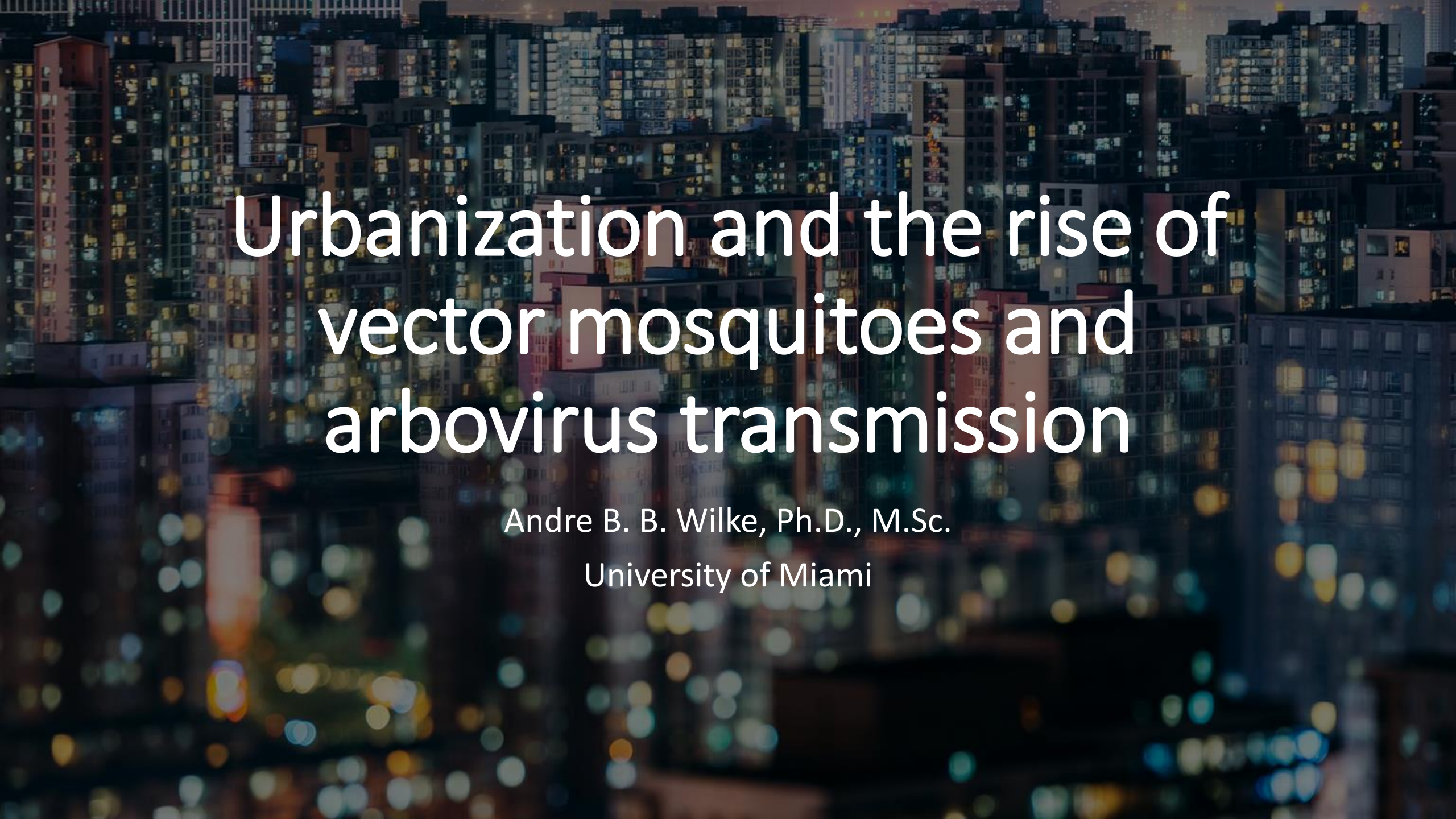

Urbanization and the rise of vector mosquitoes and arbovirus transmission

Andre B. B. Wilke, Ph.D., M.Sc.

University of Miami


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Urbanization

Urbanization is characterized not only by an increase in built up areas because of migration, but also by the natural growth of a city and consequent conversion of rural areas into urban areas.

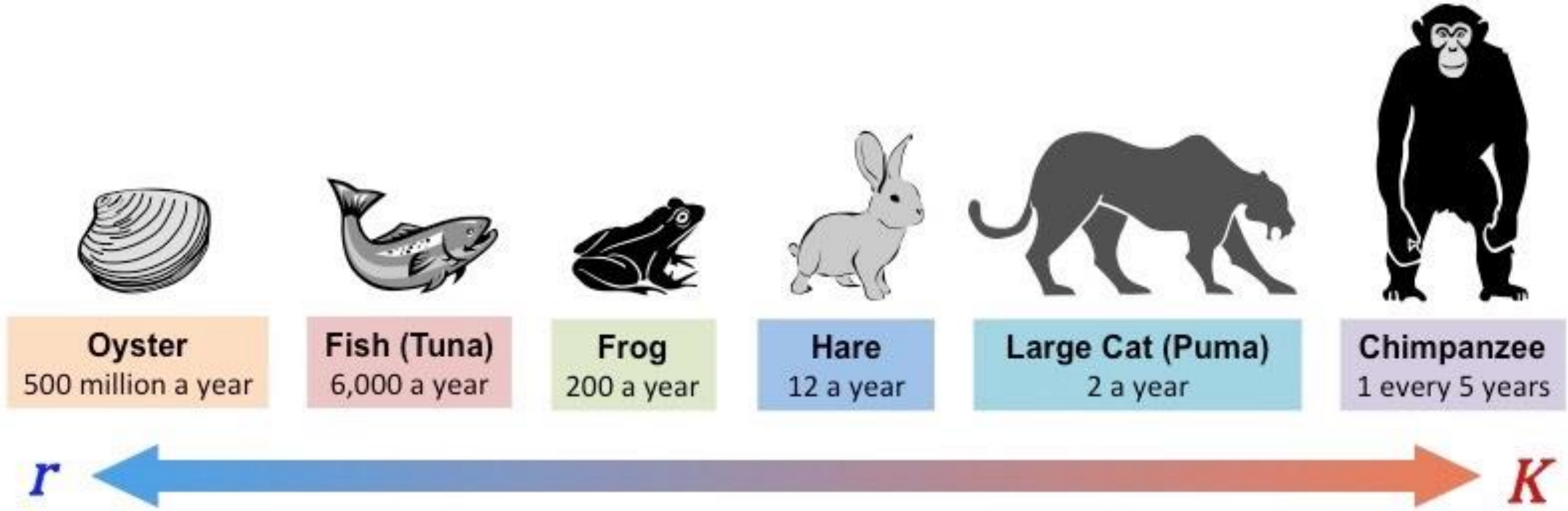
What are the consequences of urbanization?

Urbanization

Anthropogenic alterations in the environment often promote a non-random biotic homogenization of species, favoring in the process species which are capable of enduring urban environmental conditions and may associate with human activities.

