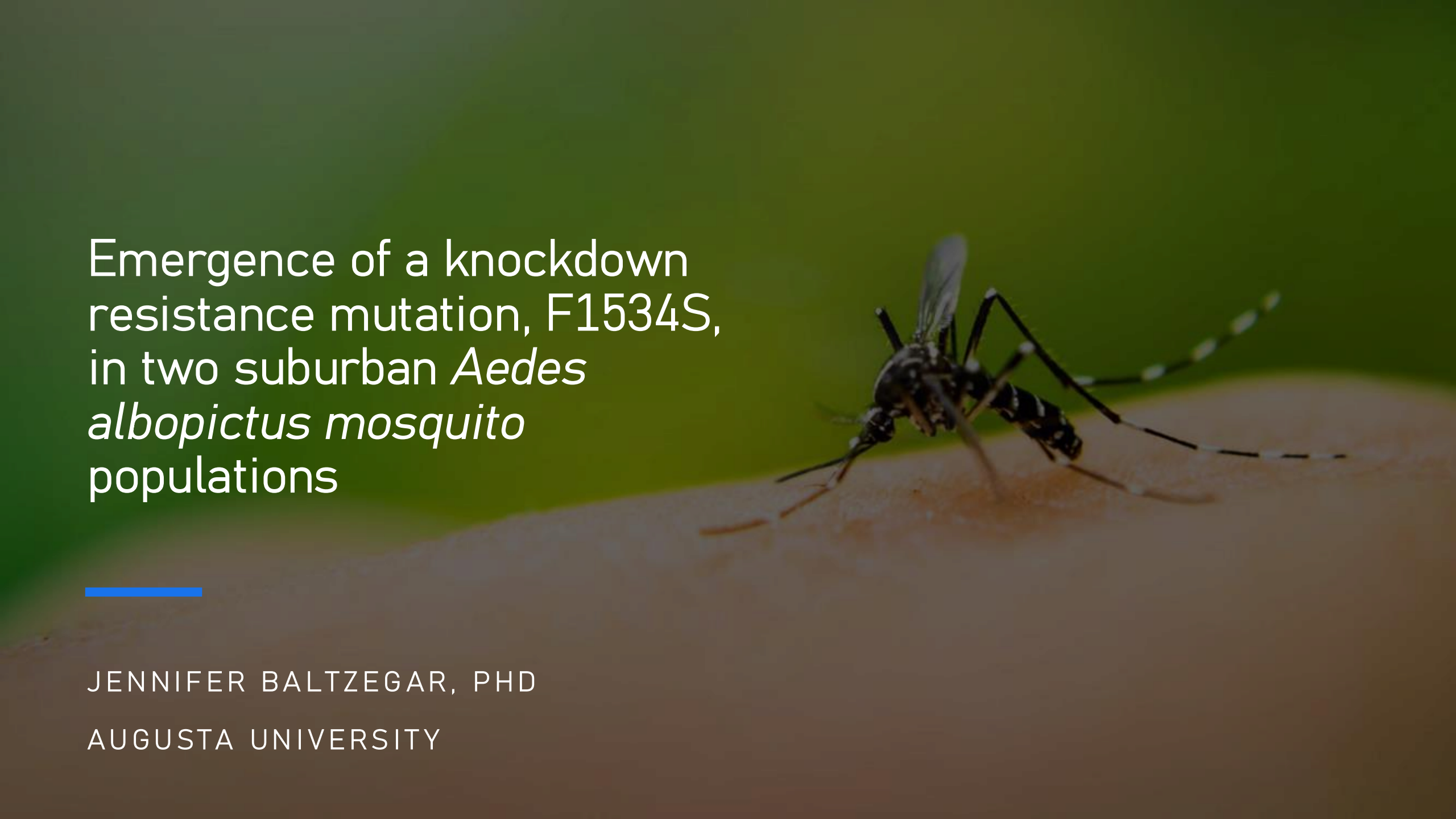
Emergence of a knockdown resistance mutation, F1534S, in two suburban *Aedes albopictus mosquito* populations



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AUGUSTA UNIVERSITY



Aedes albopictus

- Invasive to USA
- First appeared 1980s
- Populations expanding
- Competent vector
- Typically controlled via insecticide sprays





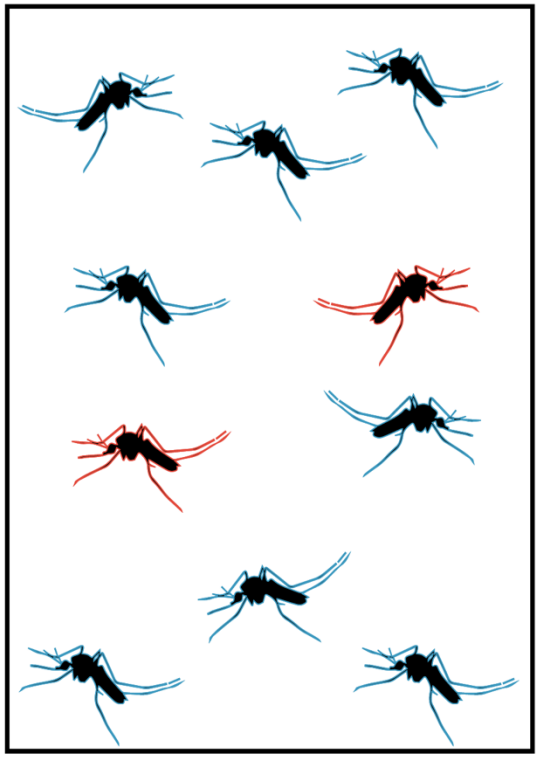
Insecticides reduce populations

- Pyrethroids most common
- Target voltage-gated sodium channel (VGSC)
- Paralyze and cause death
- Pyrethroid Resistance = knockdown resistance (kdr)

