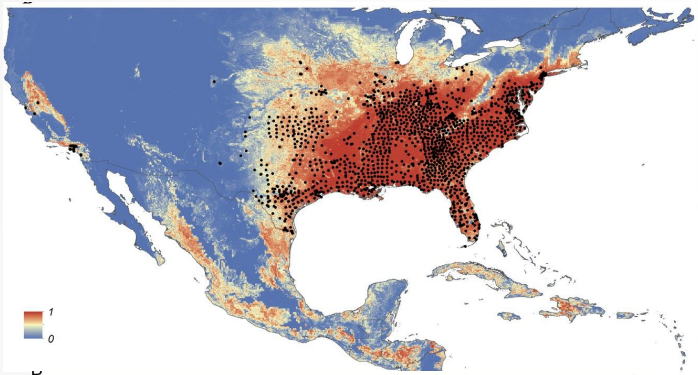
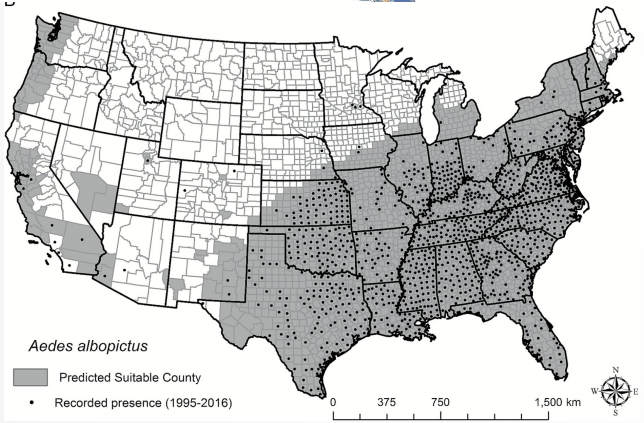
Urban microclimate and mosquito dynamics

Michelle V. Evans, Courtney C. Murdock

October 18, 2017

New technologies allows us to make more accurate range maps





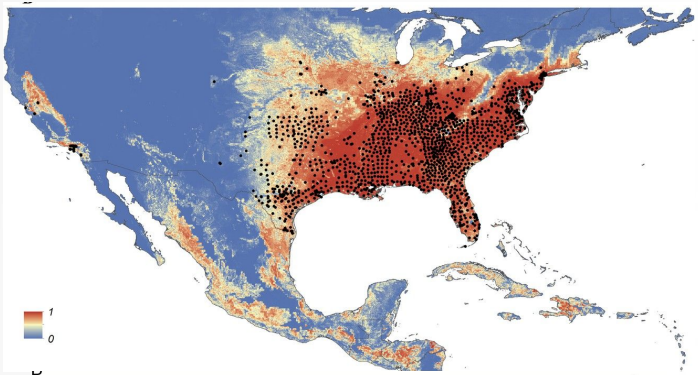
Creation of species distribution maps using statistical predictive tools

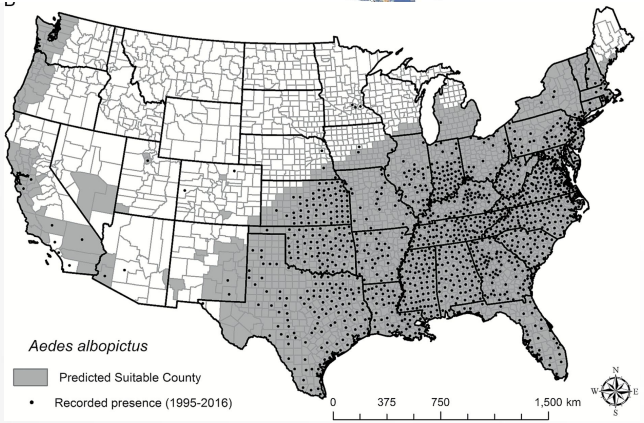
Collection of species presence points into databases with thousands of records

Linking recorded presence points with climate data

Kraemer et al. 2015, Johnson et al. 2017

New technologies allows us to make more accurate range maps





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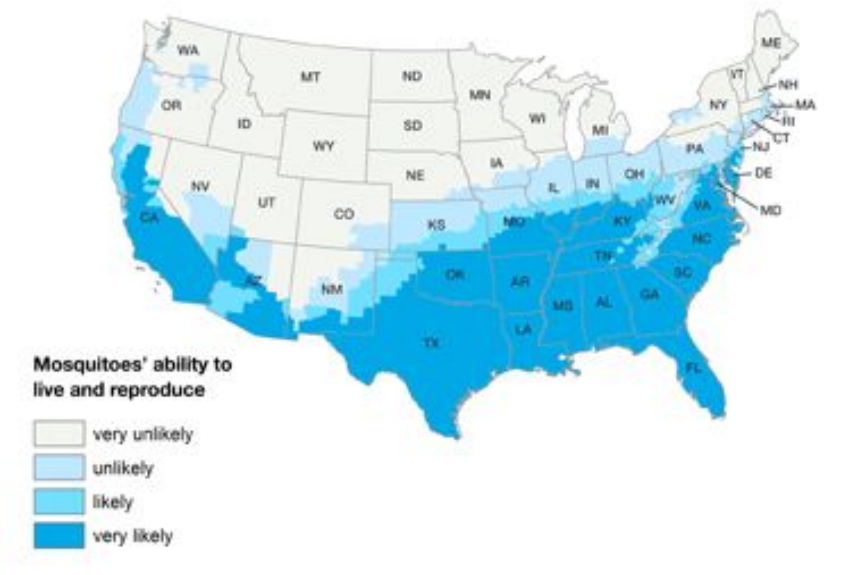
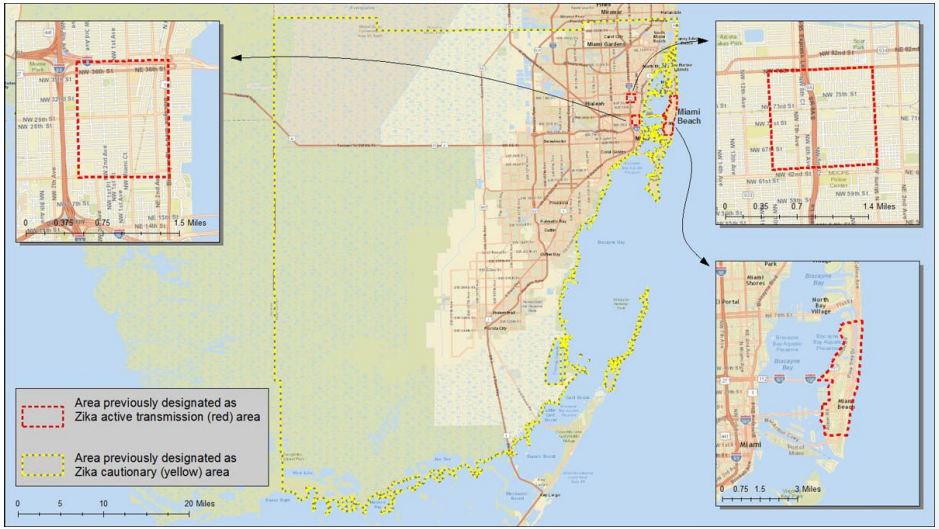
Large scale range maps may not be relevant at fine-scales