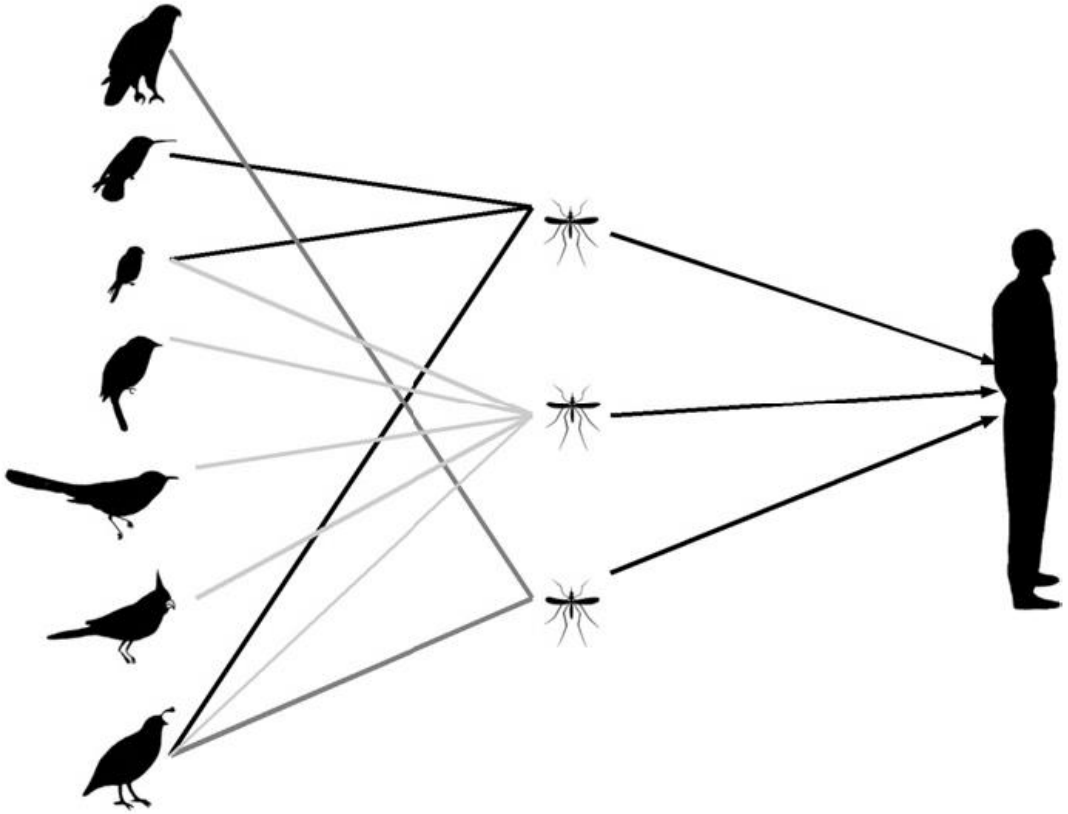
What are the consequences of biodiversity loss?

Urban Exploiters



The *r-K* Scale of Reproductive Strategy: Offspring Numbers

Dilution Effect



Dengue 2019

Most prevalent arbovirus in the world

Region	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Andean Subregion	307,352	125,766	201,522	228,634	253,549	256,031	208,150	131,302	81,564	180,744
Central America Isthmus and Mexico	194,769	124,245	288,865	445,915	298,061	408,087	295,042	185,937	172,388	658,991
Latin Caribbean	32,325	7,855	21,058	34,667	17,676	20,606	8,685	2,621	3,688	22,058
Non-Latin Caribbean	105,169	19,569	13,387	47,591	10,492	7,537	10,385	4,879	3,282	15,479
North America	65	7	186	543	668	945	990	453	331	1,158
Southern Cone	1,008,889	796,548	639,348	1,627,453	604,394	1,722,487	1,651,575	254,453	300,140	2,134,617
The Americas	1,648,569	1,073,990	1,164,366	2,384,803	1,184,840	2,415,693	2,174,827	579,645	561,393	3,013,047

CDC Southeastern Regional Center of Excellence in Vector-Borne Diseases: The Gateway Program

- Our main goal is to provide strategic support to improve and guide mosquito control operations and policies in Miami-Dade.

Ornamental Bromeliads

- Our findings show that ornamental bromeliads contribute to the proliferation of *Aedes aegypti* in Miami-Dade County and emphasizes the need to consider ornamental bromeliads in future vector-control strategies to control Zika and other arboviruses.

Wilke *et al. Parasites & Vectors* (2018) 11:283
https://doi.org/10.1186/s13071-018-2866-9

Parasites & Vectors

RESEARCH Open Access

Ornamental bromeliads of Miami-Dade County, Florida are important breeding sites for *Aedes aegypti* (Diptera: Culicidae)

André B. B. Wilke[1*], Chalmers Vasquez[2], Paul J. Mauriello[2,3] and John C. Beier[1]

Construction Sites

Our findings indicate that vector mosquitoes are breeding in high numbers at construction sites and that these areas have reduced biodiversity of species sheltering almost exclusively *Aedes aegypti* and *Culex quinquefasciatus*.

Such findings suggest that construction sites are important producers of vector mosquitoes.

PLOS ONE

RESEARCH ARTICLE

Construction sites in Miami-Dade County, Florida are highly favorable environments for vector mosquitoes

André B. B. Wilke[1]*, Chalmers Vasquez[2], William Petrie[2], Alberto J. Caban-Martinez[1], John C. Beier[1]

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Trends in Parasitology

CellPress REVIEWS

Opinion

Mosquito Adaptation to the Extreme Habitats of Urban Construction Sites

André B.B. Wilke,[1,*] Alberto J. Caban-Martinez,[1] Marco Ajelli,[2,3] Chalmers Vasquez,[4] William Petrie,[4] and John C. Beier[1]

Urban Farms

Our results show that urban farms provide favorable conditions for populations of vector mosquito species by providing a wide range of essential resources such as larval habitats, suitable outdoor resting sites, sugar-feeding centers, and available hosts for blood- feeding.

The abundance of vector mosquitoes was approximately 5 times higher than in their surrounding areas.

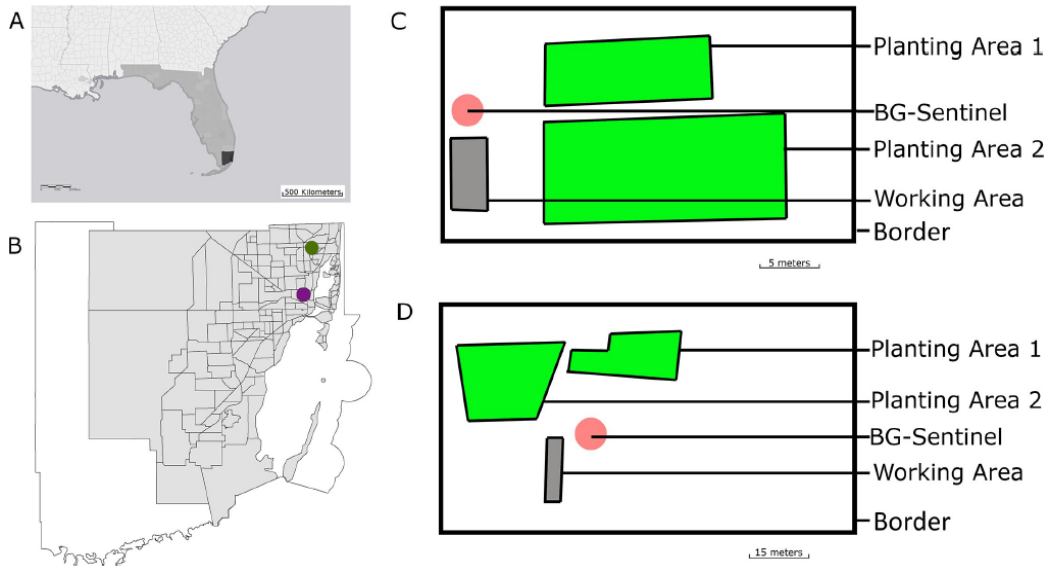
PLOS ONE

RESEARCH ARTICLE

Urban farms in Miami-Dade county, Florida have favorable environments for vector mosquitoes

André B. B. Wilke[1]*, Augusto Carvajal[2], Chalmers Vasquez[2], William D. Petrie[2], John C. Beier[1]

1 Department of Public Health Sciences, Miller School of Medicine, University of Miami, Miami, FL, United States of America, **2** Miami-Dade County Mosquito Control Division, Miami, FL, United States of America



Cemeteries

- Our results are indicating that vector mosquitoes are able to successfully exploit the resources available in the cemeteries.
- *Culex quinquefasciatus* was the most abundant species but it was neither as frequent nor present in its immature forms as *Aedes aegypti* and *Aedes albopictus*.