How resistance builds

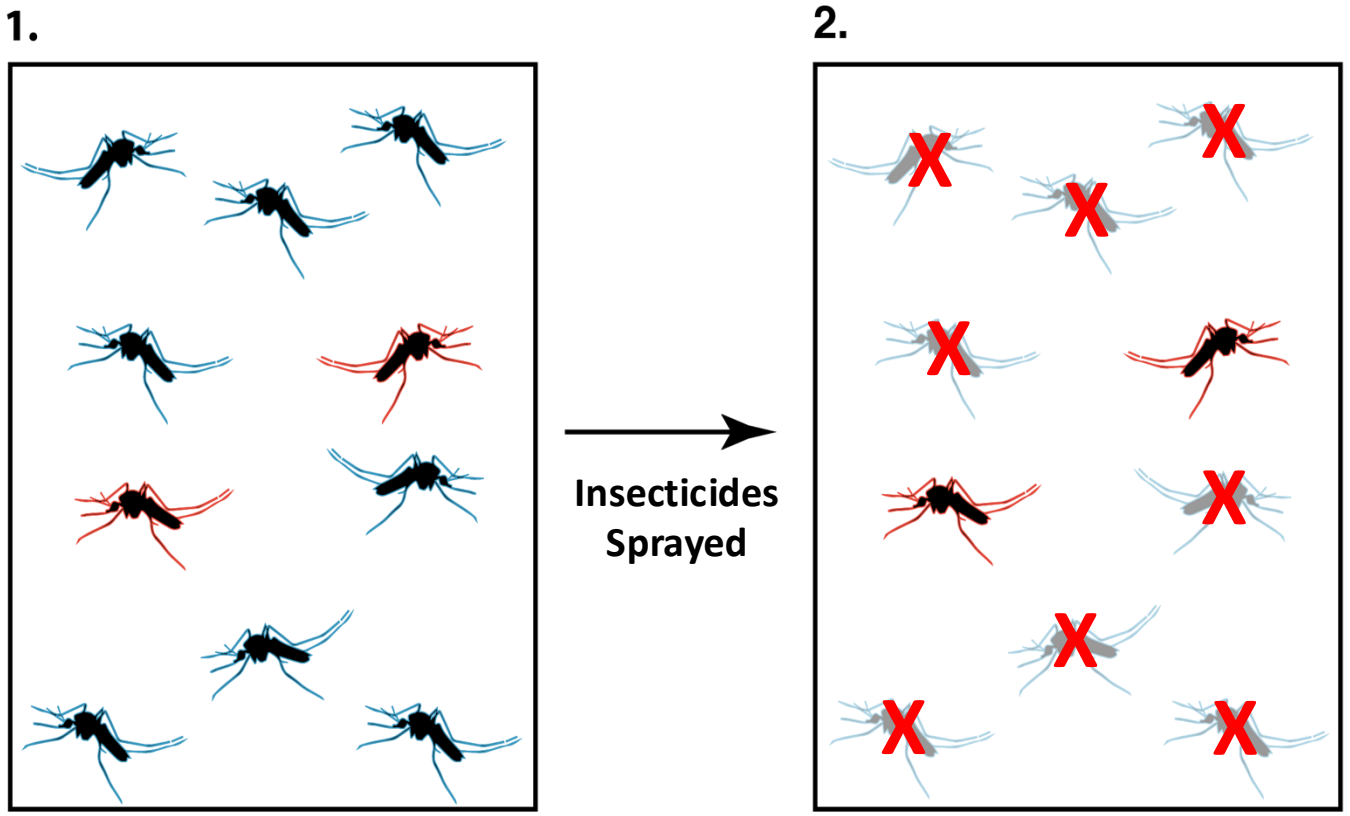
Application selects for resistance

1.



A few mosquitoes have resistance alleles
Most mosquitoes have susceptible alleles

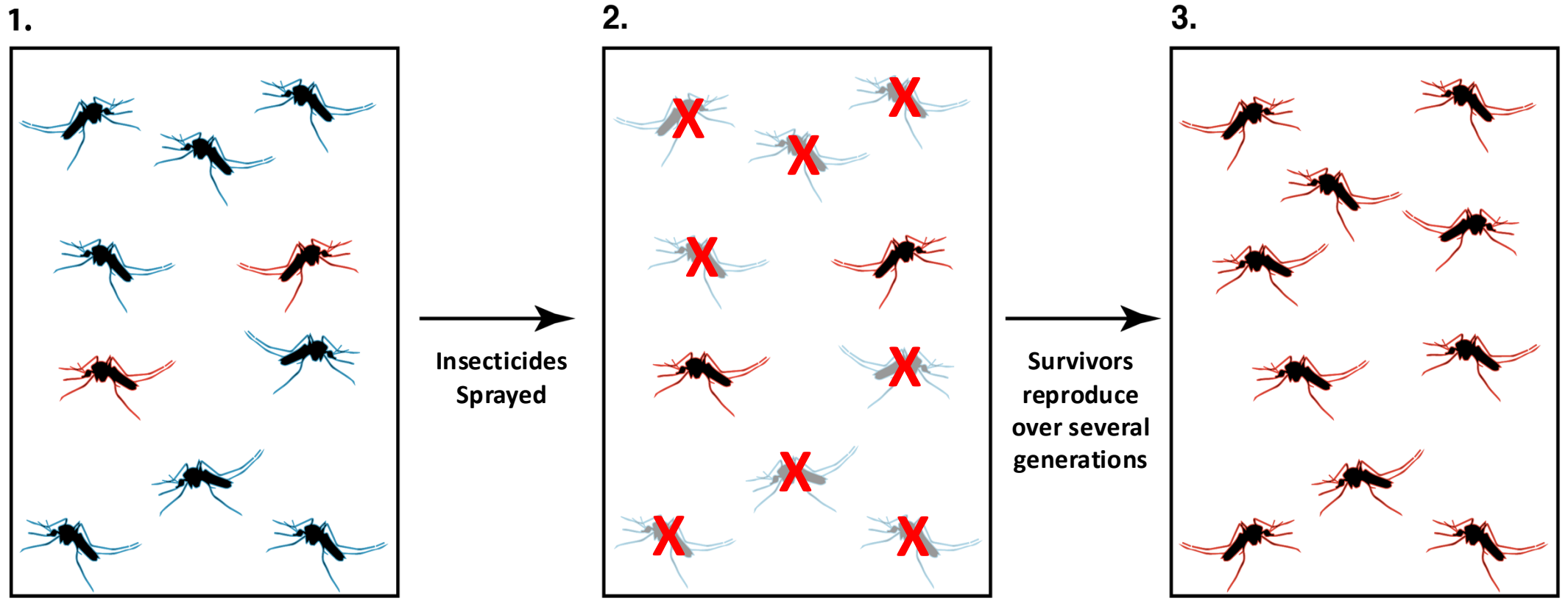
Application selects for resistance



A few mosquitoes have resistance alleles
Most mosquitoes have susceptible alleles

