Practical Residential Mosquito Management:

Optimizing for mosquito control and minimizing non-target impacts

Dan Killingsworth
Technical Services Entomologist
Central Life Sciences

2026 PROGRAM
FORTY-NINTH
ANNUAL MEETING

Georgia
Mosquito Control
Association

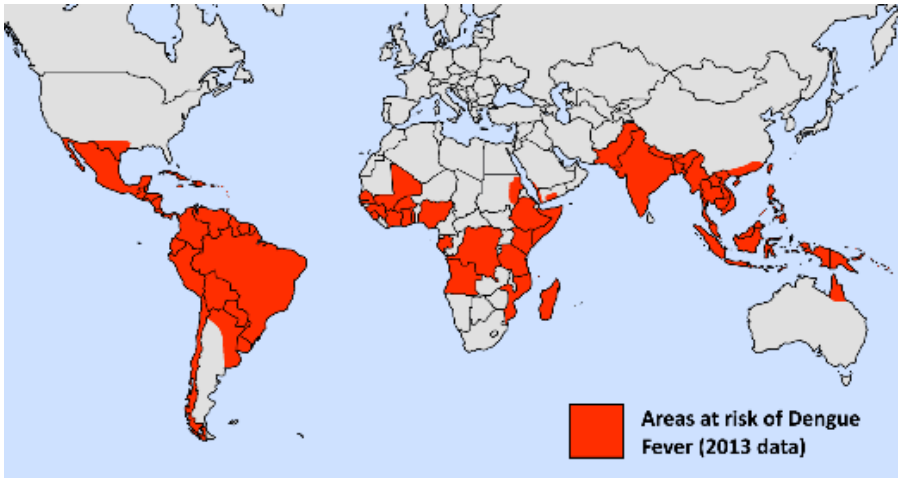


October 21-23, 2026

Villas by the Sea Resort/
Conference Center,
Jekyll Island, GA

Public Health Importance of Mosquitoes

- Mosquitoes- diverse group of flies within Culicidae
- Over 3700 species worldwide
- ~2.5% capable of transmitting vector-borne pathogens to humans
- Vector-borne diseases contribute to a high percentage of annual, global human illness and death



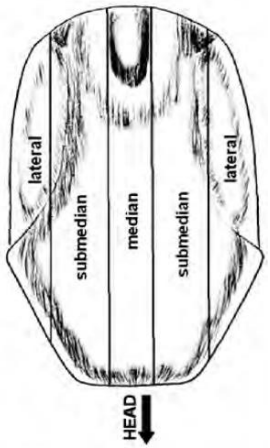
Maps sourced: https://www.safetyfirstaid.co.uk/mosquito-borne-diseases





Images: media.istockphoto.com

Mosquito Diversity




Culex (*Culex*) *gelidus*
PHILIPPINES: Negros Occ.
Kabankalan City


Orthopodomyia kummi
ARIZONA: Pima Co.
Florida Canyon, Santa Rita Mtns.


Aedes (*Abraedes*) *papago*
ARIZONA: Pima Co.
Foothills of Santa Rita Mtns.


Aedes (*Stegomyia*) *formosus*
TANZANIA: Bagomoyo Dist.


Aedes (*Stegomyia*) *guamensis*
GUAM: Talo'fo'fo


Culex (*Culex*) *restuans*
MINNESOTA: Olmsted Co.


Aedes (*Kompia*) *purpureipes*
ARIZONA: Santa Cruz Co.
Pena Blanca Canyon


Uranotaenia (*Uranotaenia*) sp.
BRAZIL: Rio de Janeiro
Reserva Ecologica de Guapiaçu


Psorophora (*Janthinosoma*) *ferox*
COSTA RICA: Heredia Prov.
La Selva Biological Station


Aedes (*Hulecoeteomyia*) *japonicus*
NEW JERSEY: Sussex Co.
Sterling Hill Mine


Aedes (*Protomacleaya*) *henderson*
NEW YORK: New York Co.
Manhattan, Central Park

Dorsal View

Images courtesy of lawrencereeves.com

Important *Aedes* Mosquito Vectors in the U.S.

- **<u>Invasive species</u>**
- *Aedes aegypti* in the US is the principal arboviral vector for:

  - Dengue virus
  - Chikungunya
  - Zika virus

- *Aedes albopictus* often primary nuisance mosquito in residential habitats



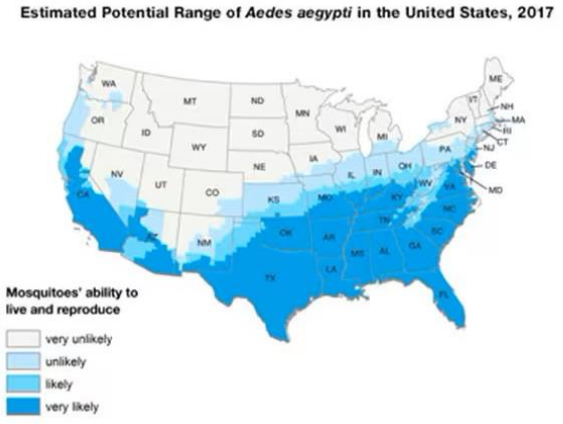
Aedes aegypti

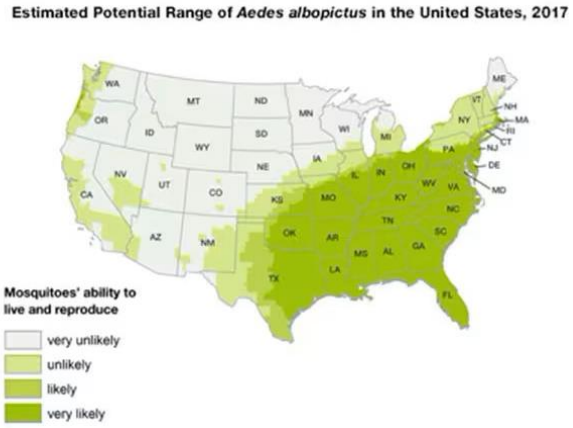
Image: CDC.gov



Aedes albopictus

Image: media.istockphoto.com





US maps courtesy of CDC

Important *Culex* Mosquito Vectors in the U.S.

- Within the southeastern US, *Culex quinquefasciatus* and *Culex nigripalpus* can vector:
  - West Nile Virus (WNV)
    - 25th anniversary in US (1999)
    - Leading cause of MBD in US
    - Reshaped mosquito management in the US
  - Eastern Equine Encephalitis (EEE)
  - Saint Louis Encephalitis (SLE)

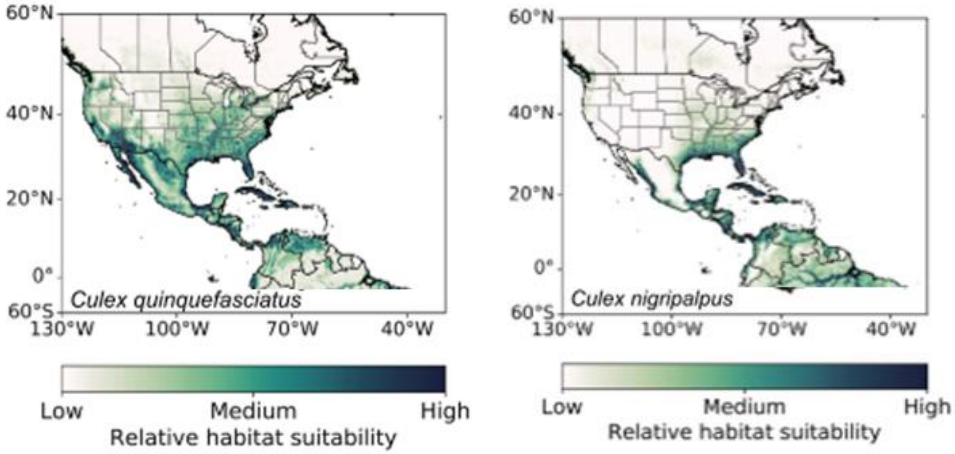
- *Culex* species can exhibit seasonal host shifting from avian to mammalian as the year progresses



Culex quinquefasciatus.
Credit: James Newman, UF/IFAS



Culex nigripalpus.
Credit: UF/IFAS FMEL



U.S. distribution of Culex quinquefasciatus and *Culex nigripalpus.*
Credit: Modified from Gorris et al.2021

Mosquitoes in Suburban Settings

Suburban habitats support mosquito activity

- Tree hole and artificial containers

  -Aedes albopictus
  -Aedes aegypti

- Stormwater infrastructure and permanent water holding habitats

  - Culex quinquefasciatus
  - Culex nigripalpus



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https://www.shutterstock.com/search/stormwater-system



https://www.shutterstock.com/search/roadside-ditch

Take Home Message

The suburban environment selects for vector and nuisance mosquito that flourish in synanthropic settings and supports host seeking, resting, and oviposition needs.