Range of Aedes aegypti



Nationwide

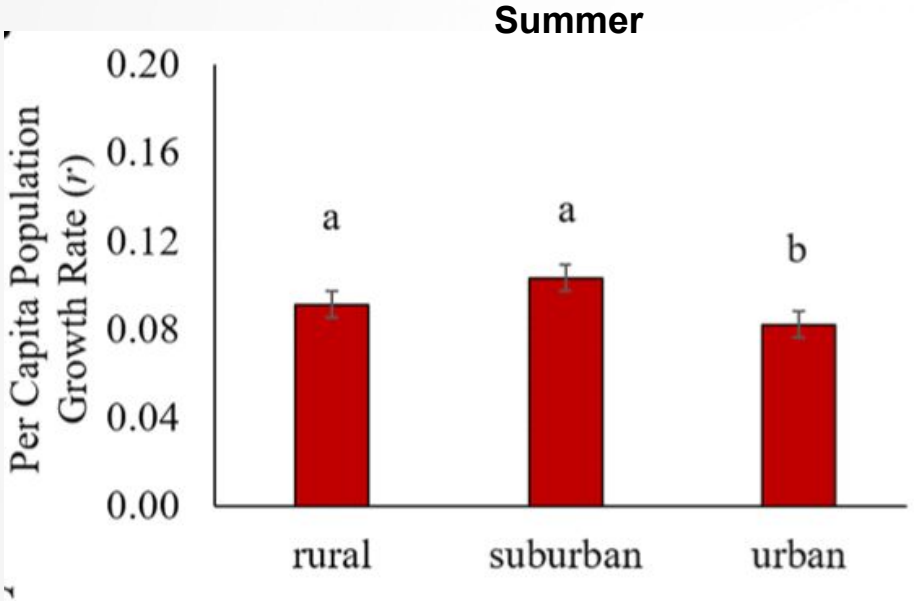
Extent of Zika outbreak in Miami, FL



Several city blocks

CDC 2017

Heterogeneity in urban microclimate results in different growth outcomes for mosquito populations



Murdock et al. 2017

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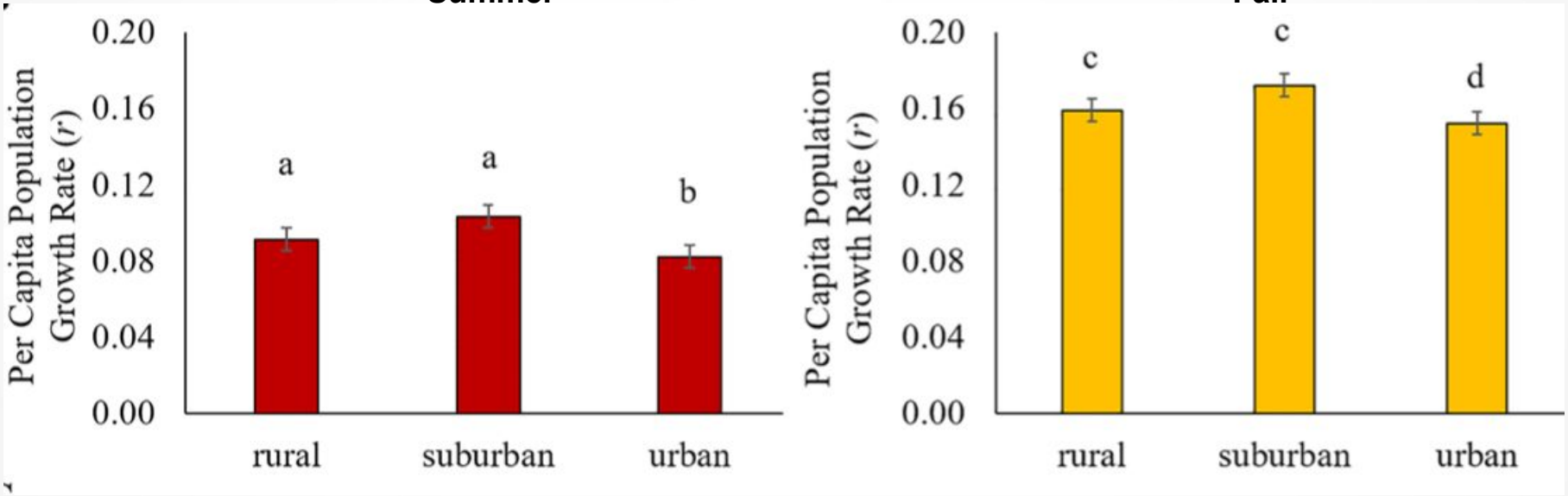

Murdock et al. 2017

Mosquito habitat differs across an urban area

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How does an urban mosquito community change over the landscape?