Mosquitoes with resistance alleles survive
Mosquitoes with susceptible alleles die

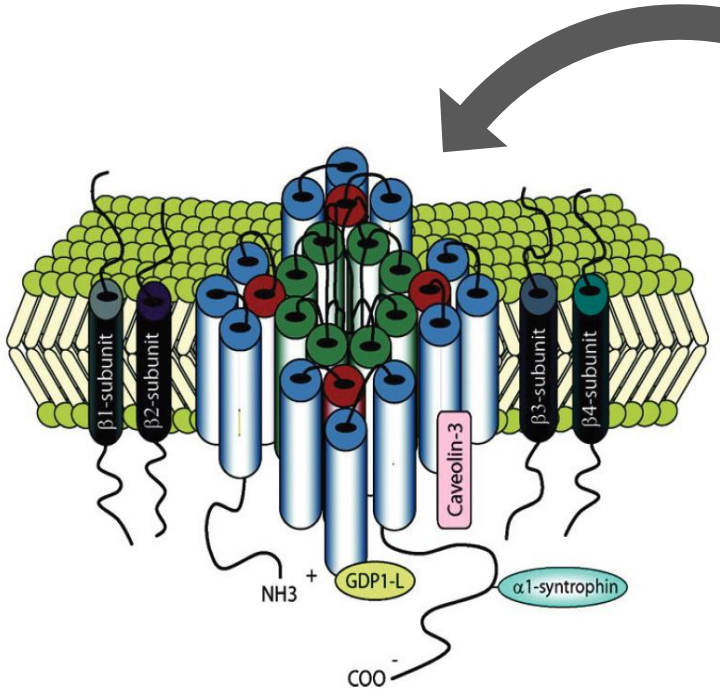
Application selects for resistance

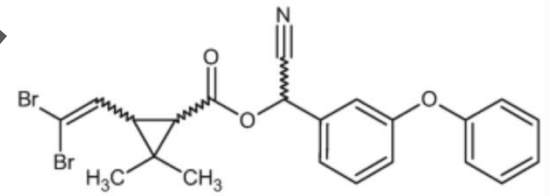


How the cell changes

VGSC is a transmembrane protein

Voltage-Gated Sodium Channel



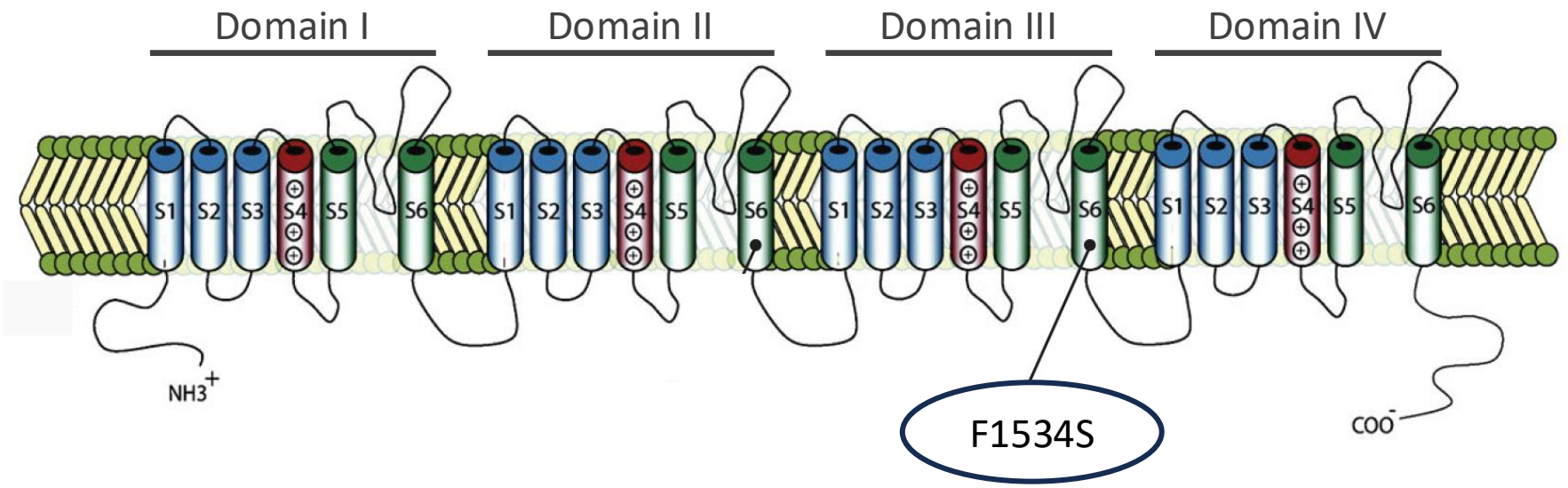


Deltamethrin

Phenotypically important mutations accumulate in the pore

F1534S mutation changes protein shape

Voltage-Gated Sodium Channel



Change in protein shape = change in protein function

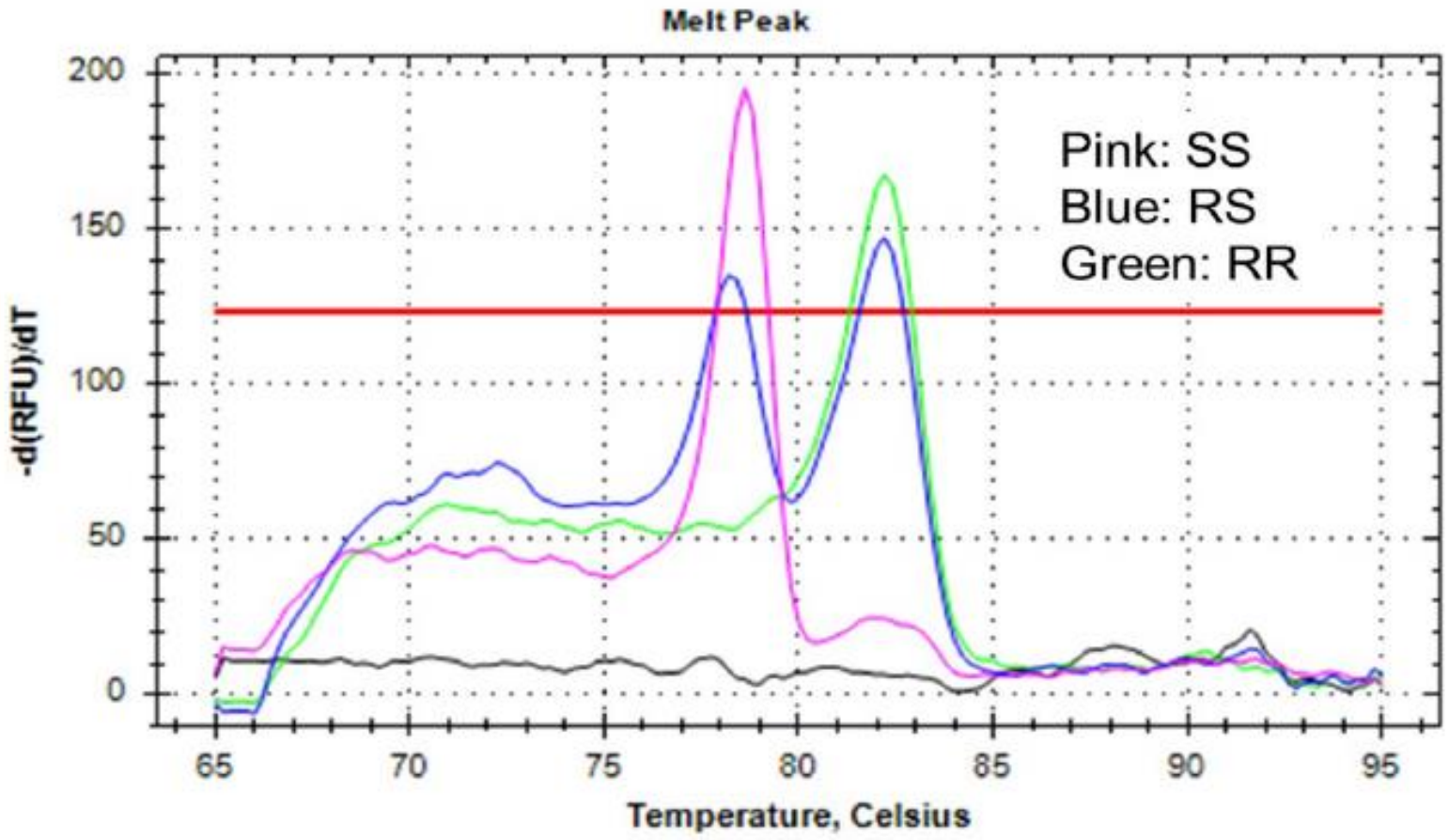
Emergence of F1534S in Raleigh, NC



Raleigh, NC

- No public mosquito control
- Homeowners use private companies to control for nuisance biting
- 2016 – 2024: Field collections of *Ae. albopictus* in freezer
- Found F1534S in 2019 sample