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Two Sides of Mosquito Control

Public Health Pest Control (PHPC)
Public Health License
- Mosquito Control Agencies
- Contracted public health applications

Private Pest Control
Certified Pest Control Operator
- General Household Pest
- Lawn and Ornamental

Contracted mosquito control service

Regulates any type of pest control business and control methods



cdc.gov



mainstreetmower.com

Barrier Treatments

- Residual insecticide applied to vegetation and other designated mosquito resting sites with a two-fold purpose of repellency and contact kill
- Private pest control mainly use backpack fogger applications (91%)
- Primary insecticide used is Bifenthrin (Type 1 Pyrethroid)
- WNV awareness and Zika scare likely promoted increase of method through hired mosquito services
- Over 4.6 million mosquito barrier treatments administered in 2017



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Backpack Fogger Limitations

- Physically demanding
  - 17.4 pounds empty
- Loud, leaky, cumbersome
- Design makes consistent delivery difficult
- Limited ability to cover large areas
- **Alternative barrier treatment methods should continuously be evaluated**



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Evaluation of Two Backpack Residual Barrier Treatment Methods for Mosquito Management and Their Nontarget Impacts in a Suburban Florida Neighborhood

Objective 1: Compare the efficacy of bifenthrin residual barrier treatments applied with a gas-powered backpack fogger versus an electric backpack sprayer, relative to untreated controls, including species-specific effects on mosquitoes and non-target arthropod impacts

Objective 2: Compare chemical use between the two backpack equipment types



Backpack Fogger

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Backpack Sprayer

npdproducts.com

Backpack Fogger



stihl.com

- Stihl SR 200 gas powered backpack fogger
- Retrofitted leaf blower
- Gravity-fed product delivery
- Airflow- approximately 341 cfm
- Droplet MVD 153 microns at 3 m (9.8 ft)
- Weight 8.4 kg (18.7 lb) empty
- Holds 7.5 L (2.1 gal)

Backpack Fogger Treatment Limitations

Maneuvering within vegetation



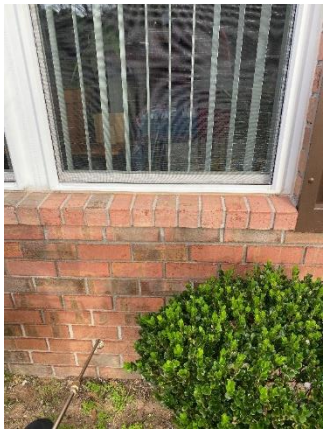
Property line limitations



Understory treatments



Tight areas



Adverse conditions



Limited treatment areas



Image source: designsomoza.com

Top Images: Daniel Killingsworth

Electric Sprayer



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- NPD Boss Eliminator E320 18-volt backpack sprayer
- Specialized sprayer wand and pressurized nozzle
- Droplet VMD 190.12 microns at 3 m (9.8 ft)
- Weight- 4.7 kg (10.5 lbs) (without payload)
- Capacity- 15.1 L (4 gal)

Experiment 2- Experimental Design

Mosquito Sampling- Weekly per site (24 weeks June-Oct)

CDC light trap with dry ice

BG-Sentinel 2 trap with dry ice and BG lure



Non-target Sampling- Weekly per site (24 weeks June-Oct)

CDC trap by-catch

BG-Sentinel 2 trap by-catch

Blue Vane trap for native bee collection (Dawn dish soap/water)



Barrier Treatments- Monthly (4 months July-Oct)

-Five properties treated with backpack fogger (Stihl SR200)

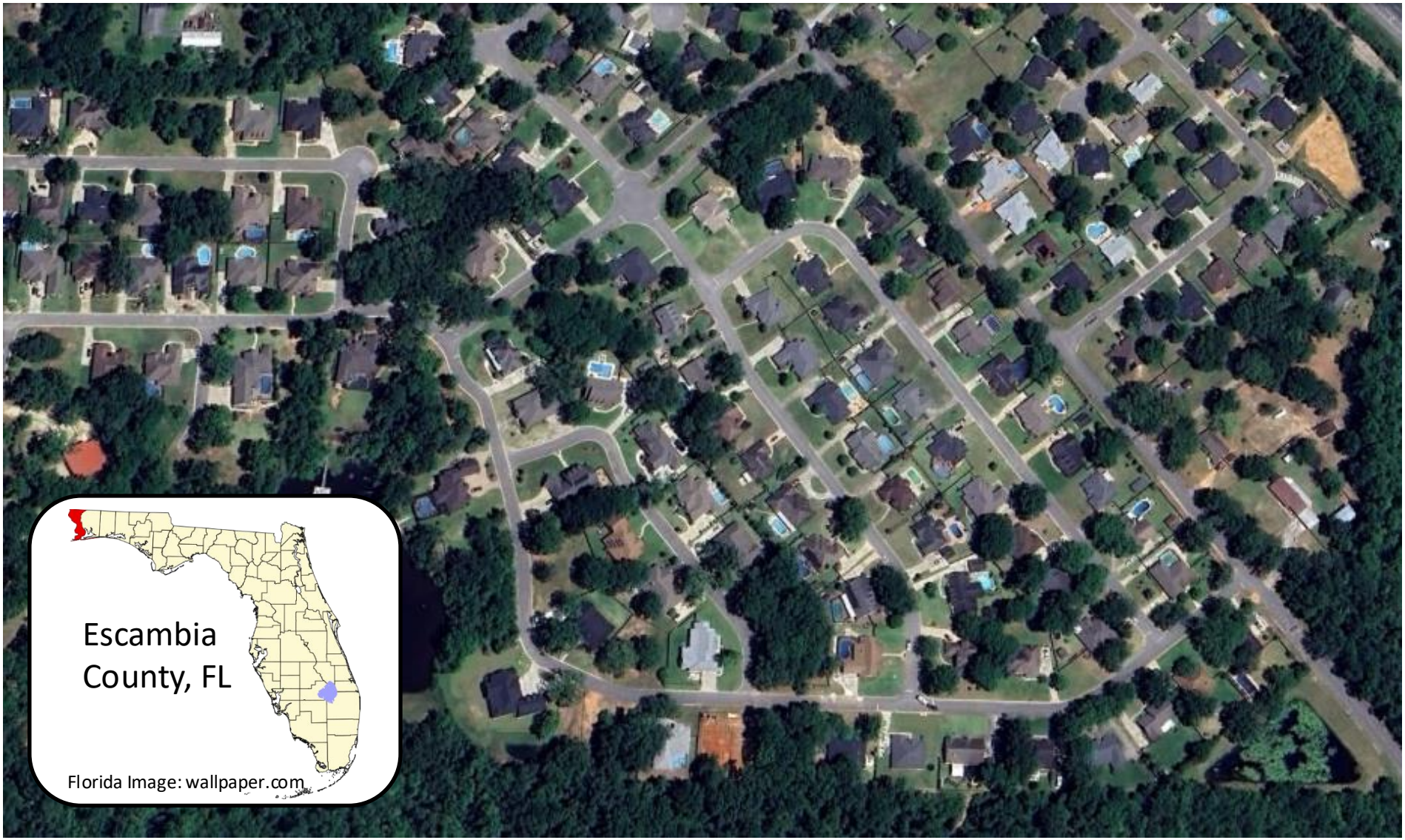
-Five properties treated using backpack sprayer (NPD Eliminator 320)

-Five properties as control (no treatments but similar setting)