What role does microclimate heterogeneity play in this?

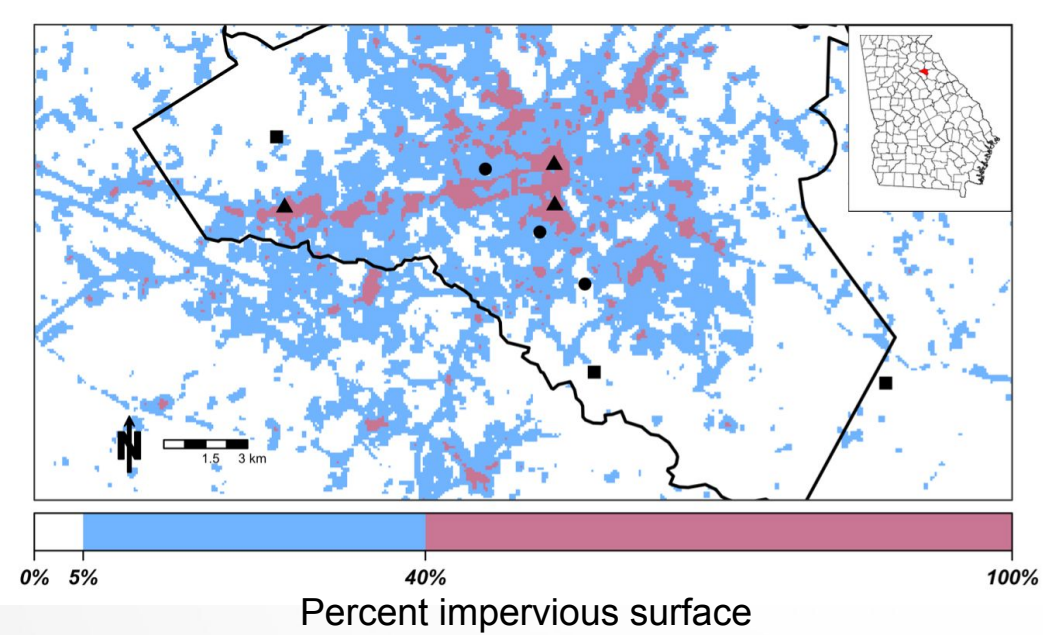
How does an urban mosquito community change over the landscape?

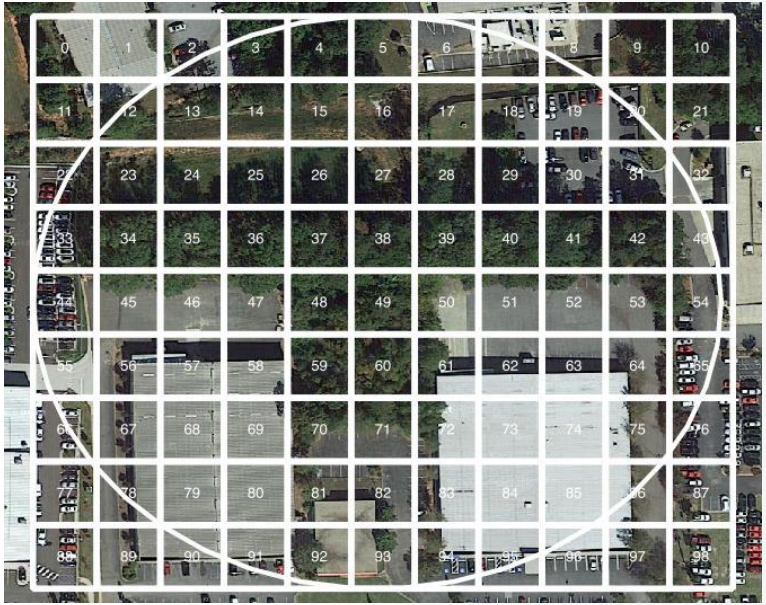
Increase in container breeding species with increasing urbanization

What role does microclimate heterogeneity play in this?

Urban heat island effect will cause shift in community composition

Surveyed larval habitat from June 2016 - May 2017





3 rural, 3 suburban, 3 urban

Surveyed within 100m radius

Recording habitat characteristics & mosquito species

All standing water noted as potential habitat, and marked positive if mosquito larvae or pupae were present