PLOS ONE

RESEARCH ARTICLE

Cemeteries in Miami-Dade County, Florida are important areas to be targeted in mosquito management and control efforts

André B. B. Wilke[1]*, Chalmers Vasquez[2], Augusto Carvajal[2], Maday Moreno[2], Yadira Diaz[2], Teresa Belledent[2], Laurin Gibson[2], William D. Petrie[2], Douglas O. Fuller[3], John C. Beier[1]

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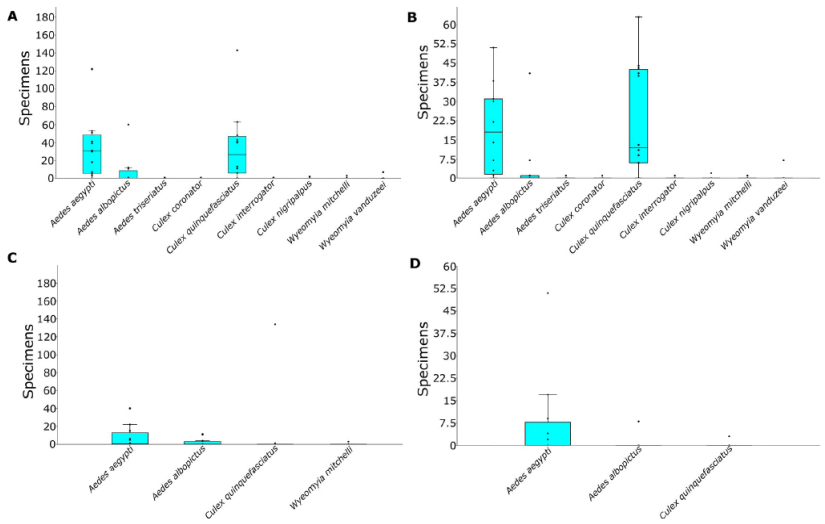


Fig 2. Box plot graph displaying the total number of mosquitoes collected in the twelve cemeteries surveyed in Miami-Dade County, Florida. (A) All collected mosquitoes; (B) adult mosquitoes; (C) larvae; and (D) pupae. Boxes represent the 25–75 percent quartiles; the horizontal line inside the box represents the median; the whiskers represent the largest data point less than 1.5 times the box height; and values further that limit are shown as outlier dots.

Tire Shops

- The main findings of this study demonstrate that vector mosquitoes, primarily *Aedes aegypti*, are being produced at tire shops in Miami-Dade County.
- Such findings suggest that tire shops have a significant role in the production of vector mosquitoes in Miami.

PLOS ONE

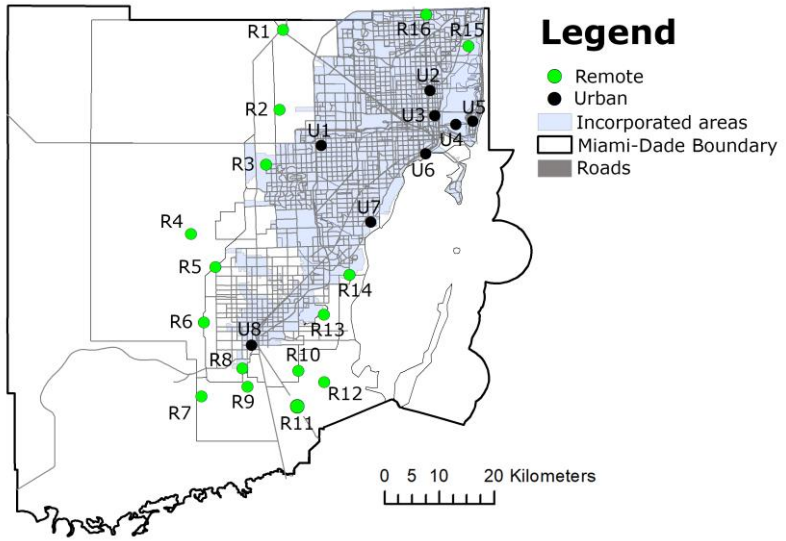
RESEARCH ARTICLE

Tire shops in Miami-Dade County, Florida are important producers of vector mosquitoes

André B. B. Wilke[1]*, Chalmers Vasquez[2], William Petrie[2], John C. Beier[1]

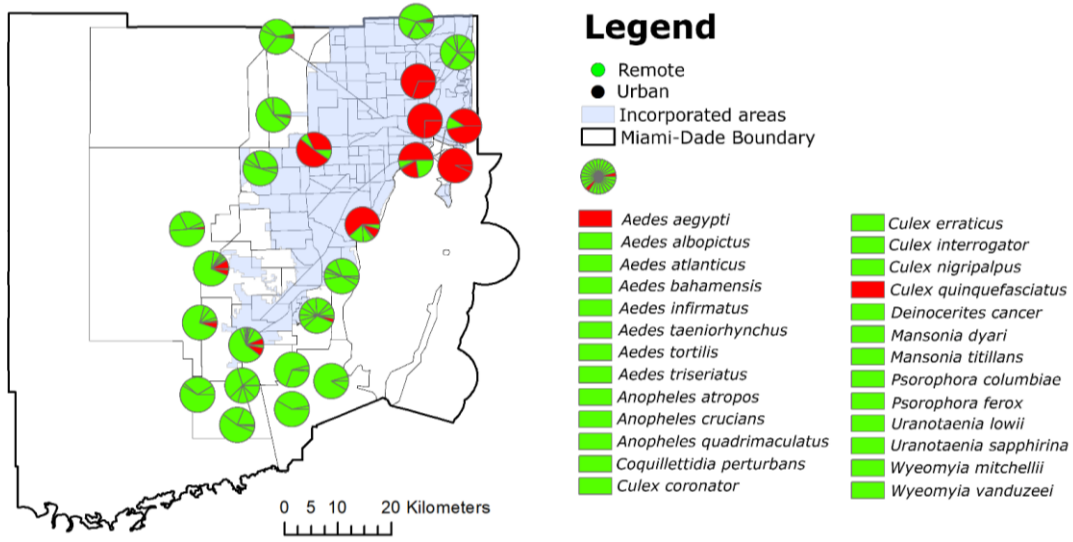
1 Department of Public Health Sciences, Miller School of Medicine, University of Miami, Miami, Florida, United States of America, **2** Miami-Dade County Mosquito Control Division, Miami, Florida, United States of America

Urbanization



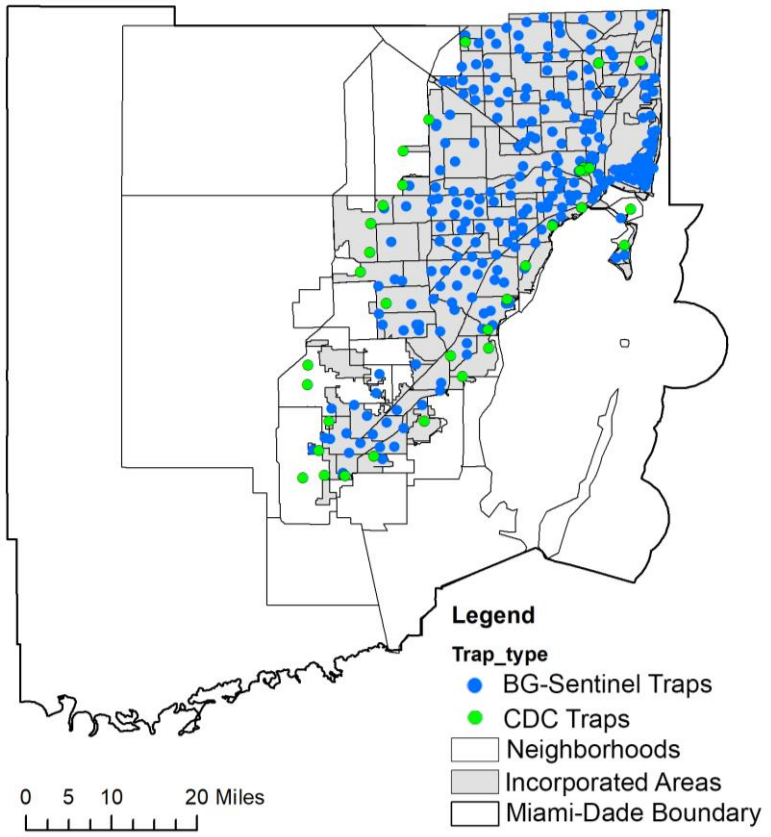
Anthropogenic land use and land cover transformation favor the proliferation of vector mosquito species.

