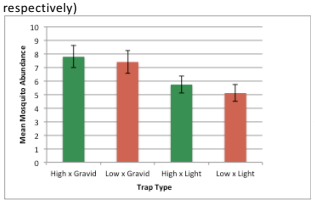
Results

- Total of 4,457 mosquitoes collected over 11-week period
- Total of 301 plant species recorded with Master Garden sites comprising 254 species and control sites 47 species

Site-wise plant species richness, mosquito species richness, total mosquito abundance, and biodiversity indices

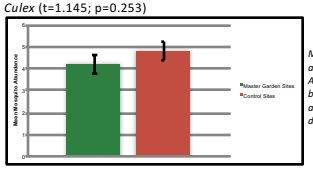
Site Address	Site Diversity	Plant Richness	Mosquito Richness	Mosquito Total (M)	Shannon-Wiener Index (H)	Simpson's Index (D)
909 McKinley	High	34	11	178	1.35	0.34
1116 Charles	Low	16	13	310	2.32	0.19
1413 Western	High	64	15	273	1.68	0.27
1418 Western	Low	8	15	444	2.70	0.18
705 Kirby	High	48	16	492	2.22	0.23
1605 Coronado	Low	7	12	408	1.98	0.26
2010 Morrow	High	21	12	610	0.52	0.30
2001 Morrow	Low	2	10	509	0.40	0.38
409 Hill	High	56	14	404	1.89	0.28
604 Hill	Low	11	12	290	2.53	0.16
804 Main	High	31	9	588	0.48	0.30
807 Main	Low	3	10	419	1.85	0.23

- A two-way ANOVA showed a significant difference for mosquitoes collected in gravid traps versus light traps but none between sites with high vs. low plant diversity or the interaction effect ($F=6.019$, $p=0.014$; $F=0.018$, $p=0.926$; $F=0.022$; $p=0.882$ respectively)



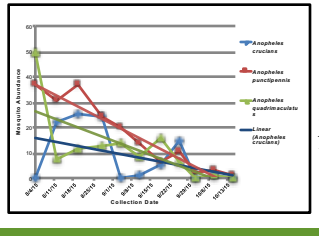
Total mean mosquito abundance for site plant diversity and trap type

- T-test for *Anopheles* and *Aedes* showed a significant difference for mosquito abundance at sites of high versus low plant diversity ($t= 4541.00$, $p=0.047$; $t=32621.00$, $p=0.043$), but not for *Culex* ($t=1.145$; $p=0.253$)



Mean mosquito abundance for Aedes genus between high and low plant diversity sites

- T-tests showed no significant differences for the eight most abundant mosquito species
- Linear regressions showed significant relationships between collection date and mosquito abundance for only *Anopheles punctipennis* and *Anopheles quadrimaculatus* ($r^2=0.922$, $p=2.75E-6$; $r^2=0.498$, $p=0.015$ respectively)



Weekly mosquito abundance for Anopheles species

Discussion

- The results do not support the hypothesis that Master Garden sites with greater plant diversity contain a larger quantity of mosquitoes due to a larger selection of sugar sources
- Mosquito abundance may have been impacted by short collection period, environmental factors, trapping inconsistencies, study limitations, etc.
- *Anopheles* and *Aedes* were more abundant in low diversity sites; it is possible that low diversity sites provide better microenvironments (i.e., warmer water [Li et al., 2014]; sunny areas [Impoinvil et al., 2008]) for growth and development of the larvae of these genera than high diversity sites
- Lack of differences between low and high diversity sites for *Culex* species may be the result of being less discriminatory of sugar sources and oviposition sites in urban populations (Gardner et al., 2014)
- Patterns at genus level were not observed at species level, suggesting that abundance of mosquito species is influenced by other environmental and landscape factors not measured in this study (Reiskind et al., 2009)
- Although not always significant, the linear regression analyses confirmed the known peaks of mosquito abundance in Central Illinois
- Lastly, this study confirmed that gravid traps collect more mosquitoes than light traps

Conclusions

- Gardens with high plant diversity in urban residential areas do not attract more mosquito species than low plant diversity gardens
- However, this study found that disease vector mosquito species are present in local residential areas
- Homeowners may be most at risk of West Nile virus from *Culex* species, malaria from *Anopheles* species, or dengue and Zika virus from *Aedes* species during summer (June-August) when temperatures and humidity are high and mosquito populations are at a maximum
- Homeowners should protect accordingly

Acknowledgments

- This study was possible due to the Illinois Natural History Survey and Medical Entomology Laboratory, UI Extension Illinois Master Gardeners Program and Sandra Mason, the gracious homeowners who provided their yards, Ephantus J. Muturi, Brenda Molano-Flores, Chang-Hyun Kim, and Millon Blackshear Jr.
- This project was funded by the University of Illinois College of Liberal Arts & Sciences fall 2015 Preble Research Scholarship

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