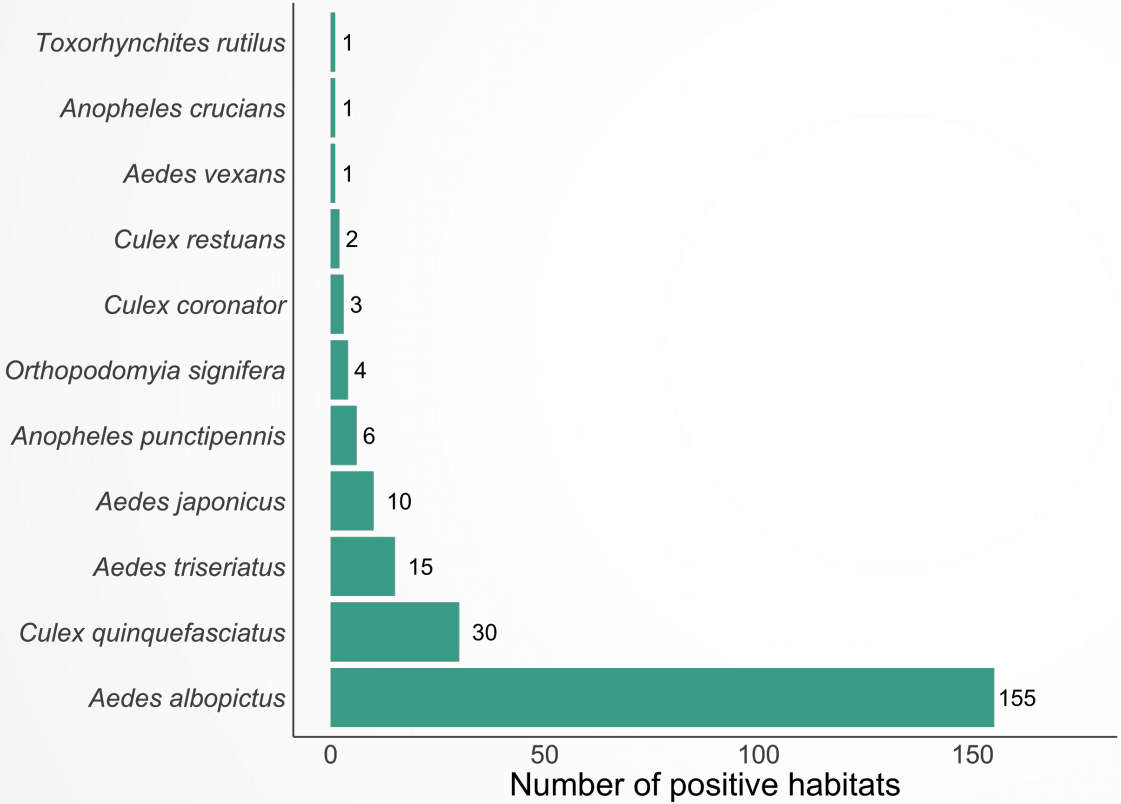
Subset of mosquito larvae were reared in the lab

Mosquitoes were identified to species

Habitat Characteristics

- Surface area
- Depth
- Canopy cover
- Type of habitat (container, pond, etc.)
- Turbidity
- Temperature
- Presence of other aquatic organisms, such as invertebrates or amphibians

Mosquito community dominated by *Aedes albopictus*



11 total species
5 genera

Aedes species most common, particularly *Aedes albopictus*

Dominated by container breeders

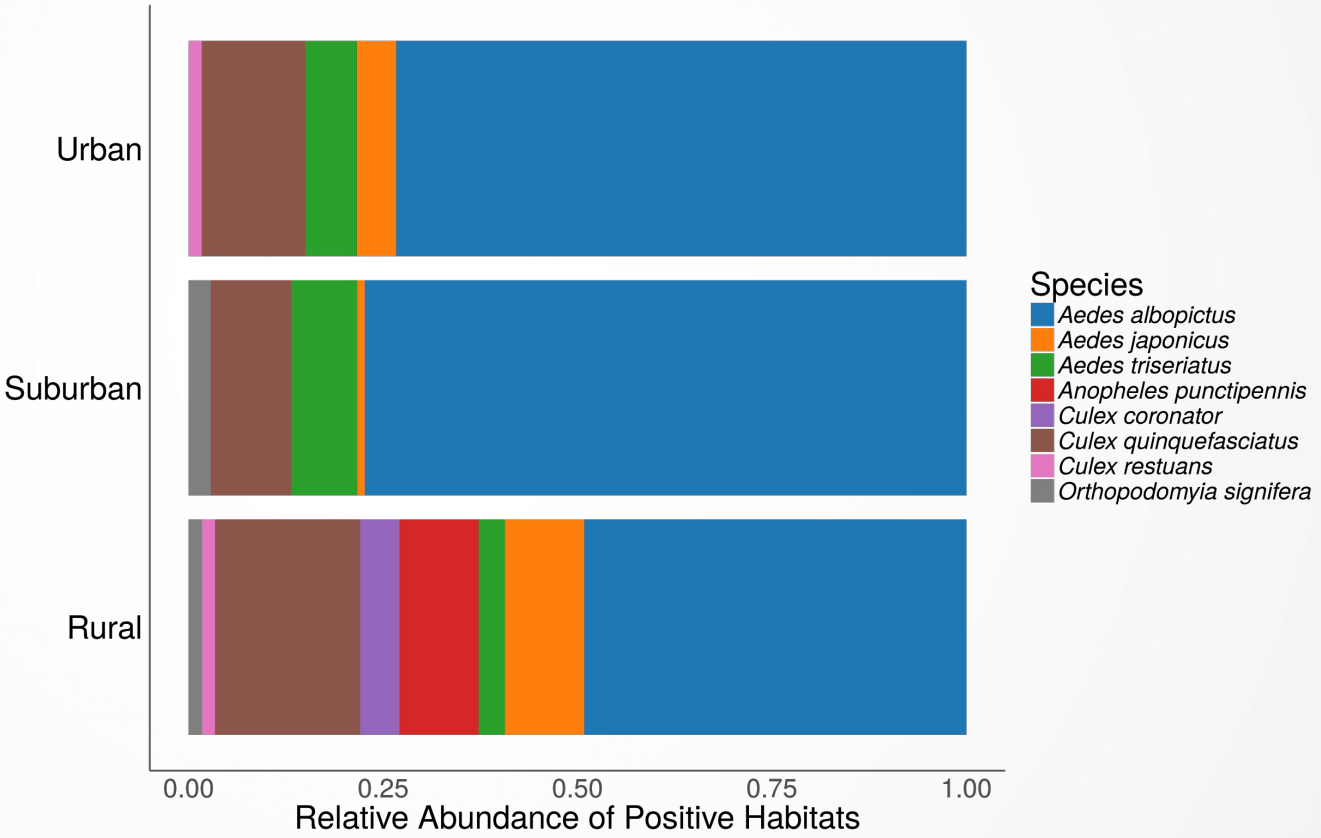
Species presence differed across land class

Habitat abundance
(positive/all)