The findings of this study shed light on the effect of urbanization on the community composition of mosquitoes by reducing species richness and increasing the abundance of *Aedes aegypti* and *Culex quinquefasciatus* in a non-random process of biotic homogenization.



Miami-Dade Adult Mosquito Surveillance Network

- 30 CDC and 320 BG-Sentinel traps baited with CO_2.
- Weekly collections.
- Since May 2016.



Numbers from August 2016 to November 2018 - 2,711,983 Collected Mosquitoes - 9 Genera - 41 Species

Our results revealed that the mosquito community in Miami-Dade County was comprised of five highly dominant species.

Culex nigripalpus, Culex quinquefasciatus, Aedes aegypti and *Anopheles crucians* are primary vectors of arboviruses.

Aedes aegypti and *Culex quinquefasciatus* had relatively high abundances year-round.

Culex coronator also had a relatively high abundance during this study and is increasingly becoming of public health concern.

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Accepted: 5 June 2019
Published online: 19 June 2019

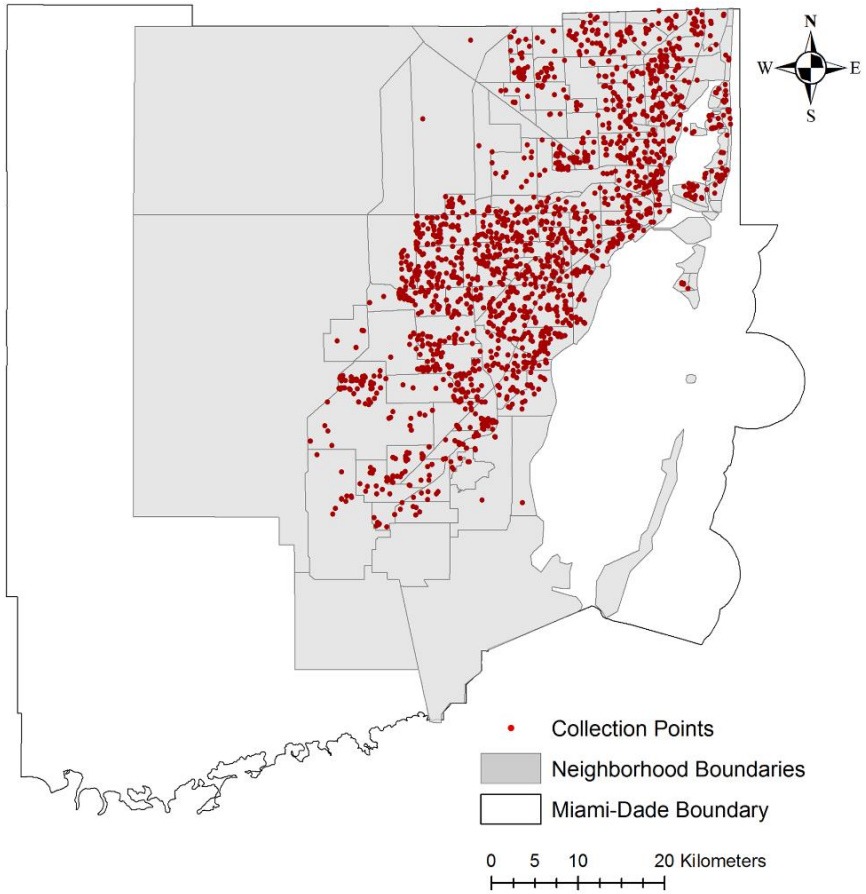
Community Composition and Year-round Abundance of Vector Species of Mosquitoes make Miami-Dade County, Florida a Receptive Gateway for Arbovirus entry to the United States

André B. B. Wilke[1], Chalmers Vasquez[2], Johana Medina[2], Augusto Carvajal[2], William Petrie[2] & John C. Beier[1]

Most Abundant Species

Species	Collected Mosquitoes	Epidemiological Importance
Culex nigripalpus	1,057,485	EEEV, EVEV, KEYV, ROCV, SLEV, WNV
Aedes taeniorhynchus	626,163	EEEV, EVEV, KEYV, WNV, ZIKV
Culex quinquefasciatus	373,571	CHIKV, EEEV, LF, MAYV, OROV, ROCV, SLEV, WNV, ZIKV
Aedes aegypti	150,588	CHIKV, DENV, MAYV, OROV, YFV, WNV, ZIKV
Anopheles crucians	132,741	EEEV, WNV
Aedes tortilis	102,526	Unknown
Aedes atlanticus	48,619	CALV, EEEV, KEYV, WNV
Culex erraticus	47,723	WNV
Deinocerites cancer	33,275	WNV
Culex coronator	26,825	SLEV, WNV
Psorophora columbiae	15,620	WNV
Psorophora ferox	14,351	MAYV, OROV, ROCV, WNV
Wyeomyia vanduzeei	13,518	Unknown
Aedes albopictus	12,213	CHIKV, DENV, YFV, WNV, ZIKV
Wyeomyia mitchelli	10,684	WNV
Culex atratus	9,774	Unknown
Aedes infirmatus	8,586	EEEV, KEYV, WNV
Anopheles quadrimaculatus	6,847	Malaria, MAYV, OROV, WNV
Mansonia dyari	5,787	Unknown
Anopheles Atropos	5,131	WNV
Aedes triseriatus	3,170	KEYV, ZIKV
Culex iolambdis	2,264	Unknown
Bahamensis	1,455	SLE
Mansonia titillans	1,086	WNV

Immature Mosquito Surveillance



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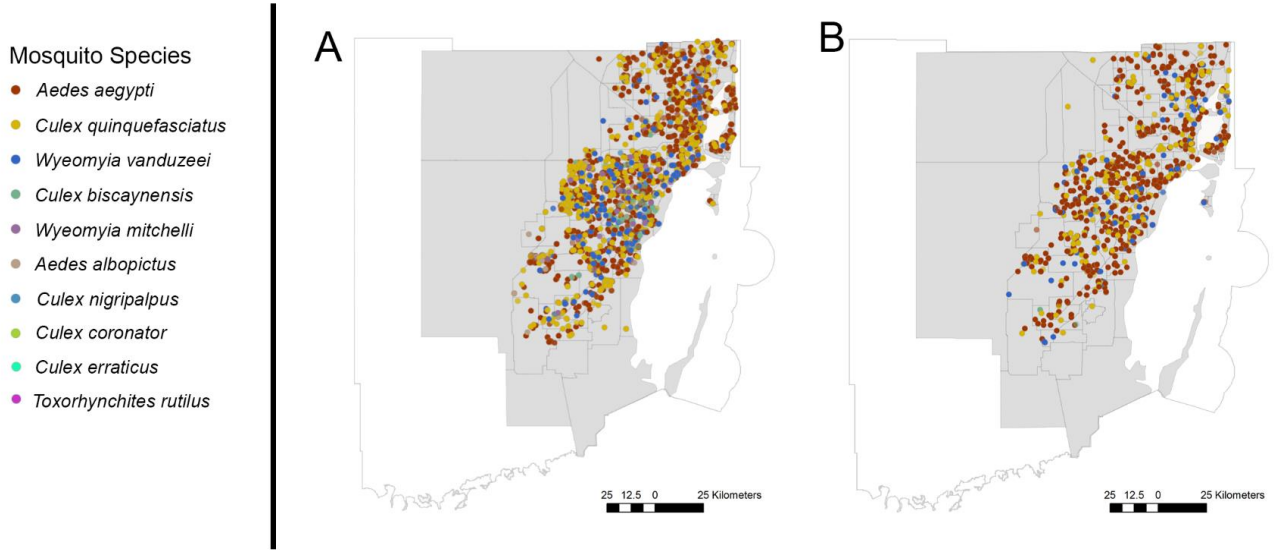
Urbanization creates diverse aquatic habitats for immature mosquitoes in urban areas