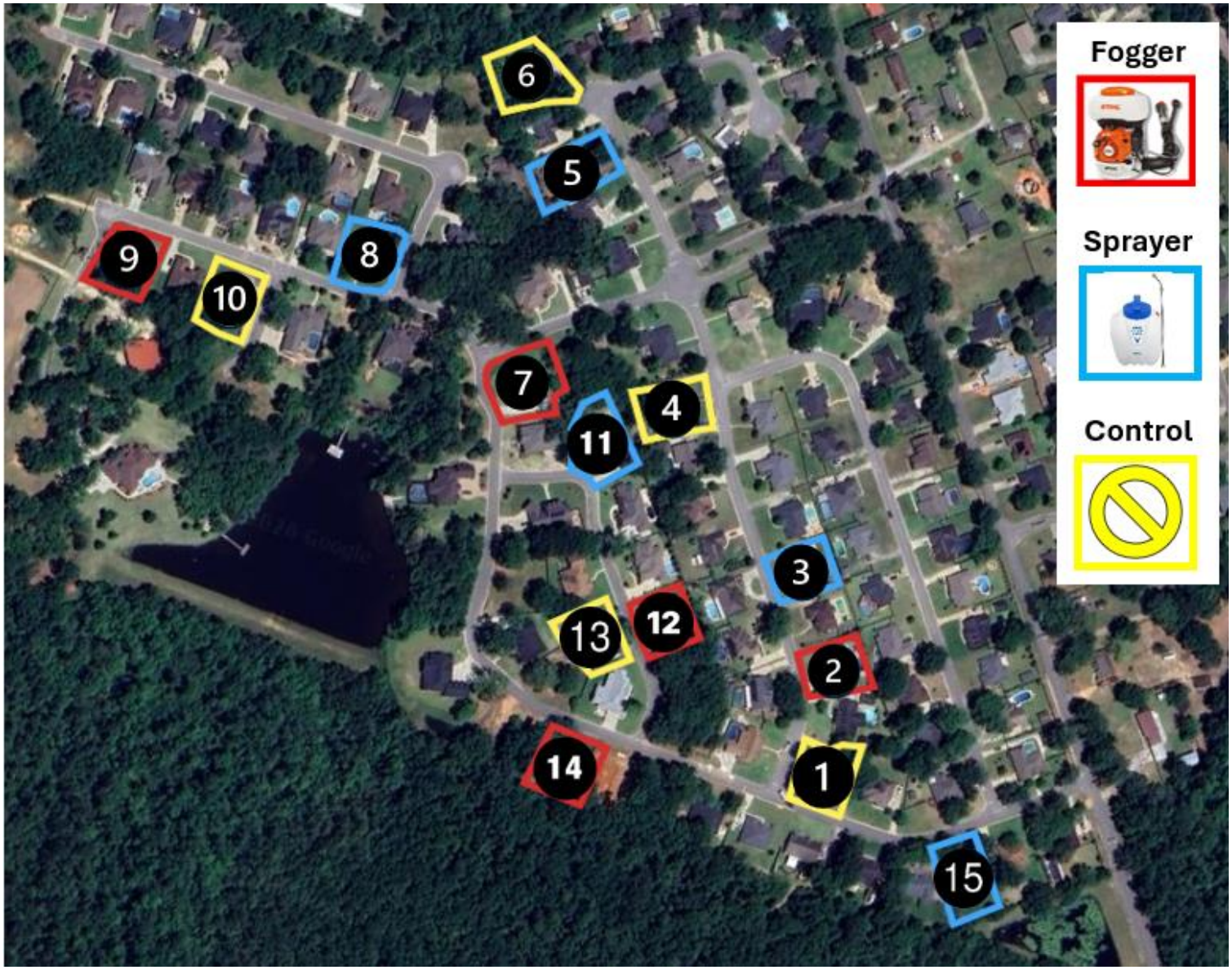
Images: Daniel Killingsworth

Study Site: Grande Oaks Subdivision



Map Image: Google Maps

Treatment sites



Map Image: Modified from Google Maps

Treatment Protocol













Images: Daniel Killingsworth

Mosquito Analyses

- Negative binomial GLMMs analyzed trap-night mosquito counts
  - Fixed effects: treatment, surveillance week, and trap type
  - Random effect: Site
  - Wald χ^2 tests assessed overall treatment effects
  - Pairwise treatment vs. control: rate ratios (RR) with 95% CIs
  - Models evaluated total mosquito abundance and 9 common vector/nuisance species
    - *Culex nigripalpus*, *Aedes albopictus*, *Aedes vexans*, *Anopheles crucians* complex, *Culex quinquefasciatus*, *Culex erraticus*, *Anopheles quadrimaculatus*, *Culex salinarius*, *Coquillettidea perturbans*
- Associations between weekly mosquito abundance and antecedent weather were evaluated with Spearman rank correlations
- Heat maps visualized abundance of the four most abundant/vector species; Moran's I assessed spatial autocorrelation
  - *Culex nigripalpus*, *Aedes albopictus*, *Aedes vexans, Culex quinquefasciatus*

Nontarget Arthropod and Chemical Usage Analyses

- Negative binomial GLMMs evaluated total nontarget arthropods and the 7 most abundant taxonomic groups
  - Diptera, Lepidoptera, Hymenoptera, Coleoptera, Hemiptera, and Neuroptera, and the class Arachnida
  - Fixed effects: treatment, week, and trap type; site included as a random effect
  - Bees were analyzed separately as a pooled group using the same model
- Chemical usage between the backpack fogger and backpack sprayer were compared using post hoc Mann-Whitney U pairwise comparisons

Results

Ae albopictus	833
Ae atlanticus	68
Ae japonicus	12
Ae solicitans	25
Ae triseriatus	3
Ae vexans	720
Ae spp	25
An crucians cx	696
An punctipennis	9
An quadrimaculatus	299
An spp	40
Cq perturbans	139
Cx coronator	631
Cx erraticus	584
Cx nigripalpus	5460
Cx quinquefasciatus	662
Cx restuans	218
Cx salinarius	139
Cx spp	546
Cu melinura	4
Mn titillans	260
Or signifera	1
Ps ciliata	2
Ps columbiae	1
Ps ferox	30
Ps howardii	3
Ps spp	4
Tox rutilus	3
Ur sapphirina	2
Ur loweii	4

Total mosquitoes collected- 11,423

Total identified to species- 10,808

Average per site- 380.8

Number of species collected- 26

Number of genera collected- 10

Most numerous- *Cx. nigripalpus* (5460)

- *Ae. albopictus* (833)
- *Ae. vexans* (720)
- *An. crucians complex* (696)
- *Cx. quinquefasciatus* (662)
- *Cx. coronator* (631)

Treatment Type	Mosquitoes
Control	4186
Fogger	3953 (233 fewer)
Sprayer	3284 (902 fewer)



stihl.com

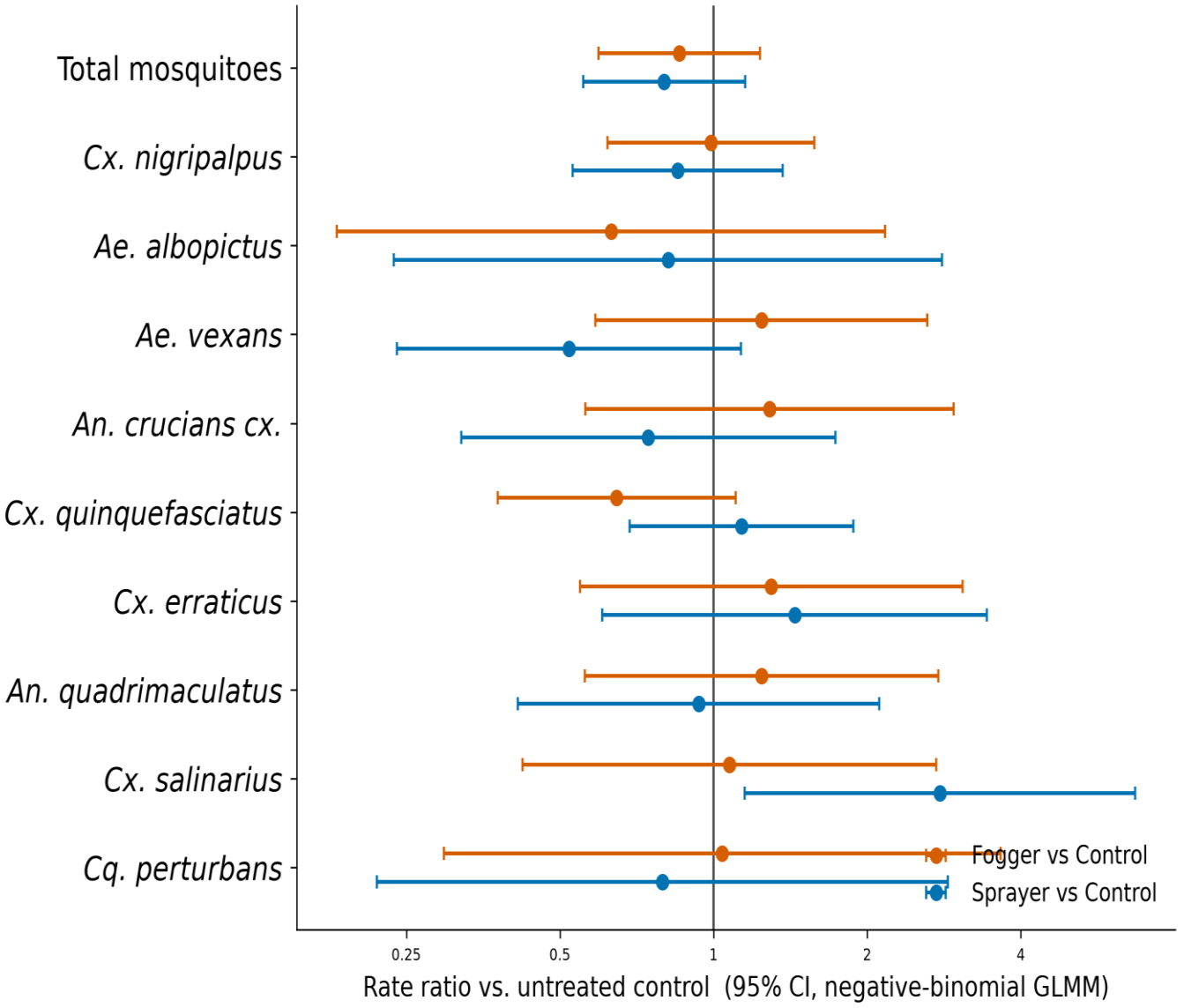


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Treatment Effect on Mosquito Abundance