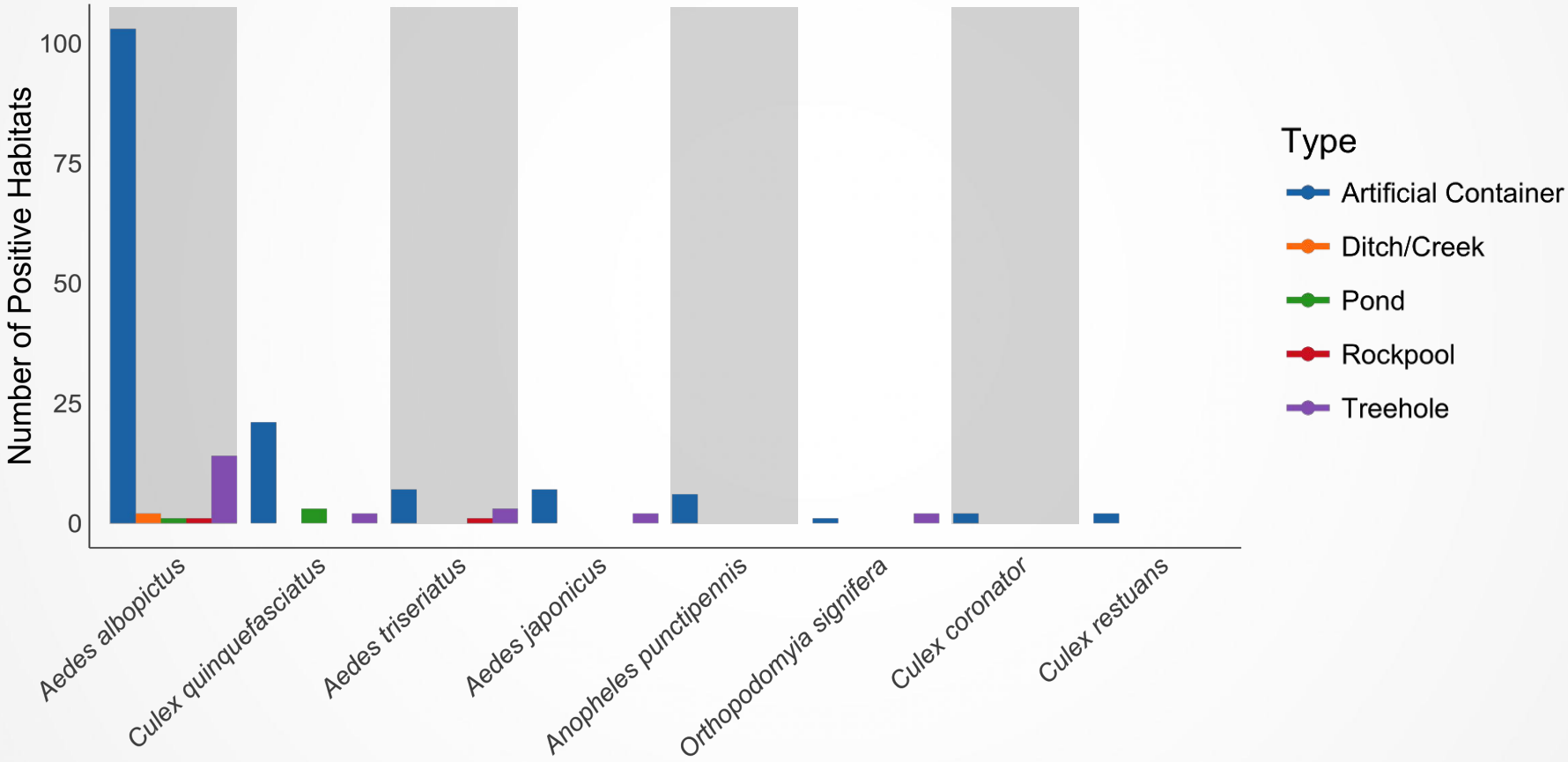
55 /173

130 /337

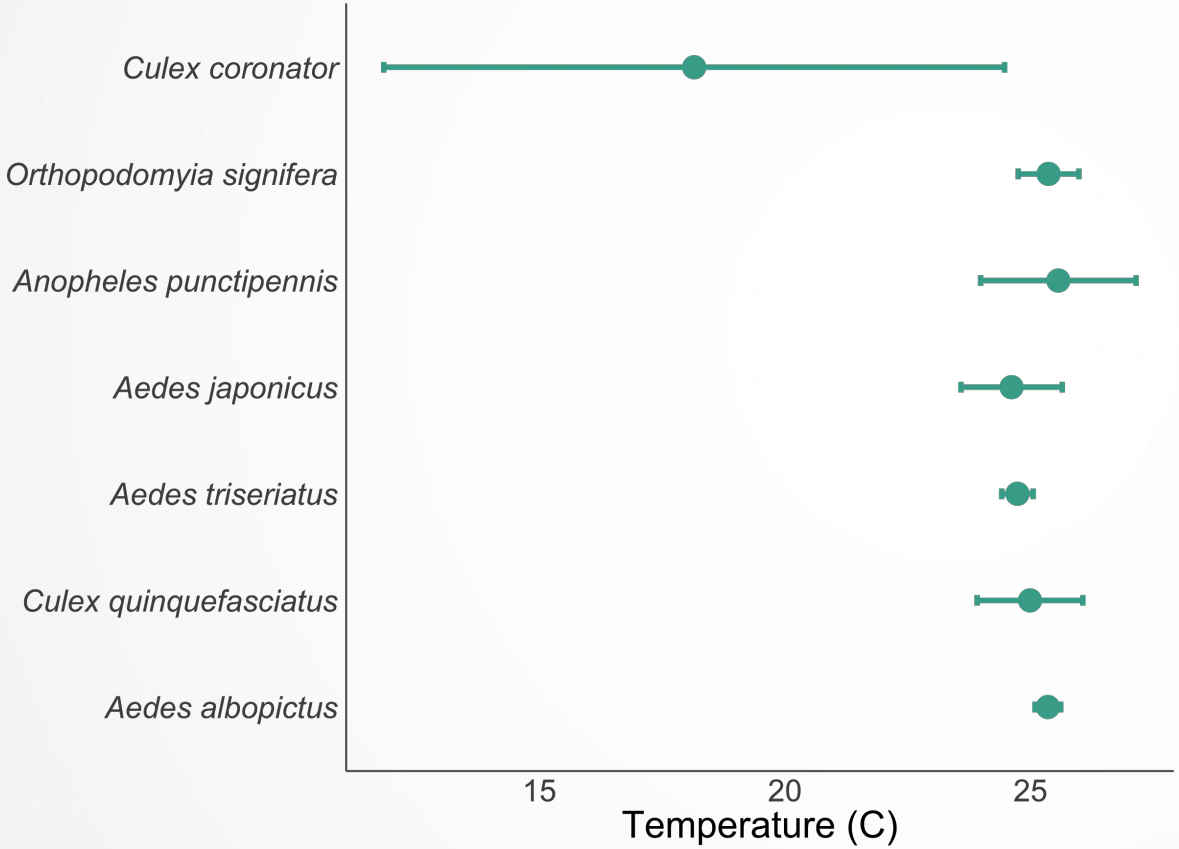
63 /167



All species were found primarily in artificial containers

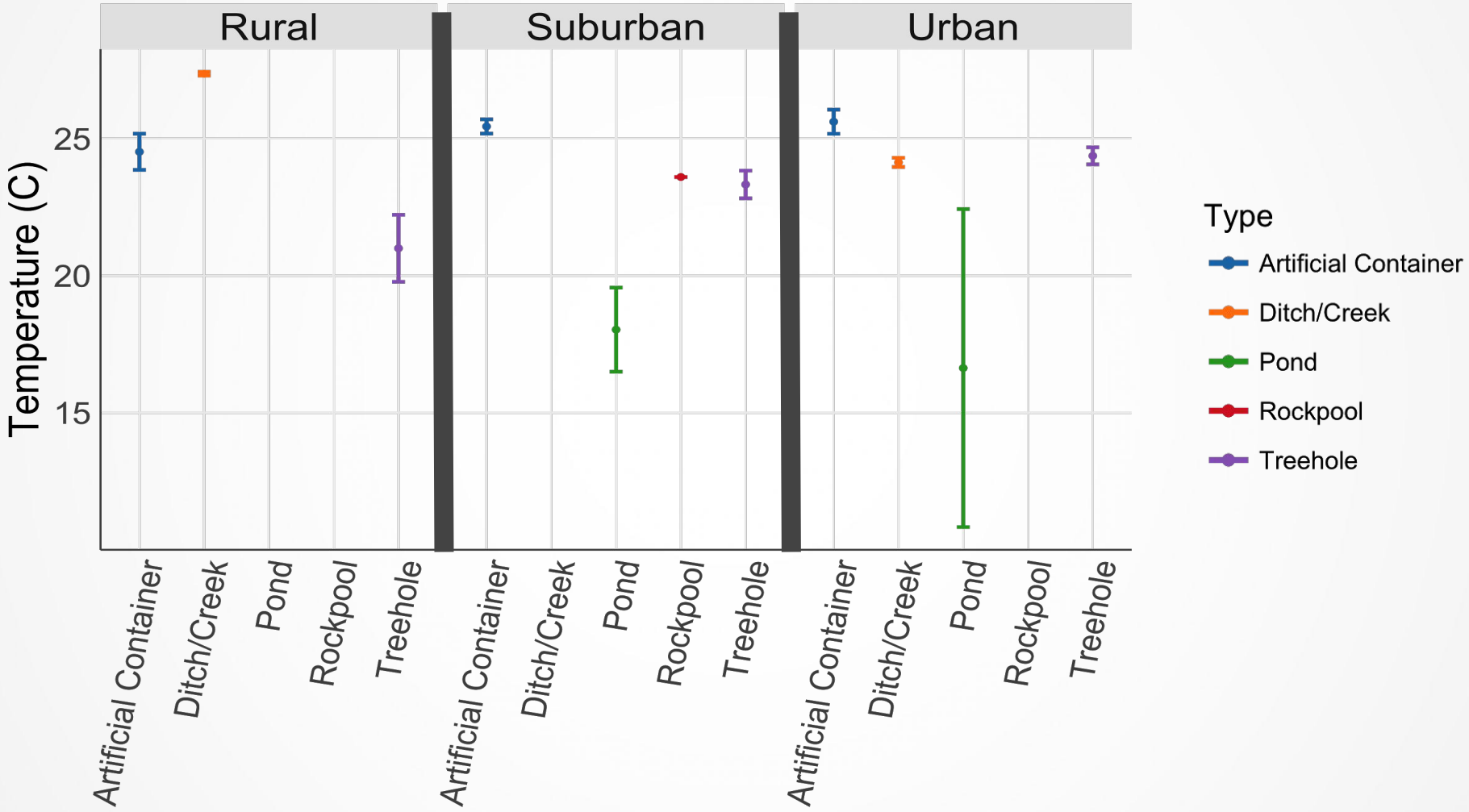


Species were found across a similar range of temperatures



24 - 25 °C is predicted optimal temperature for *Aedes* mosquito species

Expansion of *Cx. coronator* into the southeast


Rural
Suburban
Urban
Temperature (C)
25
20
15
Artificial Container
Ditch/Creek
Pond
Rockpool
Treehole
Type
Artificial Container
Ditch/Creek
Pond
Rockpool
Treehole

Urbanization can shape mosquito populations

Urban and suburban areas were more homogeneous, dominated by *Ae. albopictus*

Primary source of habitat is artificial containers

Temperatures did not differ by species or land class, except for treeholes

- Suggests that endemic species may be more vulnerable to urban microclimate

Must consider other qualitative measures to explain partitioning of species

- Biotic effects, aquatic nutrients, bloodmeal availability, etc.