André B. B. Wilke[1*], Catherine Chase[1], Chalmers Vasquez[2], Augusto Carvajal[2], Johana Medina[2], William D. Petrie[2] & John C. Beier[1]

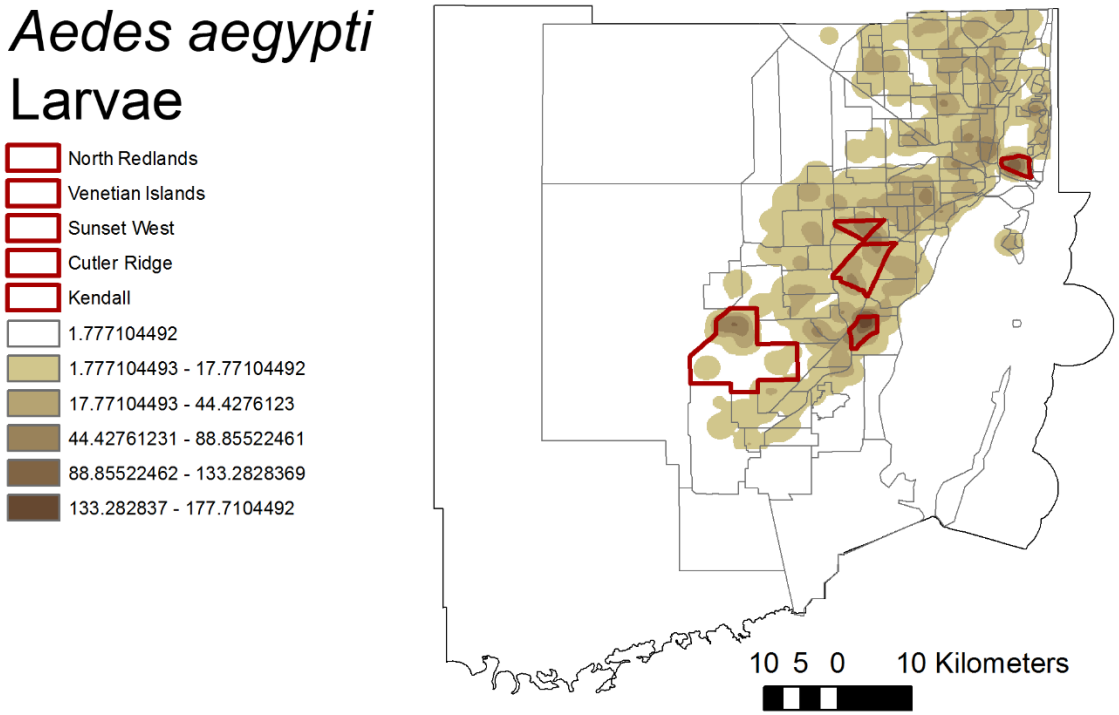
Immature Mosquito Surveillance

- Surveys were requested by citizen complaints through 311 calls.
- Immature mosquito surveys were conducted from April 2018 to June 2019 - 2,488 inspections.
- Mosquitoes were collected in 76 different types of aquatic habitats.
- A total of 44,599 immature mosquitoes were collected:
- *Aedes aegypti* - 19,206 larvae and 2,997 pupae.
- *Culex quinquefasciatus* - 14,358 larvae and 1,193 pupae.

Distribution of immature mosquitoes



Heat map based on the relative abundance of *Aedes aegypti*



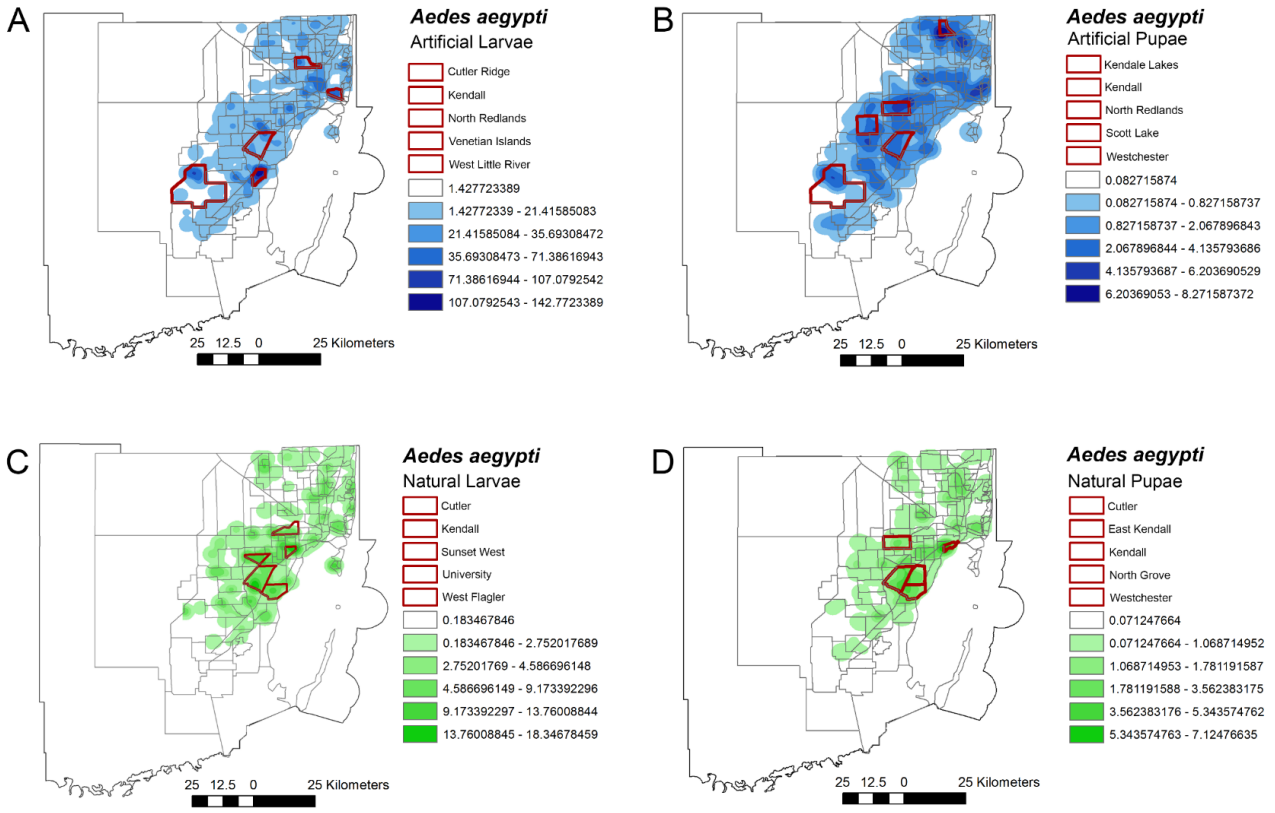
Heat map based on the relative abundance of *Aedes aegypti* breeding in natural and artificial habitats in Miami-Dade County, Florida.