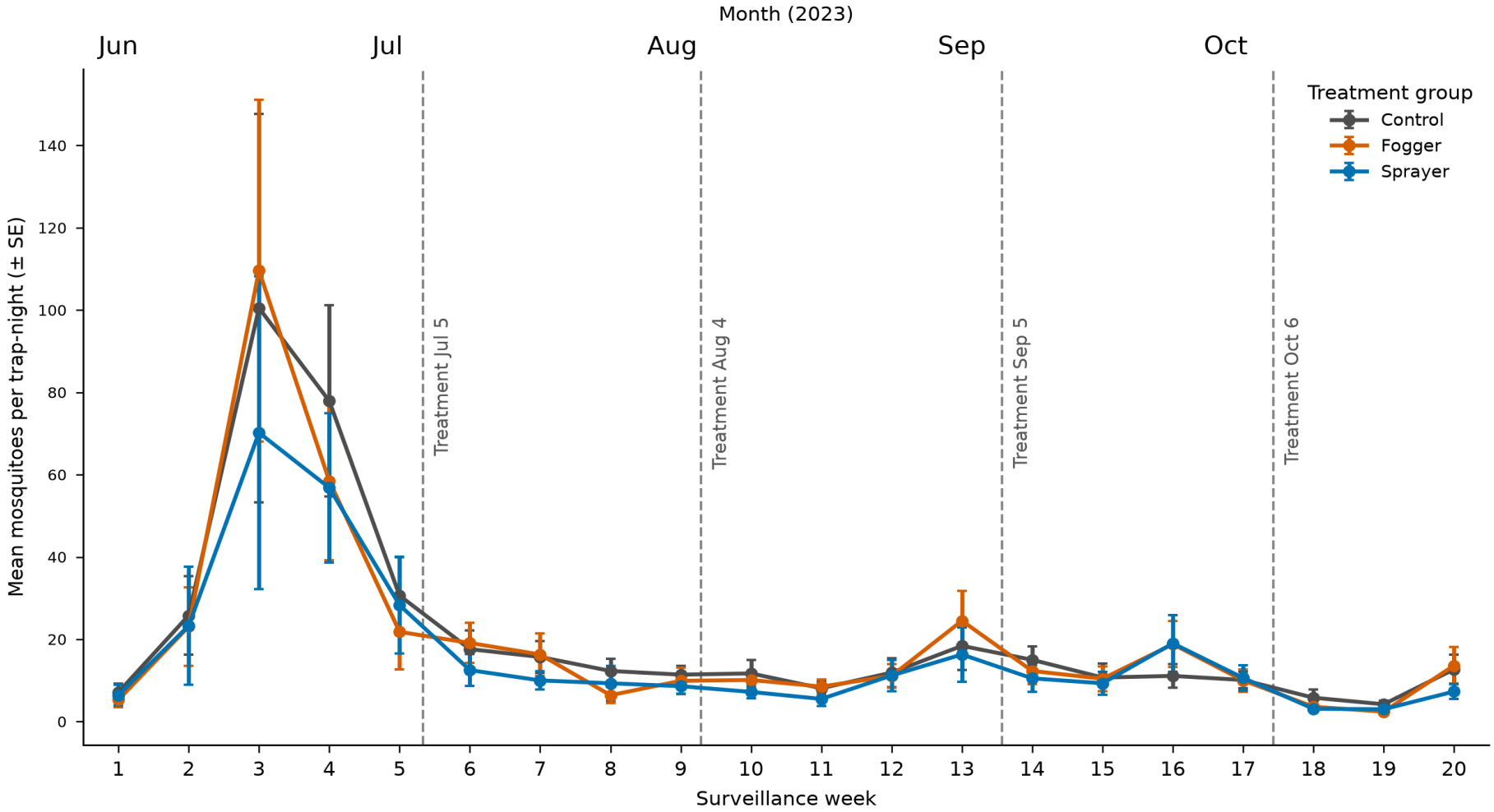
- Neither backpack fogger or sprayer reduced total abundance
- Of the nine key species analyzed separately, six showed no significant treatment effect
- 3 species signaled treatment effect but was not significant:

Aedes vexans
Culex quinquefasciatus
Culex salinarius
(Higher than control)



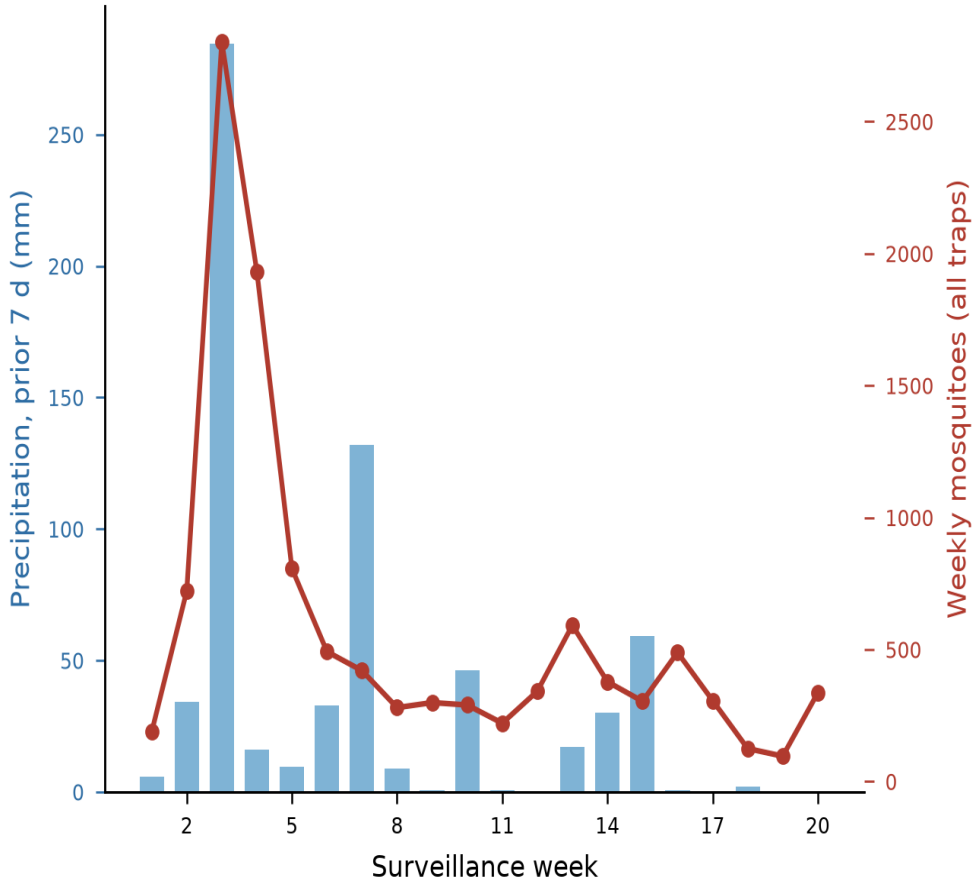
Weekly Mosquito Abundance by Treatment

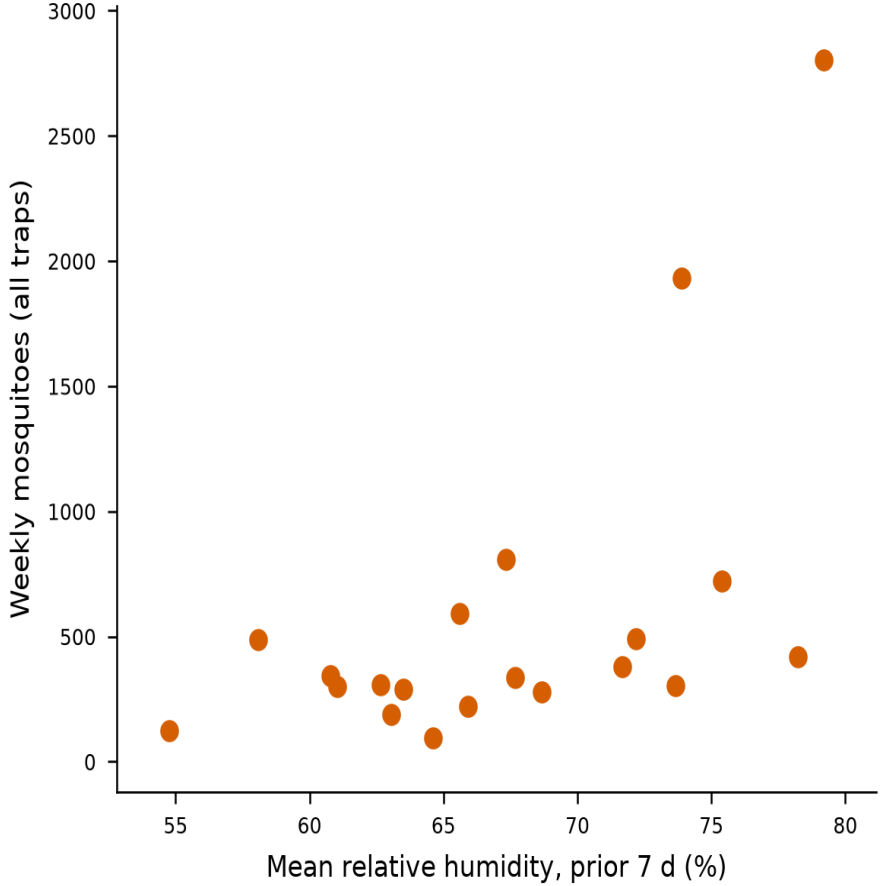
- Abundance varied among surveillance weeks
- Week was significant for total mosquitoes and for every key species
- Treatment groups followed same temporal trajectory with overlapping standard errors
- No divergence from the control after any of the four monthly barrier treatments



Mosquito Abundance in Relation to Weather

- Mosquito abundance peaked in mid–late June following heavy early-season rainfall and declined during cooler, drier weeks
- Abundance positively associated with antecedent moisture
- Strongest associations: preceding-week mean RH, minimum RH, and precipitation