Developed a genotyping assay

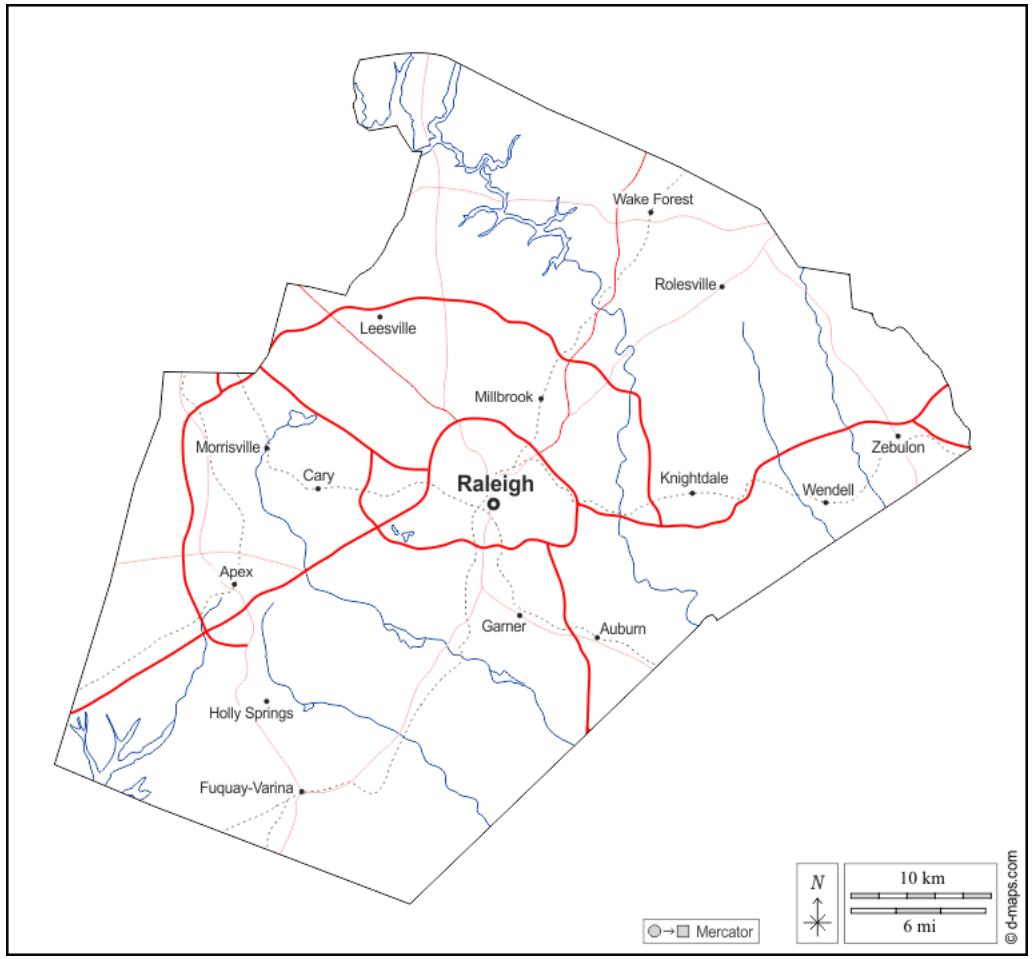


<u>Benefits Meltcurve PCR</u>

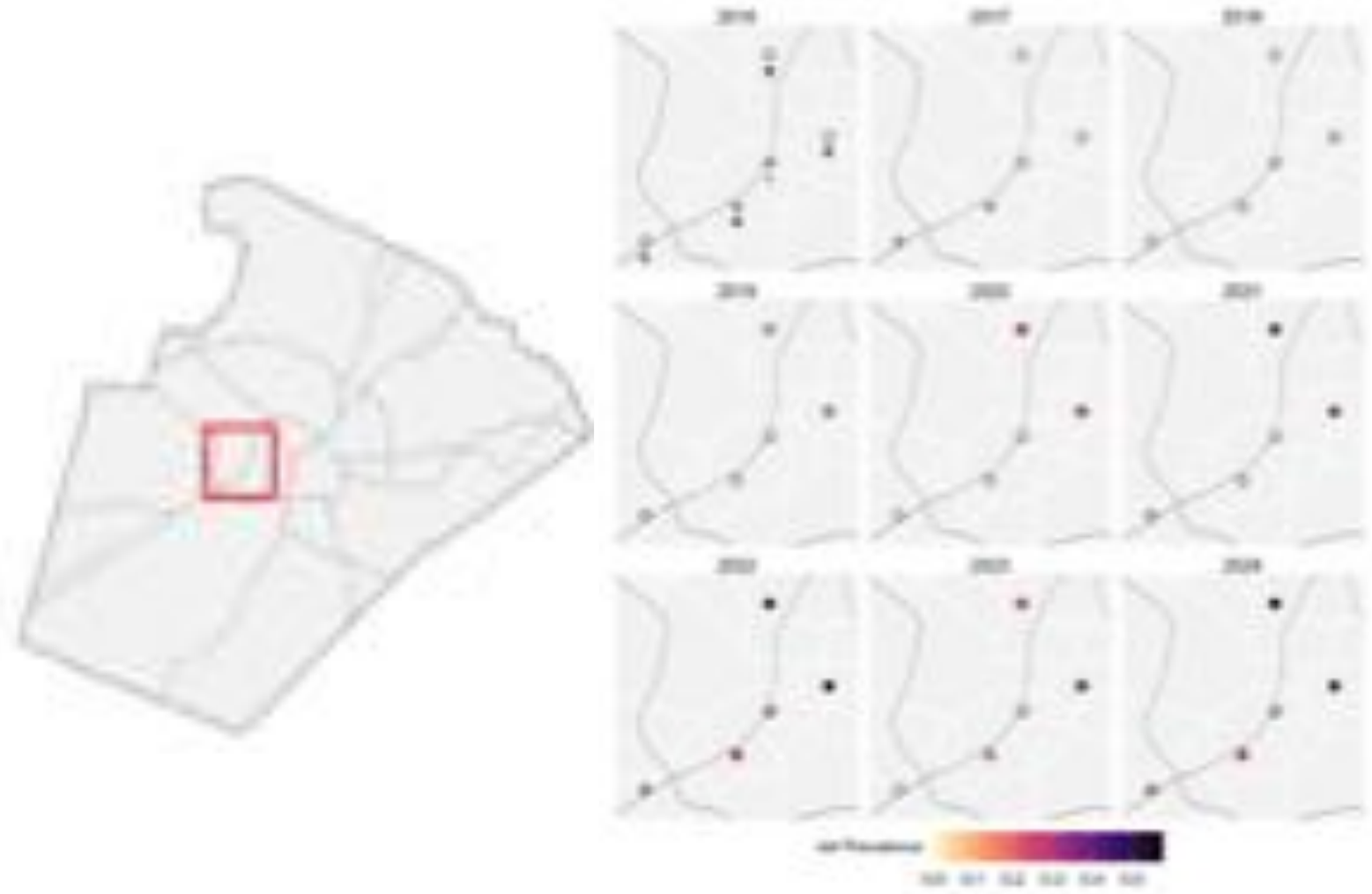
- High-throughput
- Cost effective
- Individual genotypes
  - SS, SR, RR
- Validated accuracy
  - 98.8% concordance with sequenced based genotyping