(A) Larvae collected in artificial aquatic habitats.

(B) Pupae collected in artificial aquatic habitats.

(C) Larvae collected in natural aquatic habitats.

(D) Pupae collected in natural aquatic habitats.

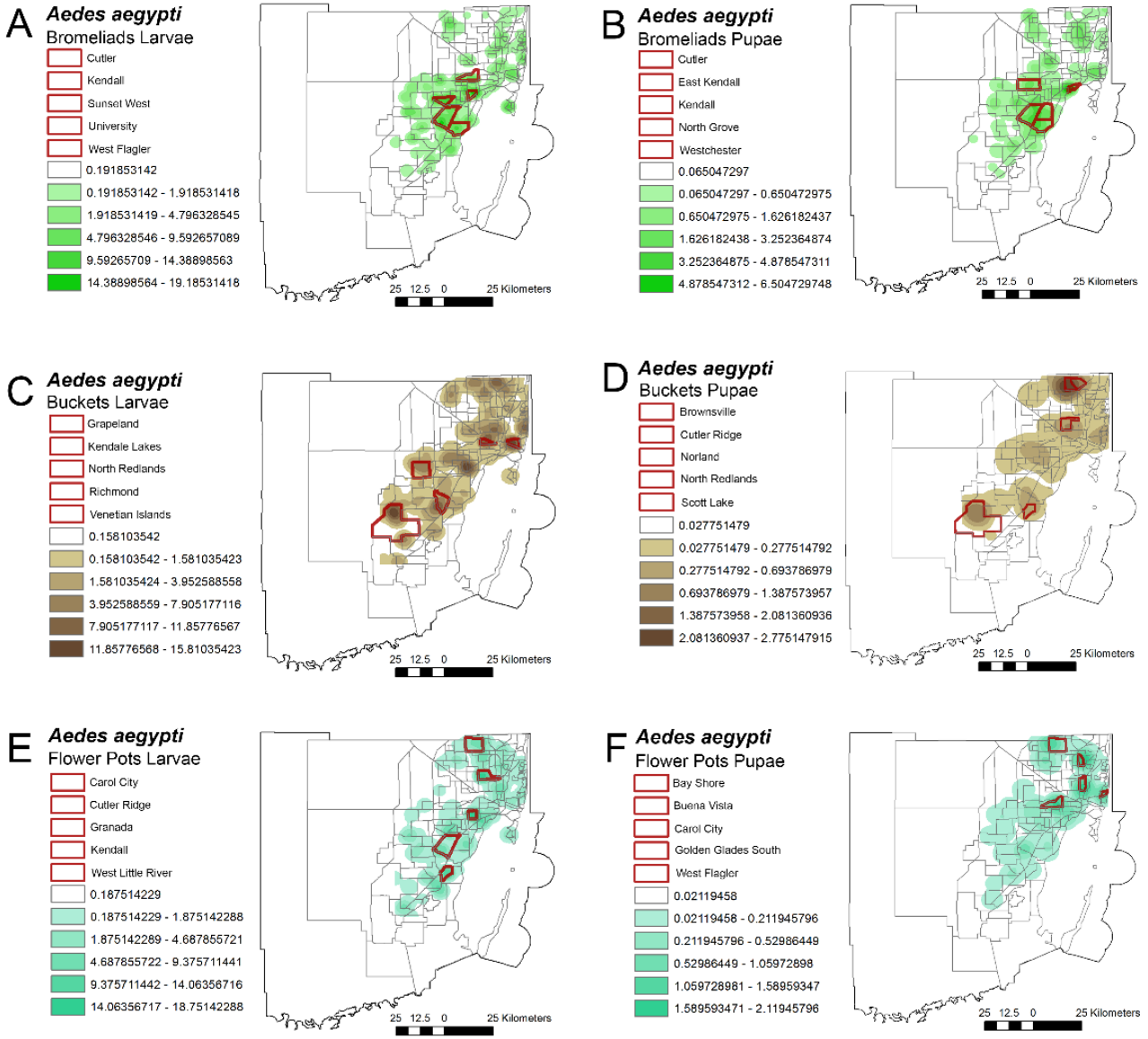


Heat map based on the relative abundance of *Aedes aegypti* in the most productive aquatic habitats.

(A) Larvae and (B) pupae collected in bromeliads.

(C) Larvae and (D) pupae collected in buckets.

(E) Larvae and (F) pupae collected in flower pots.



Proliferation of *Aedes aegypti*

- Storm drains, bromeliads, and garbage cans had a lower percentage of *Aedes aegypti* larvae over the total percentage of larvae and pupae adjusted for daily rainfall when compared to tires.
- These results are indicating that storm drains, bromeliads and garbage cans had significantly more pupae in relation to larvae when compared to tires, traditionally know as productive aquatic habitats for *Aedes aegypti*.

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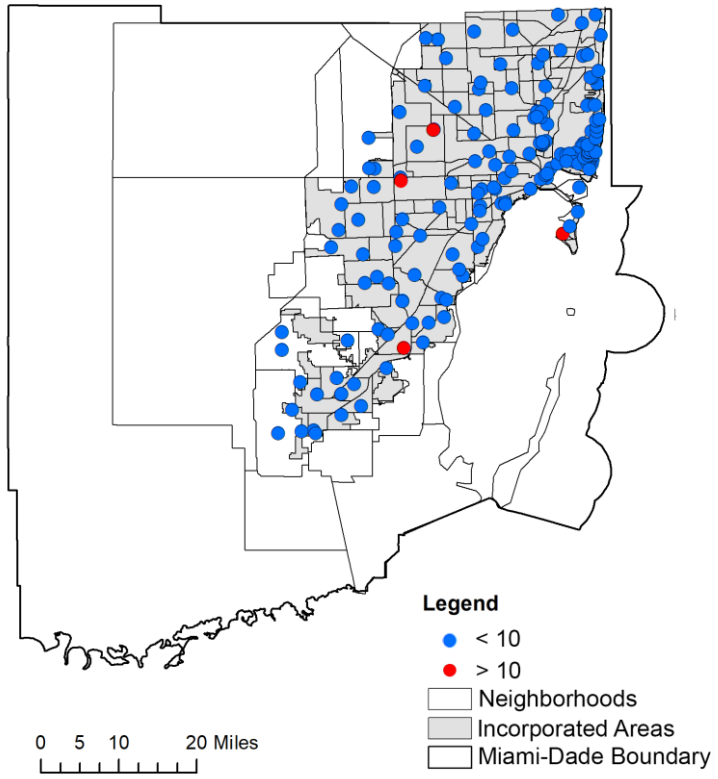
Proliferation of *Aedes aegypti* in urban environments mediated by the availability of key aquatic habitats

André Barretto Bruno Wilke[1✉], Chalmers Vasquez[2], Augusto Carvajal[2], Johana Medina[2], Catherine Chase[1], Gabriel Cardenas[1], John-Paul Mutebi[3], William D. Petrie[2] & John C. Beier[1]