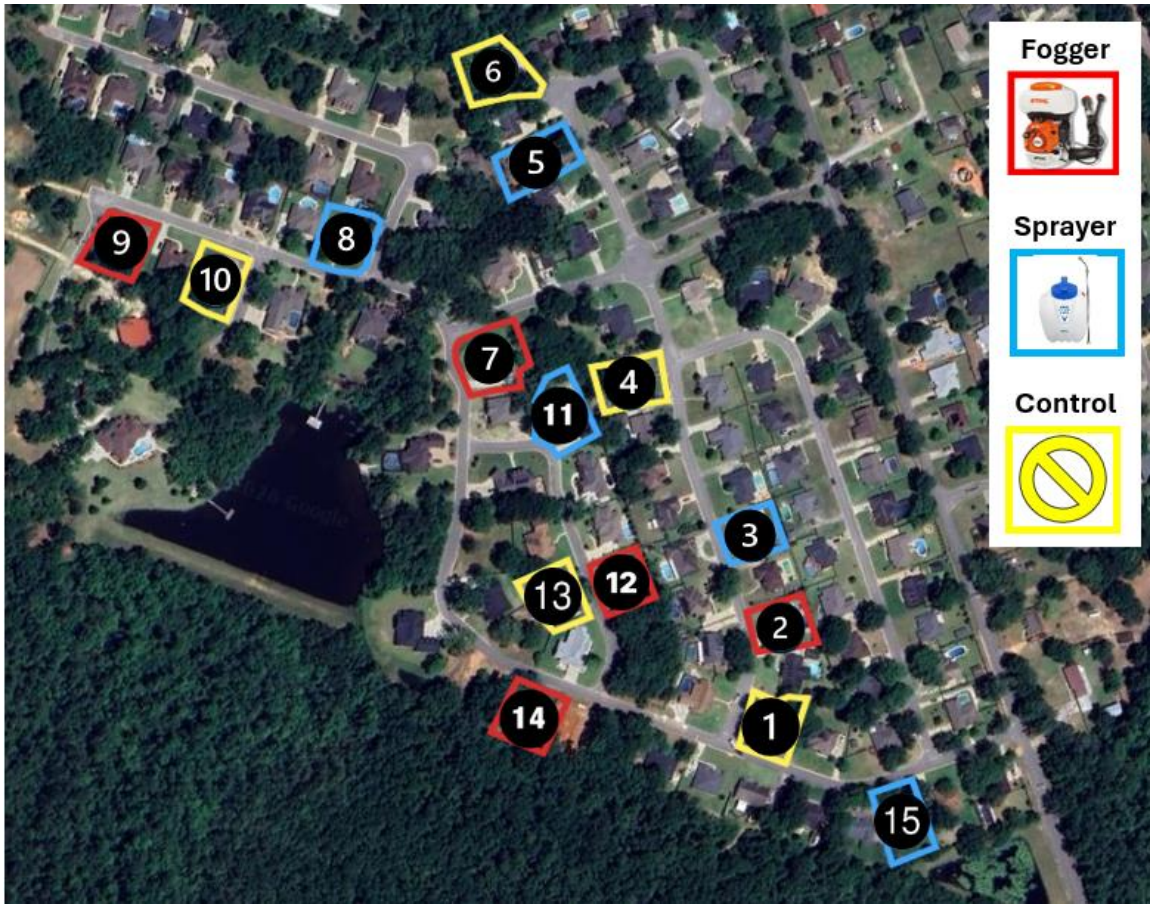




Mosquito Spatial Distribution

- Mosquitoes varied spatially among properties
- Moran's I spatial autocorrelation analysis detected no significant spatial clustering for any of the four most abundant vector or nuisance species:

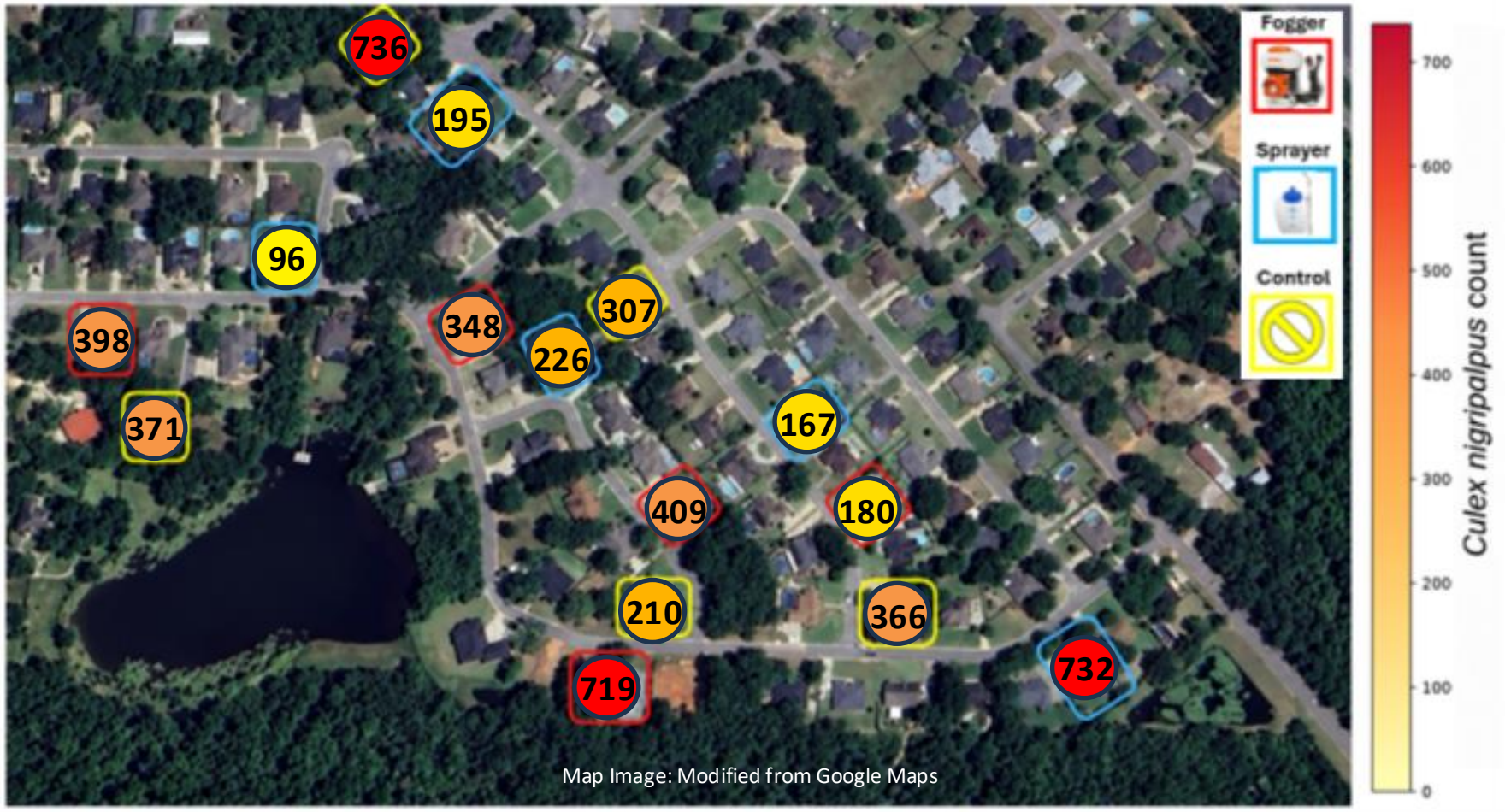
  Culex nigripalpus
  Aedes albopictus
  Culex quinquefasciatus
  Aedes vexans