Two Sampling Schemes

- Annual at 5 sites
  - 2016 - 2024
- Expansive in 3 years
  - 2016, 2018, 2023



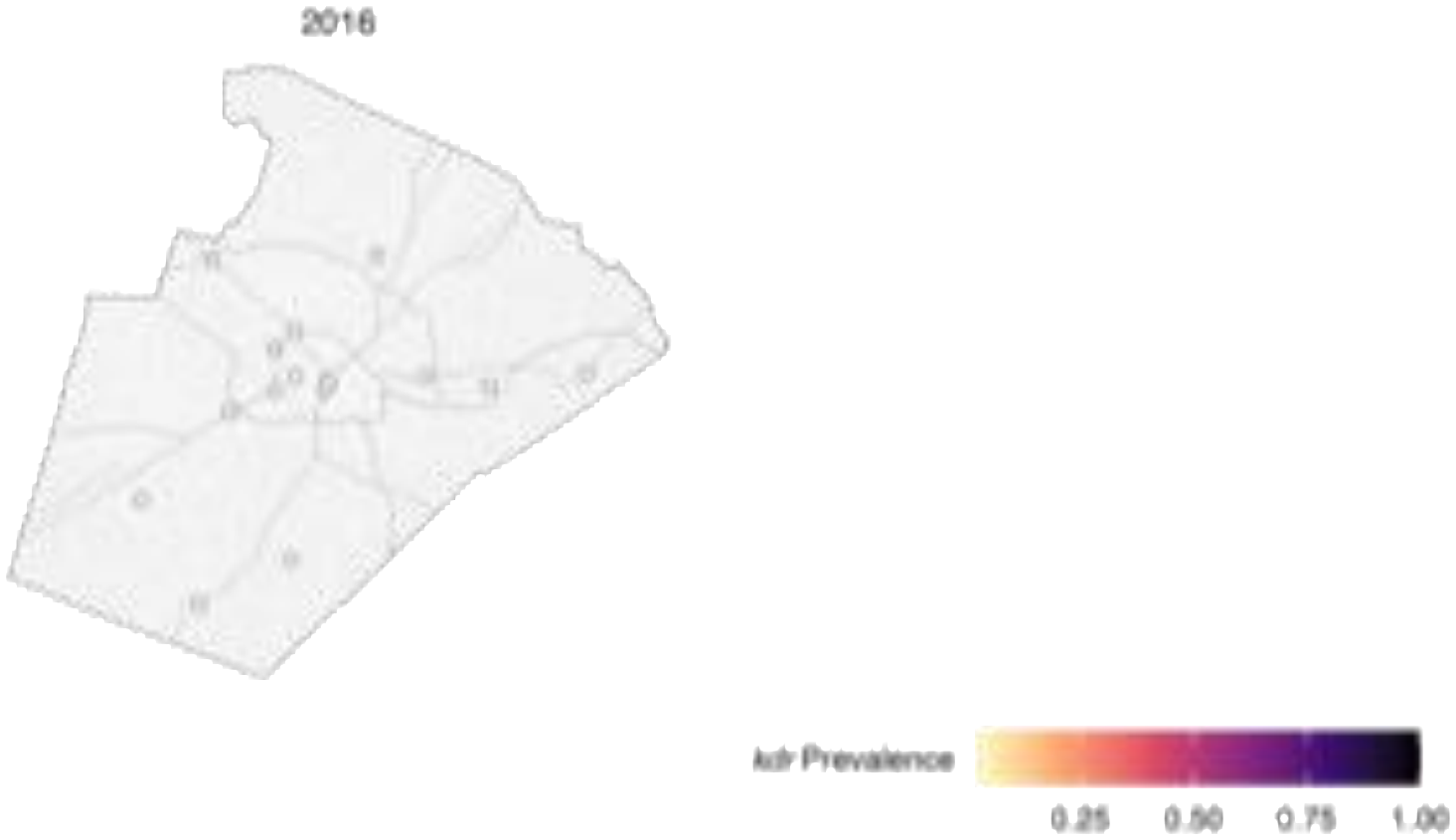
KDR at frequently sampled locations



- KDR emerges at these sites in 2018
- Spreads to all sites by 2022
- Frequency increases quickly