Thank you!

The Murdock Lab

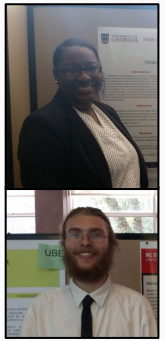
Research Assistants

Diana Diaz

Nicole Solano

Lindsey Jones

Carl Hintz



UNIVERSITY OF GEORGIA
Graduate School

UNIVERSITY OF GEORGIA
Odum School of Ecology

The University of Georgia
ICON
Integrative Conservation
Ph.D. Program

Population Biology of Infectious Diseases
REU site @ UGA

NSF

mvevans@uga.edu

mvevans89

@mv_evans

Extra slides!

The issue of scale-mismatch

150 mi resolution

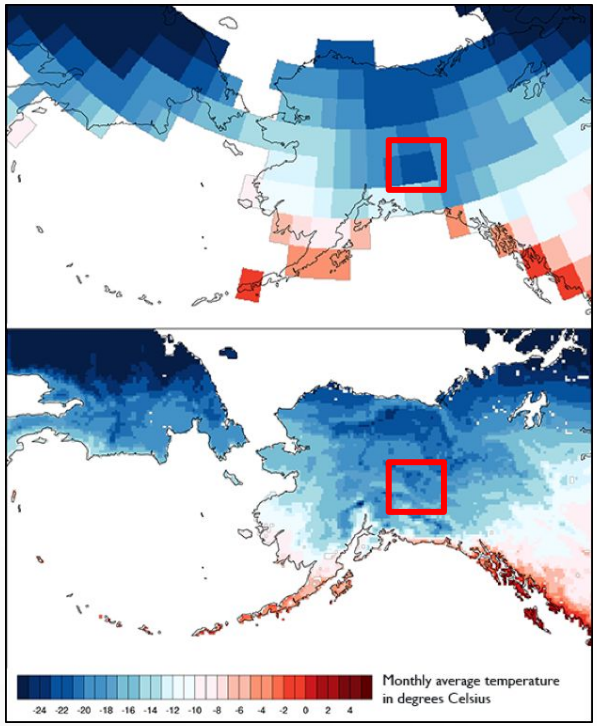
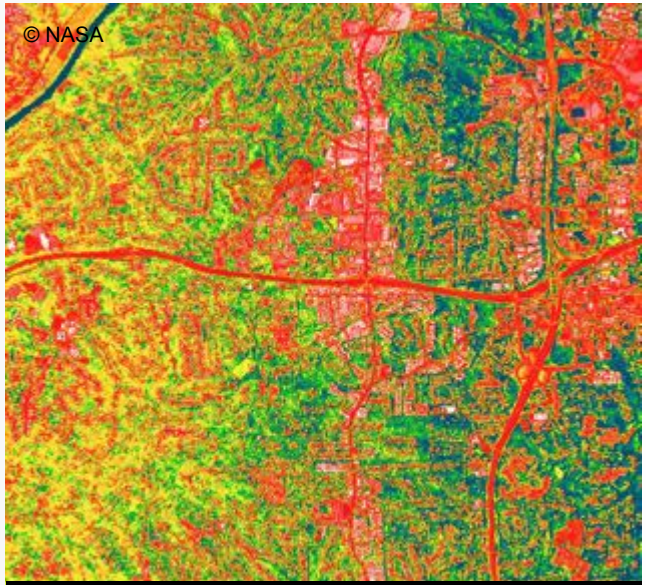


Photo Credit: Univ. of Alaska - Fairbanks

12 mi resolution

Climate data is often recorded at a coarser scale than mosquitoes experience...

leading to incorrect predictions of species presence at a fine scale



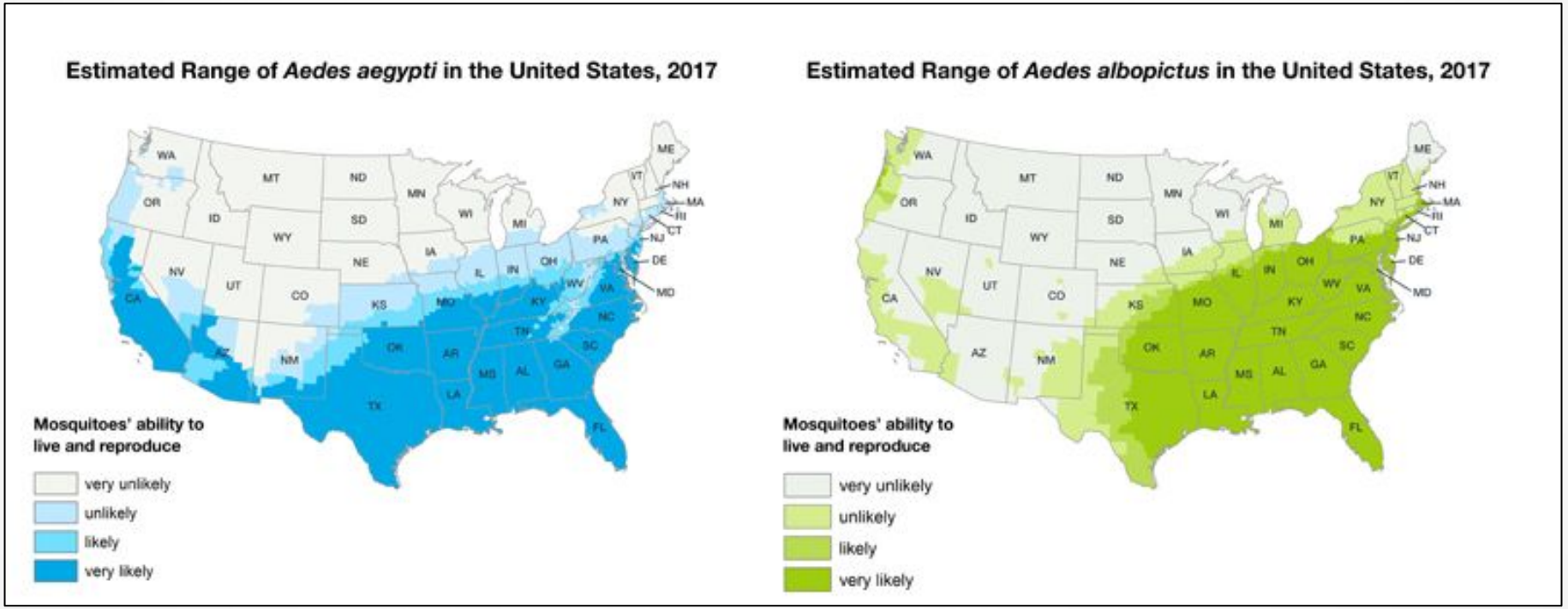
Land Surface Temperatures in Atlanta, GA