Map Image: Modified from Google Maps

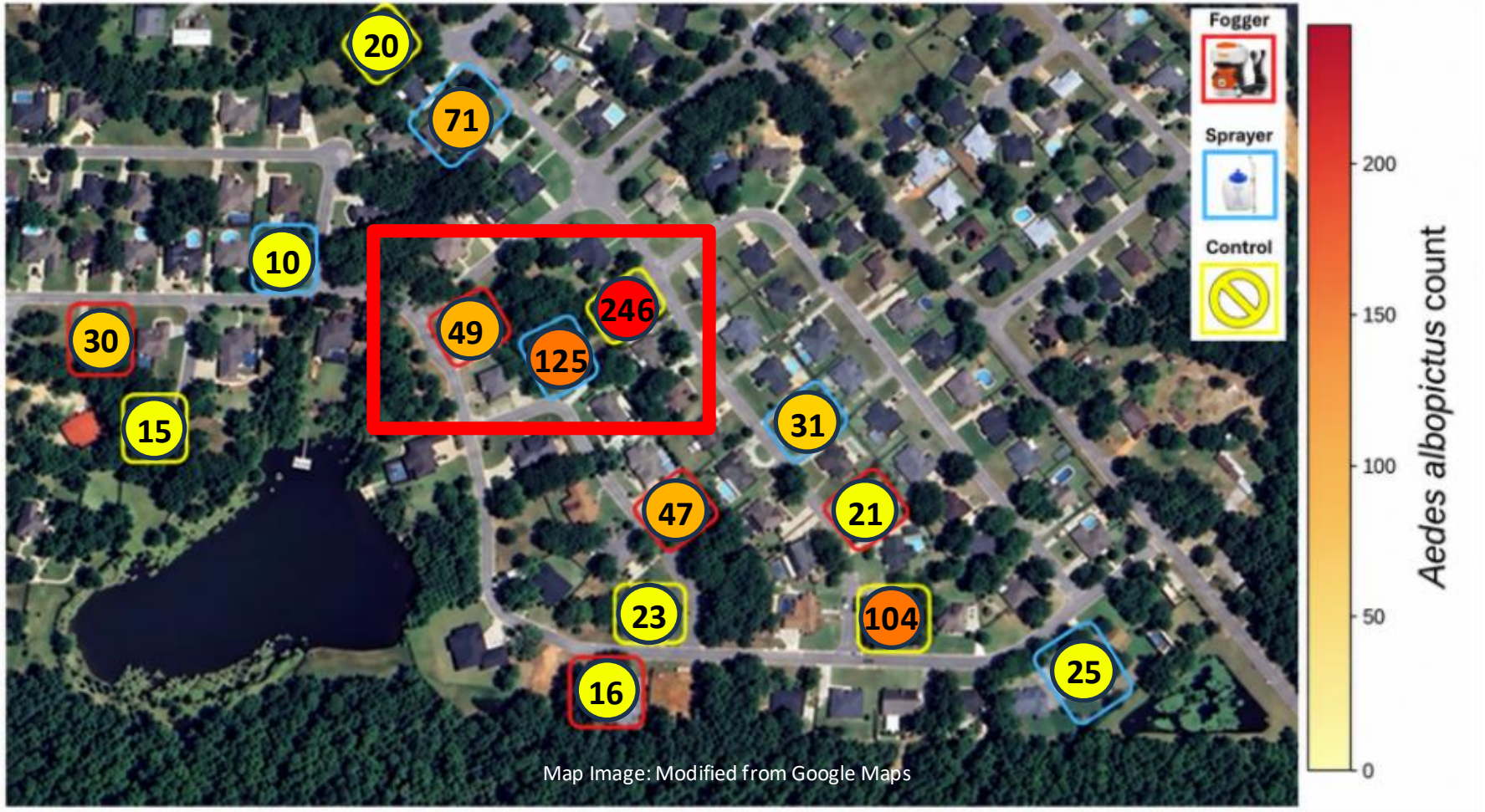
Culex nigripalpus Spatial Distribution

- Present at all sites
- Higher counts occurred at sites along the wooded edge of the subdivision
- Adjacent untreated woodlands and wetlands may have provided external habitat, allowing mosquitoes to enter treated properties without contacting treated vegetation at sites



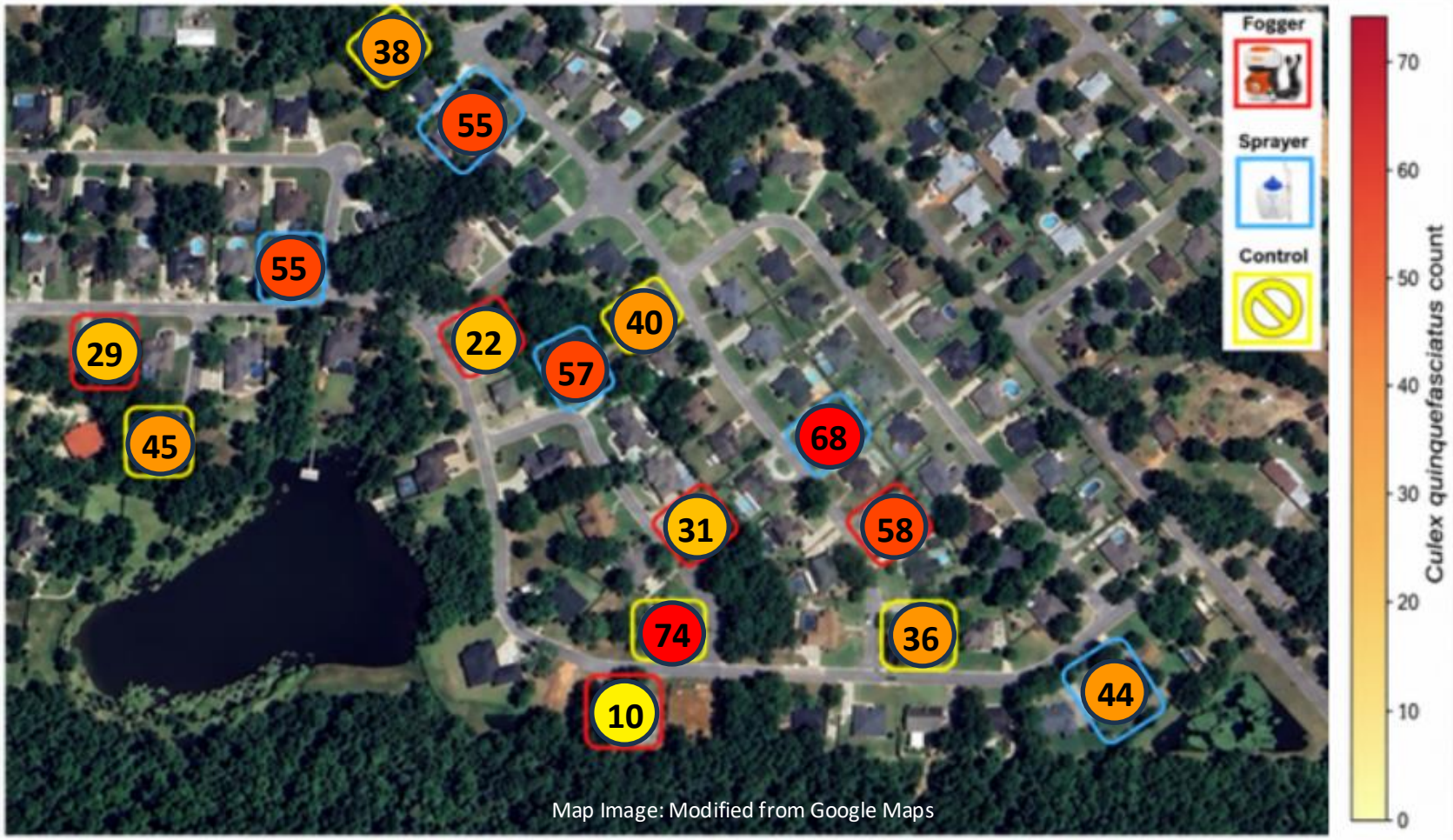
Aedes albopictus Spatial Distribution

- *Aedes albopictus* was concentrated at three sites, which accounted for 57% of total captures
- Targeted source reduction may complement barrier treatments



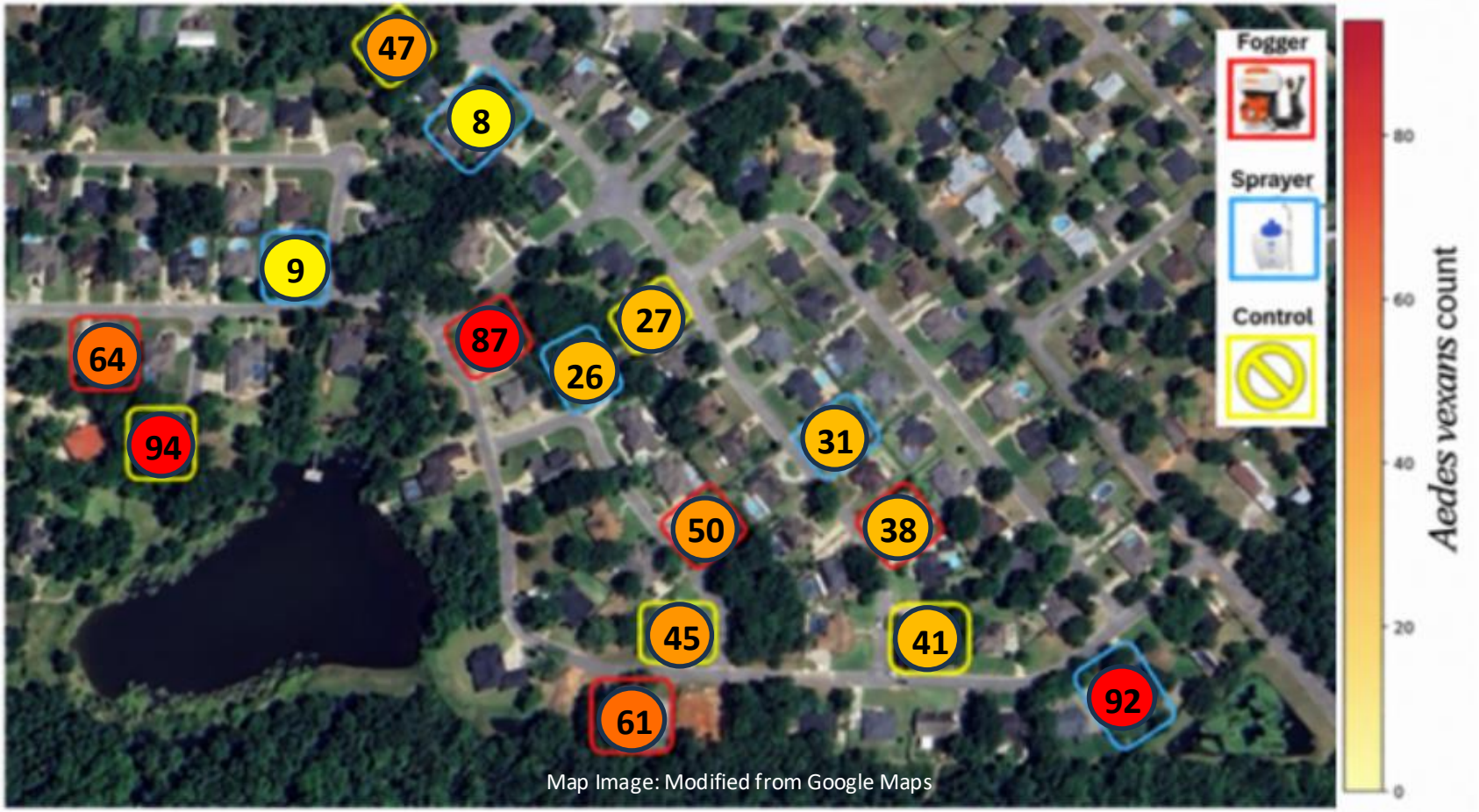
Culex quinquefasciatus Spatial Distribution