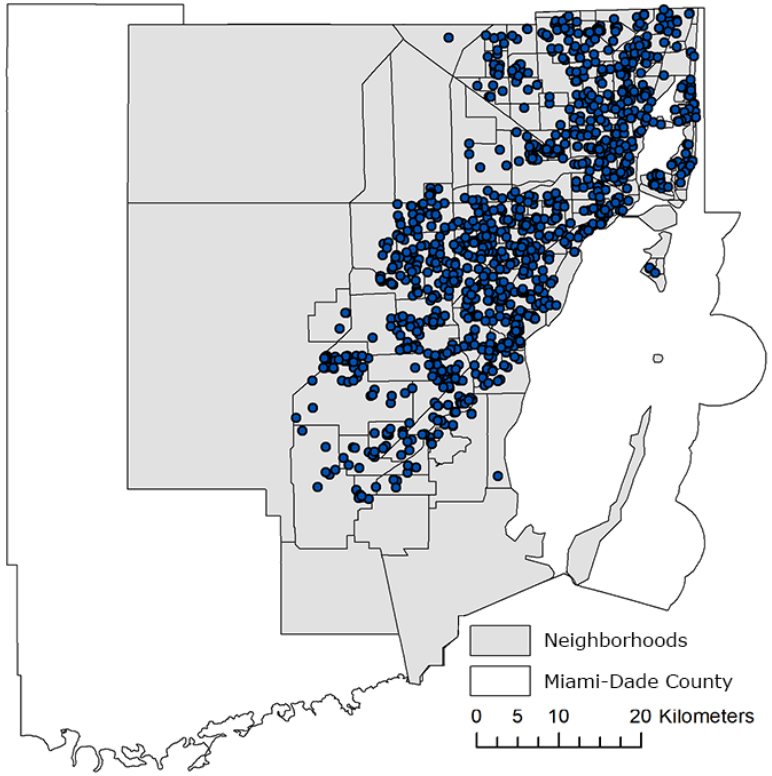
Habitats	Estimate	Standard error	Significance *P*
Intercept	0.994814	0.04234	**< 0.0001**
Rainfall	− 0.057539	0.02833	**0.0422**
Bromeliads	− 0.339891	0.04741	**< 0.0001**
Buckets	0.041822	0.05354	0.4348
Plastic Containers	− 0.045725	0.06541	0.4845
Flower Pots	− 0.010125	0.05634	0.8574
Fountains	0.00686	0.06206	0.912
Garbage Cans	− 0.176147	0.08135	**0.0304**
Planters	0.0135	0.08615	0.8755
Storm Drains	− 0.456627	0.05026	**< 0.0001**
Tires	0		
Sigma	0.563806	0.01285	**< 0.0001**

Implementation

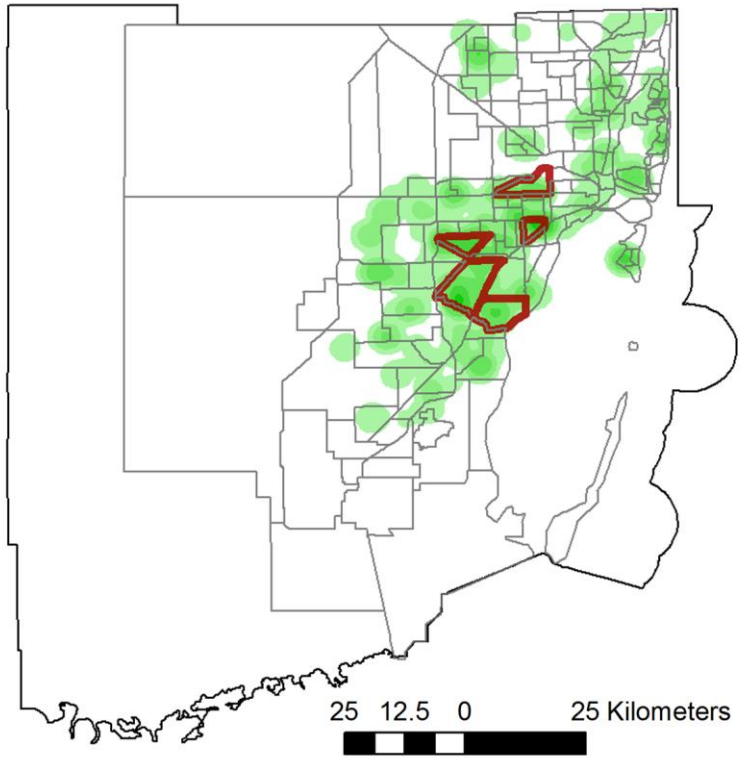
Adult Surveillance



Immature Surveillance



Geospatial Analysis



Effectiveness of *Bacillus thuringiensis israelensis - Bti*

Our objective was to assess the effectiveness of the Buffalo Turbine in propelling *Bti* and the Grizzly ULV Sprayer in propelling Deltamethrin to control high densities of *Aedes aegypti* in urban environments.

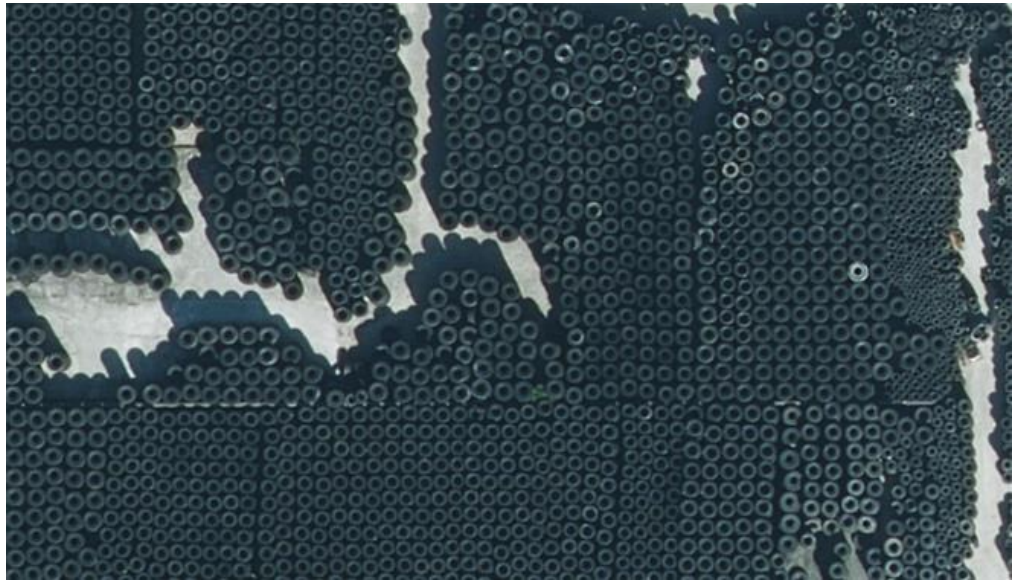
PLOS ONE

RESEARCH ARTICLE

Effectiveness of adulticide and larvicide in controlling high densities of *Aedes aegypti* in urban environments

André B. B. Wilke[1]*, Chalmers Vasquez[2], Augusto Carvajal[2], Monica Ramirez[2], Gabriel Cardenas[1], William D. Petrie[2], John C. Beier[1]

1 Department of Public Health Sciences, Miller School of Medicine, University of Miami, Miami, FL, United States of America, **2** Miami-Dade County Mosquito Control Division, Miami, FL, United States of America



Tires Shop

- We collected 25,000 *Aedes aegypti* in 6 BG-S traps in 24 hours.
- 10,960 in only one trap.
- The threshold to trigger a chemical intervention is 10 *Aedes aegypti* per trap.