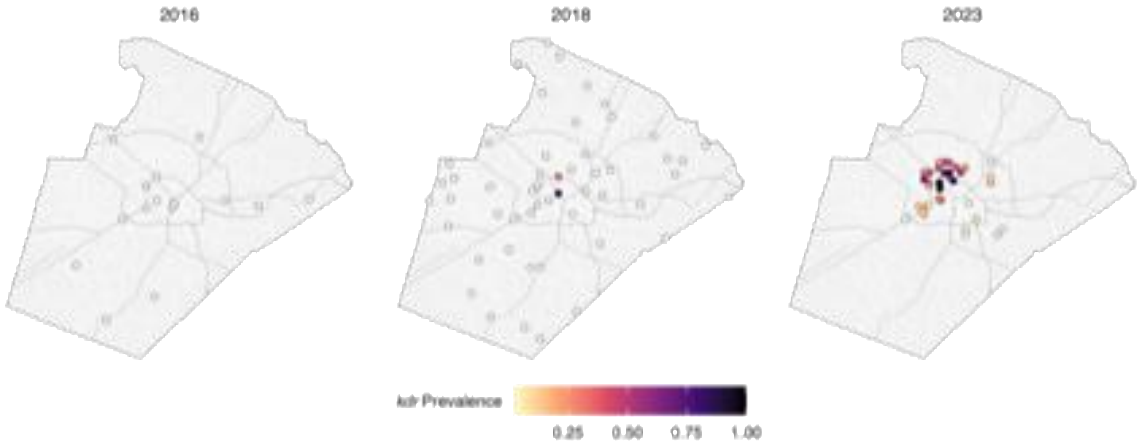
Baltzegar *et al.* 2026. Parasites Vectors

Distribution of kdr alleles in Wake County



Baltzegar *et al.* 2026. Parasites Vectors

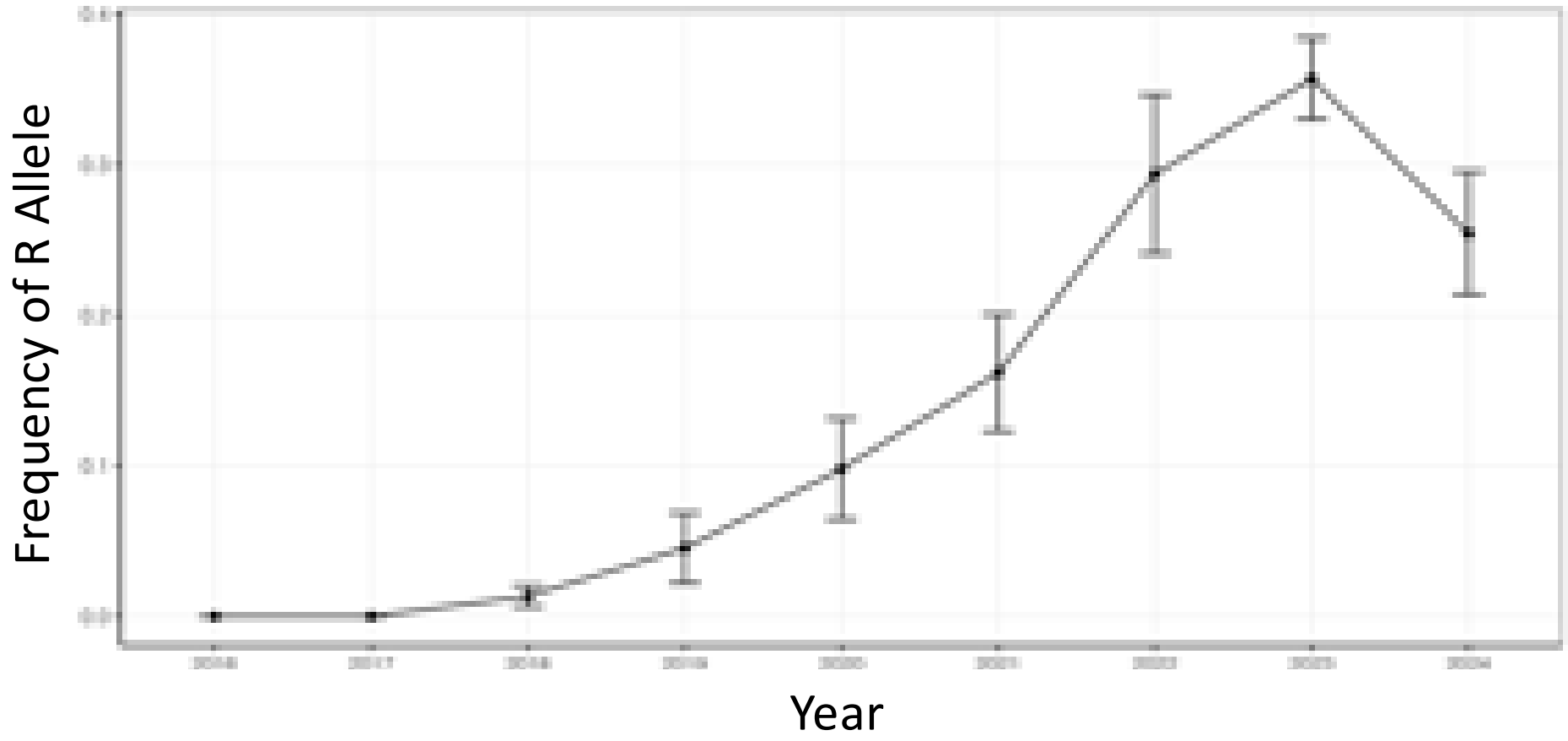
Distribution of kdr alleles in Wake County