- Widespread distribution throughout neighborhood
- Catch basins may facilitate movement throughout the subdivision, limiting site-level treatment effects
- Pyrethroid resistance may have contributed to the lack of effect, but bifenthrin susceptibility was not assessed



Aedes vexans Spatial Distribution

- Higher abundance along neighborhood perimeter near permanent water sources
- Like *Cx. nigripalpus*, adjacent wooded and wetland habitat may have provided untreated resting habitat, allowing captured mosquitoes not to encounter treated vegetation at sites



Nontarget Arthropods Collected

Total nontargets collected- 8,915

Average per site- 3.92

Most numerous - Lepidoptera (2328)

- Chironomidae (1245)
- Tipulidae (1131)
- Assorted Diptera (2967)

Pollinator Interest- (200)

- *Apis mellifera* (33) Honey bee
- *Bombus* (6) Bumble bees
- Halictidae (19) Sweat bees
- Megachile (Genus) (118) Leafcutters
- Osmiini (Tribe) (35) Mason bees
- Melissoides (23) Long-horned bees



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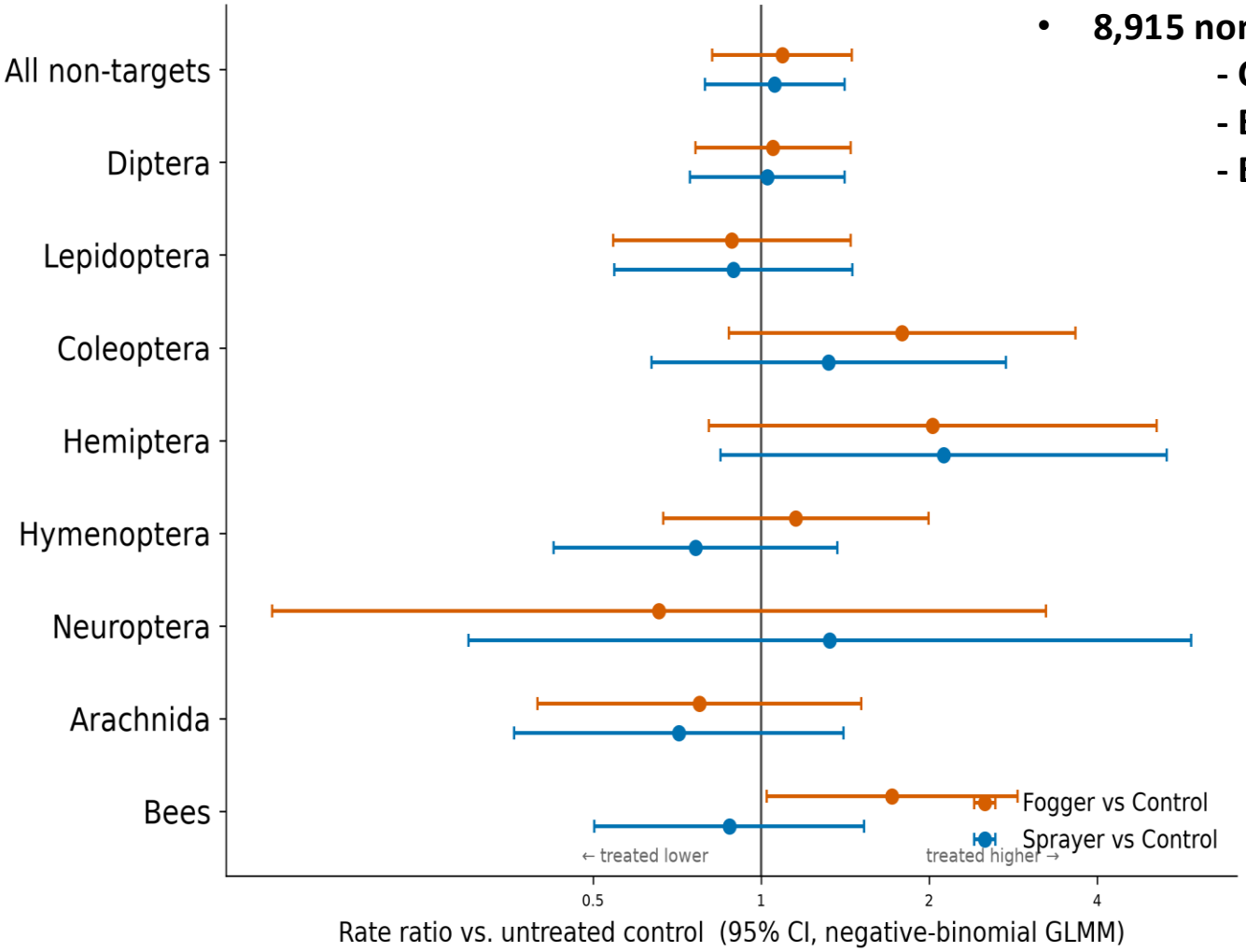






ENY-2046/IN1285: Bees of Florida

Nontarget Arthropod Abundance by Treatment

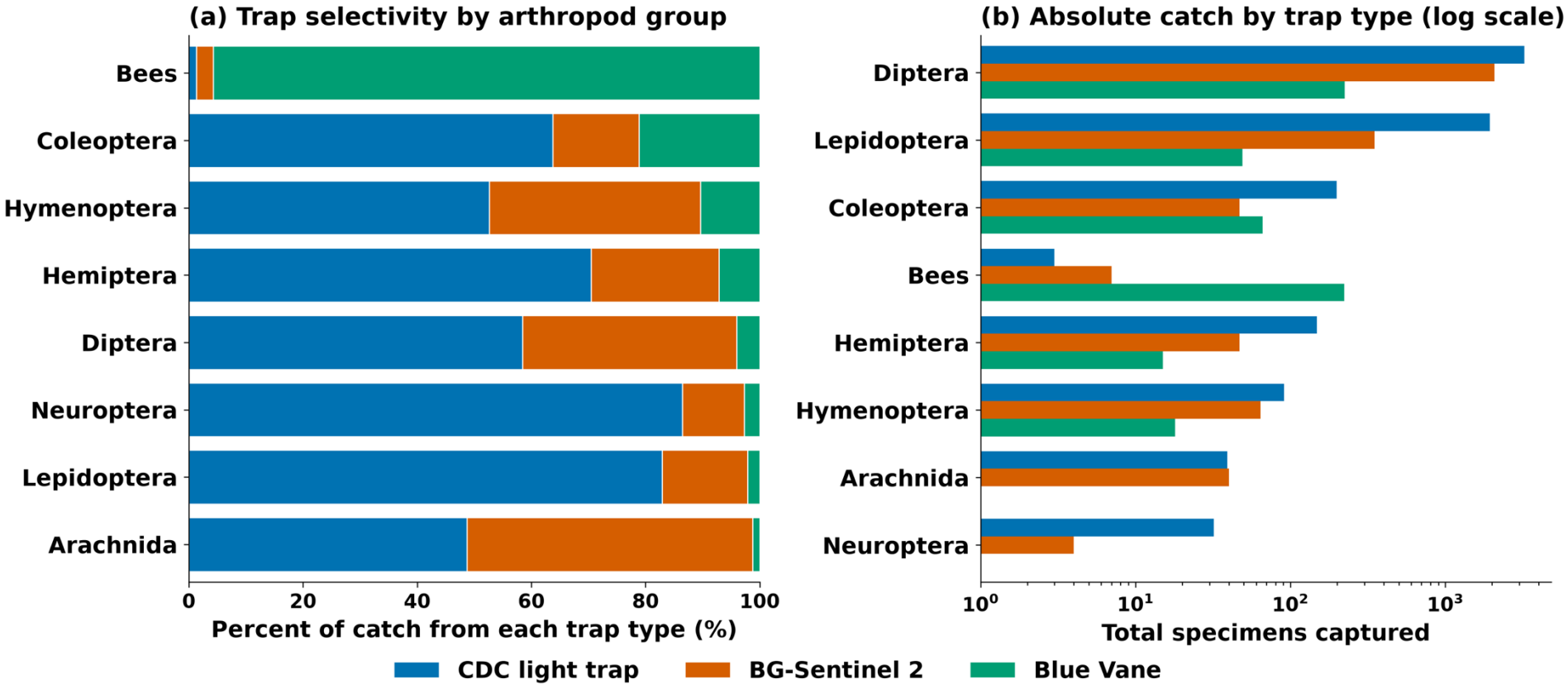


- **8,915 nontarget arthropods collected**
  - **Control: 2,970**
  - **Backpack fogger: 3,007**
  - **Electric sprayer: 2,938**