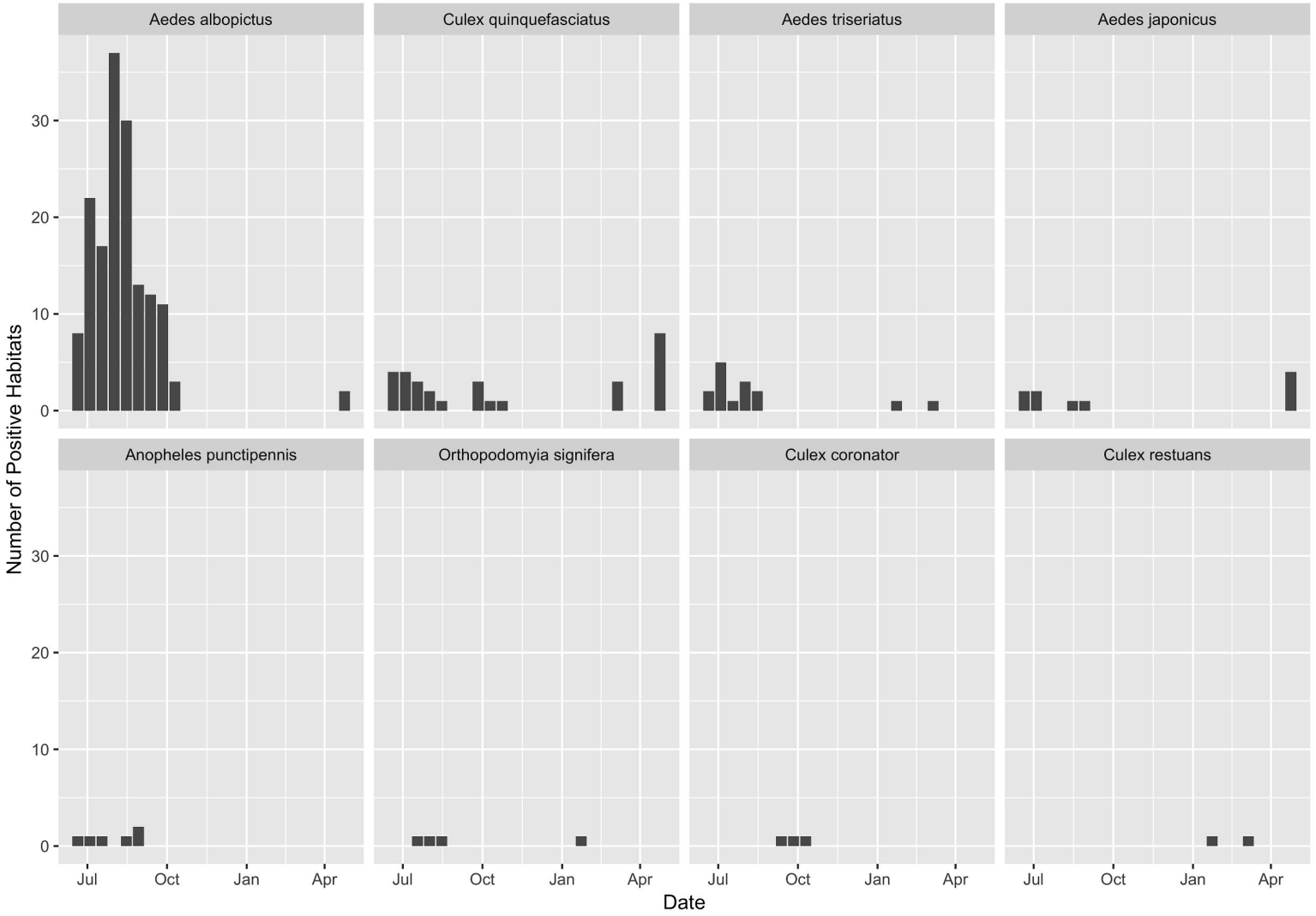
Developed landscapes have a wide range of climates, called microclimates

At a fine-scale, the distribution of mosquito species may be different than that predicted by range maps

How does a mosquito community change across the fine-scale of an urban gradient?

Mosquito species range maps are an important tool in public health




Aedes albopictus
Culex quinquefasciatus
Aedes triseriatus
Aedes japonicus
Anopheles punctipennis
Orthopodomyia signifera
Culex coronator
Culex restuans
Number of Positive Habitats
0
10
20
30
Jul
Oct
Jan
Apr
Date

Species presence differed across land class

Anthropophilic mosquitoes found in urban and suburban areas

Rarer species were found in rural land classes

Anopheles were exclusively rural