- No kdr in 2016
- Emerged in center of county in 2018
  - Wealthy neighborhoods
- KDR Spread quickly and rose in frequency

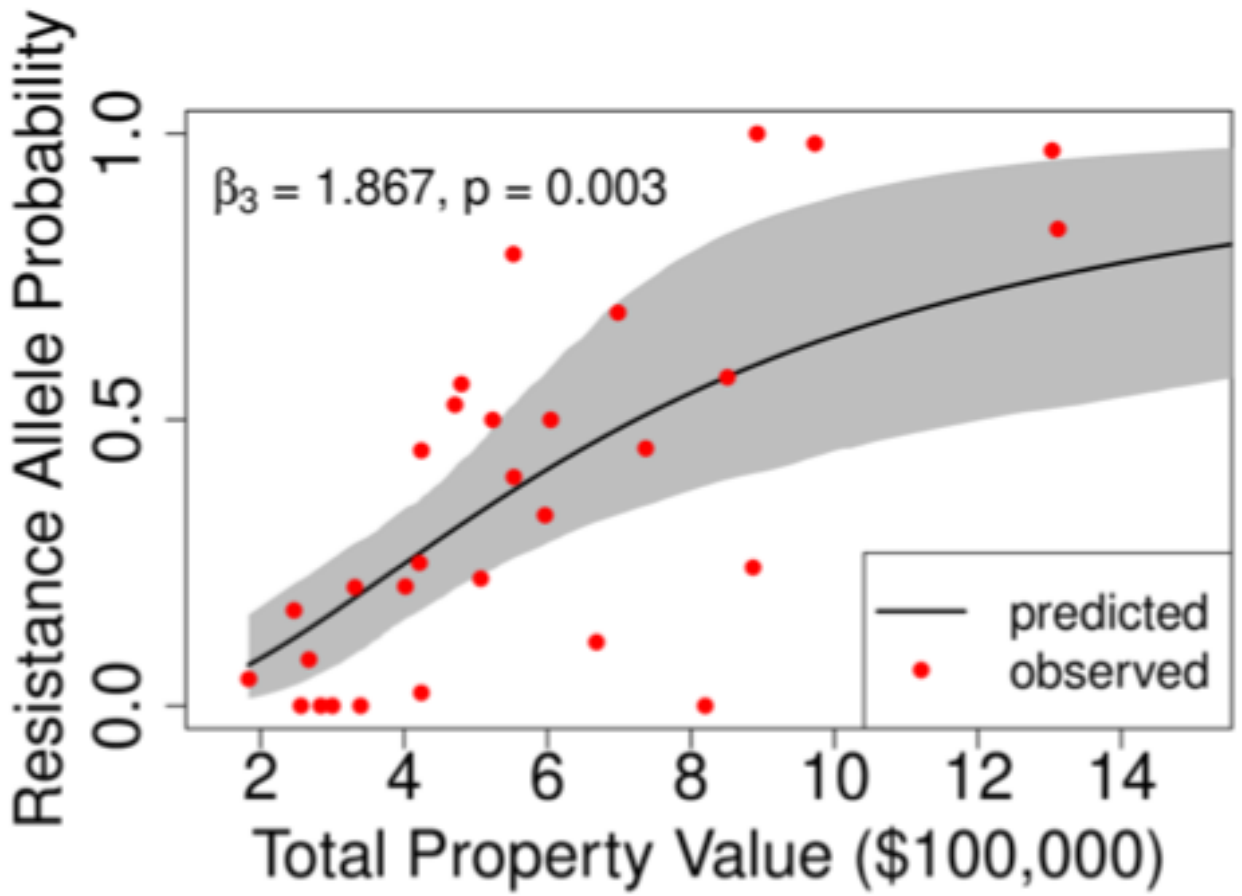
Baltzegar *et al.* 2026. Parasites Vectors