- Neither treatment significantly reduced any of the seven focal taxonomic groups

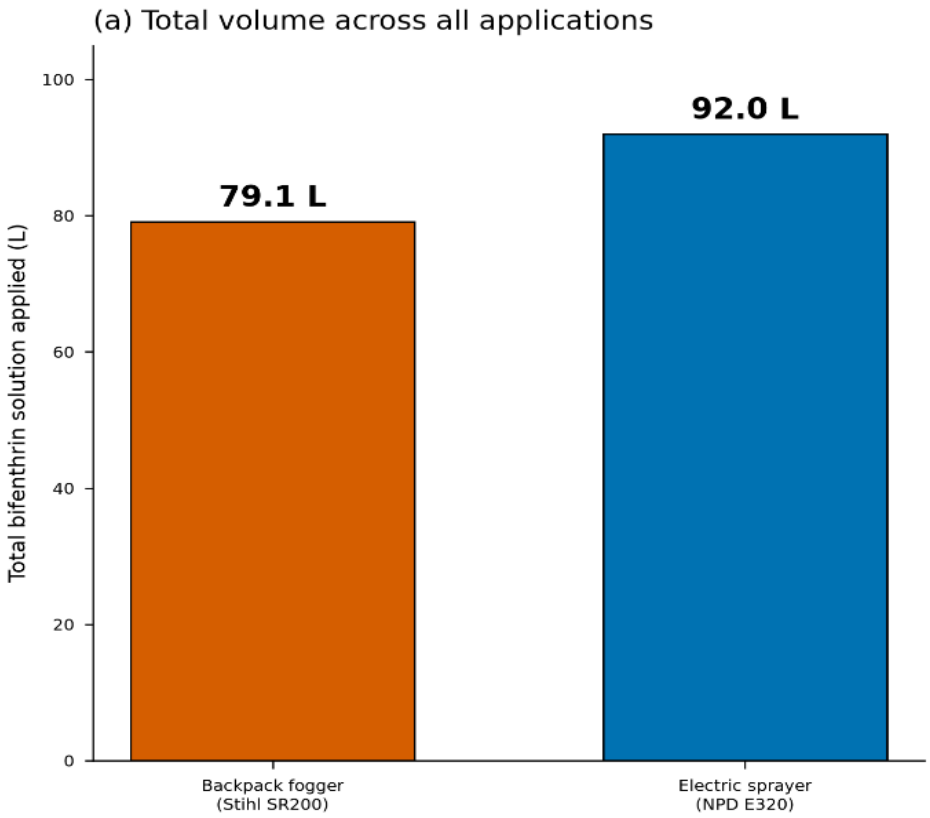
Nontarget Arthropods by Trap Type

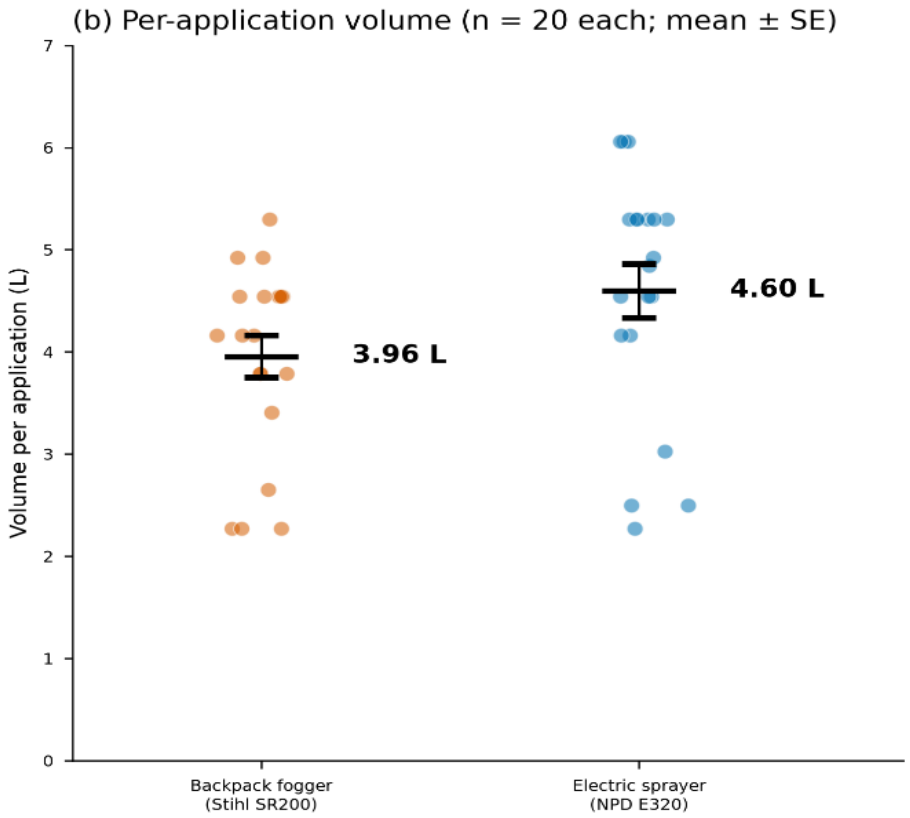
- Trap type influenced nontarget captures
  - Ex. Blue Vane traps collected 223 of 233 bees
- CDC light and BG-Sentinel 2 trap nontarget captures were incidental, so results reflect trap-specific abundance rather than the broader nontarget community



Chemical Volume by Equipment Type

- Total application volume:
  - Backpack fogger: 79.1 L (3.9 L/application)
  - Electric sprayer: 91.9 L (4.6 L/application)
- Volume increased with lot size; application volume/hectare did not differ between equipment types





Study Conclusions

- Total mosquito abundance: Untreated controls > Backpack fogger > Electric sprayer
  - But neither treatment significantly reduced mosquito abundance relative to controls
    - No treatment differences were detected for total or individual mosquito species
- Mosquito abundance varied by week, suggesting strong temporal/weather effects
- Neither treatment reduced nontarget arthropod abundance
  - Bee abundance was higher at backpack fogger sites than controls
  - Only measured abundance and not sublethal impacts
- Trap type influenced nontarget captures; results reflect trap-specific abundance, not the entire nontarget community
- Both equipment types had similar application rates per treated hectare

Study Limitations/Future Directions

- Limited replication: one neighborhood, one season, and five properties per treatment
  - Repeated weekly observations did not increase independent sample size beyond the 15 properties
- Paired CDC and BG-Sentinel 2 traps improved coverage but introduced trap-specific biases, potentially obscuring treatment effects
- Insecticide exposure was not quantified, so we could not determine whether mosquitoes received sufficient exposure to produce population-level effects; droplet deposition, canopy penetration, treated area, and bifenthrin residues were not measured
- Future studies: increase spatial/temporal replication and measure canopy structure, deposition, and residual activity, with complementary adult and larval surveillance

Summary

Study Results

- Neither backpack fogger or backpack sprayer significantly reduced total mosquito populations relative to control sites
- Weather strongly predicted catch rates
- No adverse treatment effects on nontarget arthropod abundance were detected

Practical Application

- Mosquito barrier treatments may be improved when used in conjunction with surveillance and source reduction techniques designed to assess and inhibit the life-cycle of the target pest population





Images: media.istockphoto.com

Acknowledgements

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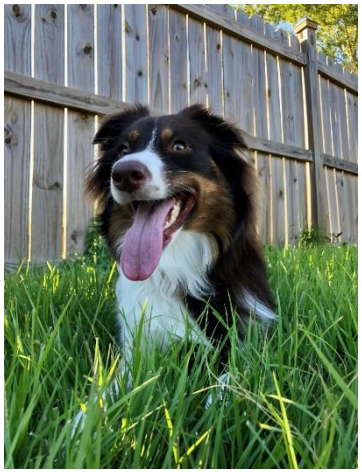


Heron's Forest HOA BOD and residents

Thank you to my family and friends!



Residents of Grande Oaks subdivision

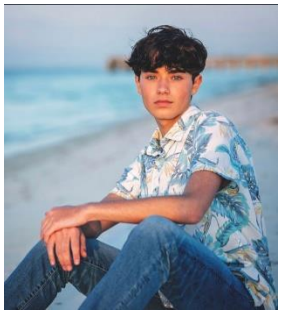


Bonnie



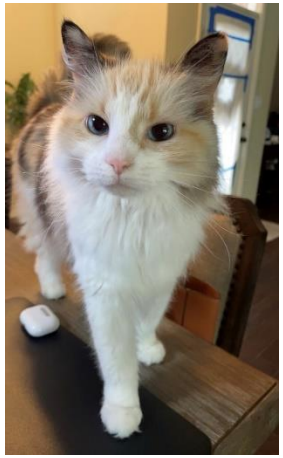






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PEST & LAWN



Lucy

Thank You!

Questions?

Dan Killingsworth
dangator12@ufl.edu

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