Adult *Ae. aegypti*

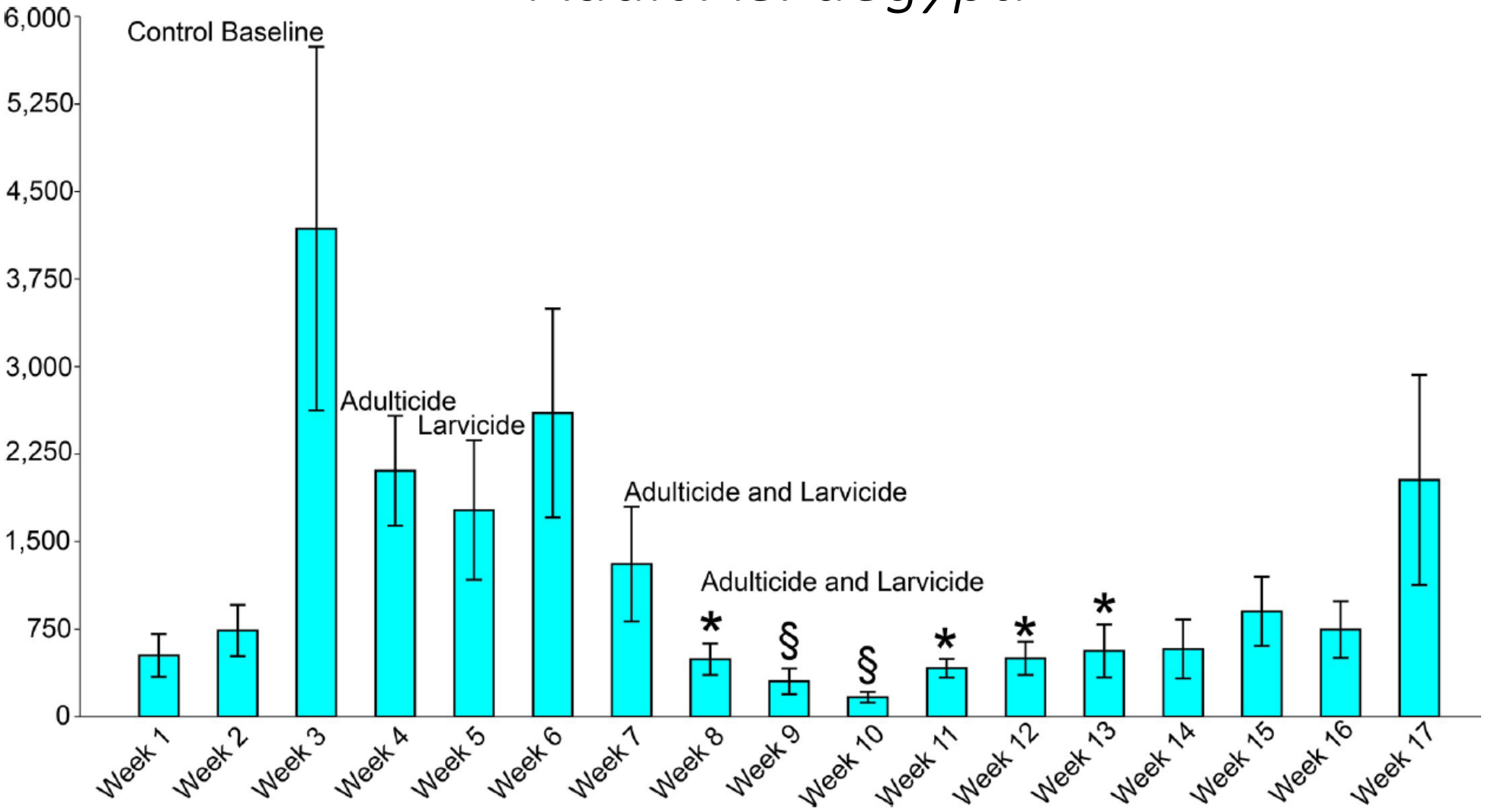


Fig 4. Bar chart displaying the effect of insecticide intervention in the abundance of adult *Ae. aegypti* at the study area in Miami-Dade County, Florida. Each bar displays the mean value; the whisker interval represents a 95% confidence interval standard error. Statistically significant values after multiple testing adjustment with Bonferroni. * = Significant values; § = Statistically significant values after multiple testing adjustment with Bonferroni.

Immature *Ae. aegypti*

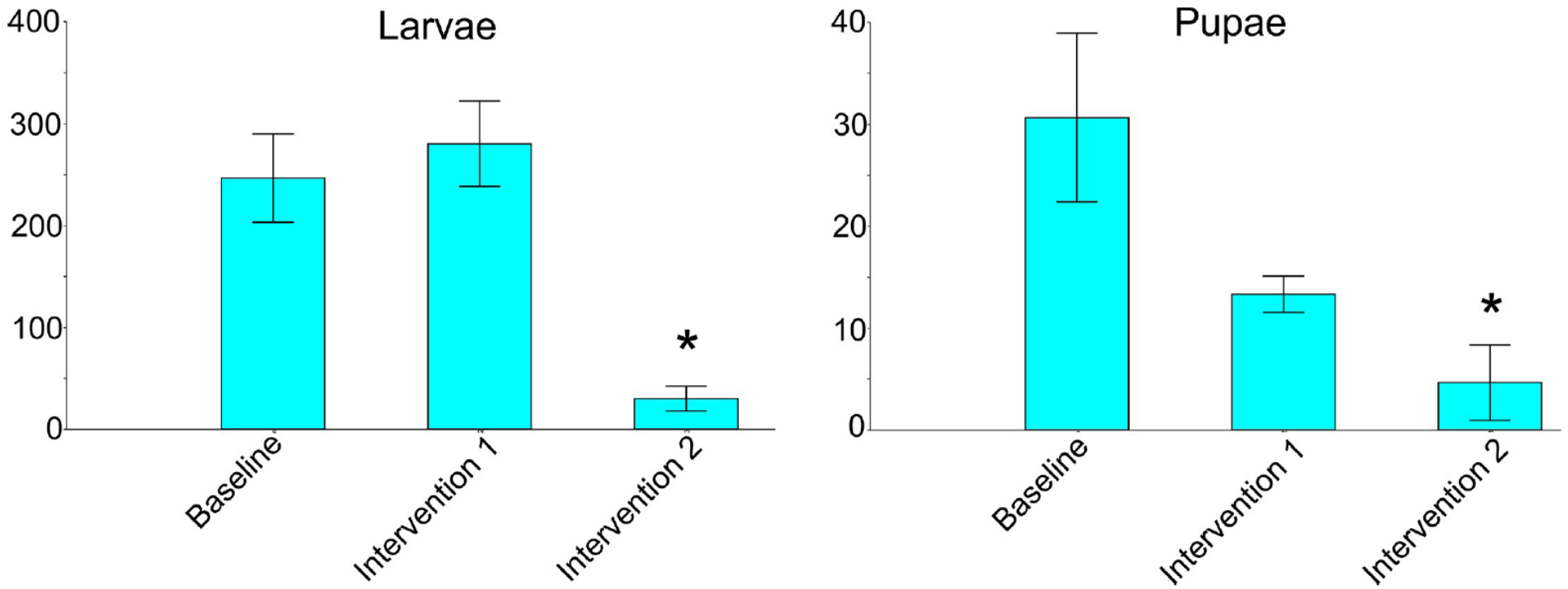


Fig 5. Bar chart displaying the effect of insecticide intervention in the abundance of immature *Ae. aegypti* at the study area in Miami-Dade County, Florida. Each bar displays the mean value; the whisker interval represents a 95% confidence interval standard error. * = Significant values.

Future Perspectives

- Natural areas must be preserved.
- Deforestation leads to biodiversity loss - reduction in the number of dead-end hosts.
- Increase in the likelihood of *arbovirus* transmission to humans.
- Increase in the incidence of infectious diseases, including the ones transmitted by mosquito vectors.

Final Considerations

- Environmental crimes.
- Flexibilization of environmental legislation.
- Limited resources to public health.
- Environmental disequilibrium and biodiversity loss.
- All these factors together increase arbovirus transmission.

Section of Epidemiology and State Medicine.

President—Dr. F. E. Fremantle, O.B.E.

[October 25, 1929.]

The Disappearance of Malaria from England.

S. P. James, M.D., D.P.H., I.M.S. (retd.)

(Adviser on Tropical Diseases to the Ministry of Health).

"The decline in malaria cases in England was due not to natural factors or the application of any preventive method, but rather to the progressive improvement of social, economic, educational, medical and public health conditions."

James S. The disappearance of malaria from England. Proc. R. Soc. Med. **1929**;1–17.

Thank You!