KDR Frequency: 2016 - 2024



Baltzegar *et al.* 2026. Parasites Vectors

KDR higher in wealthy neighborhoods

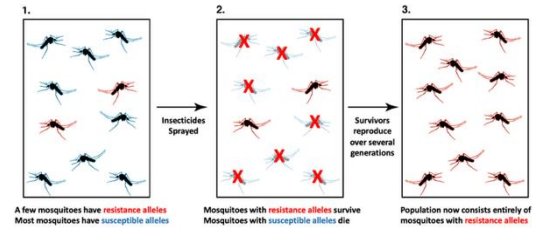


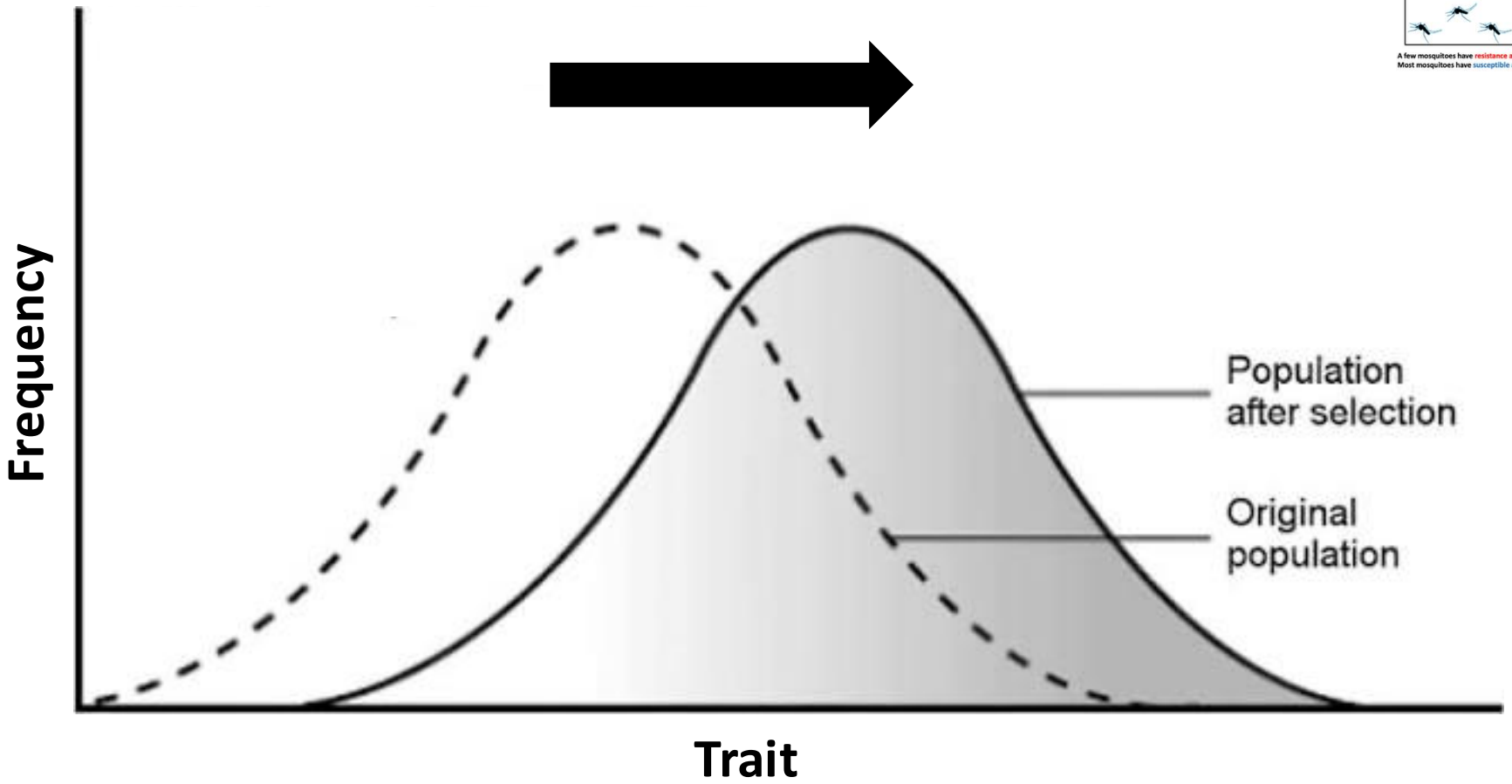
KDR frequency can be predicted by Total Property Value

Butler *et al.* 2026. R. Soc. Open Sci.

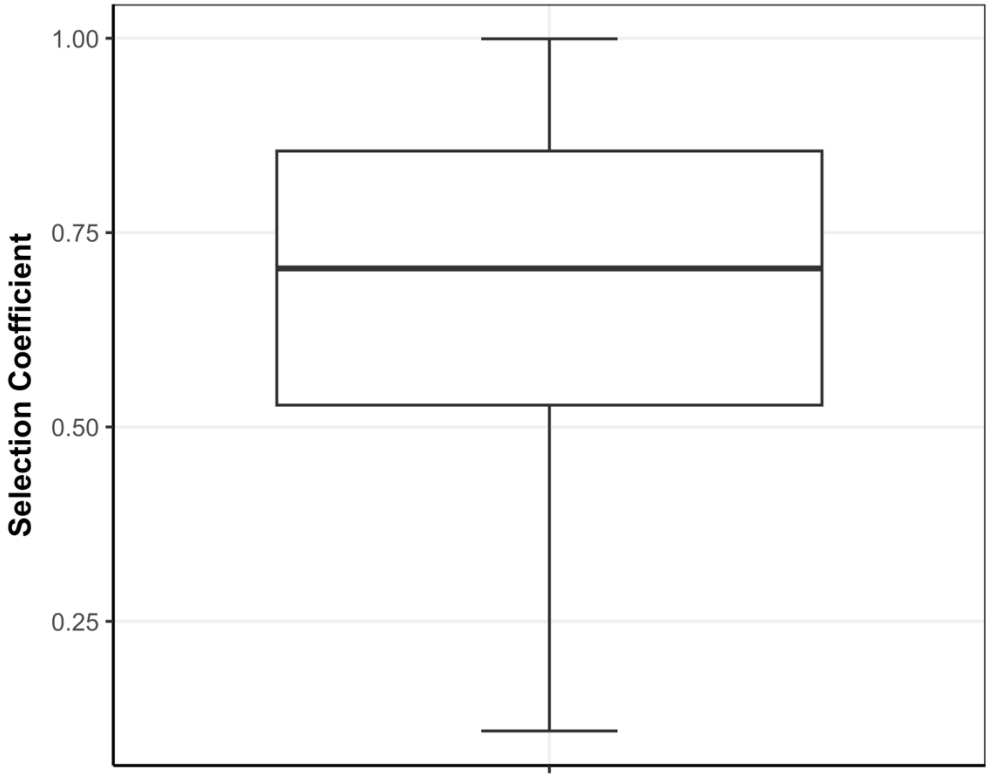
How selection pressure affects increase of KDR

Directional Selection





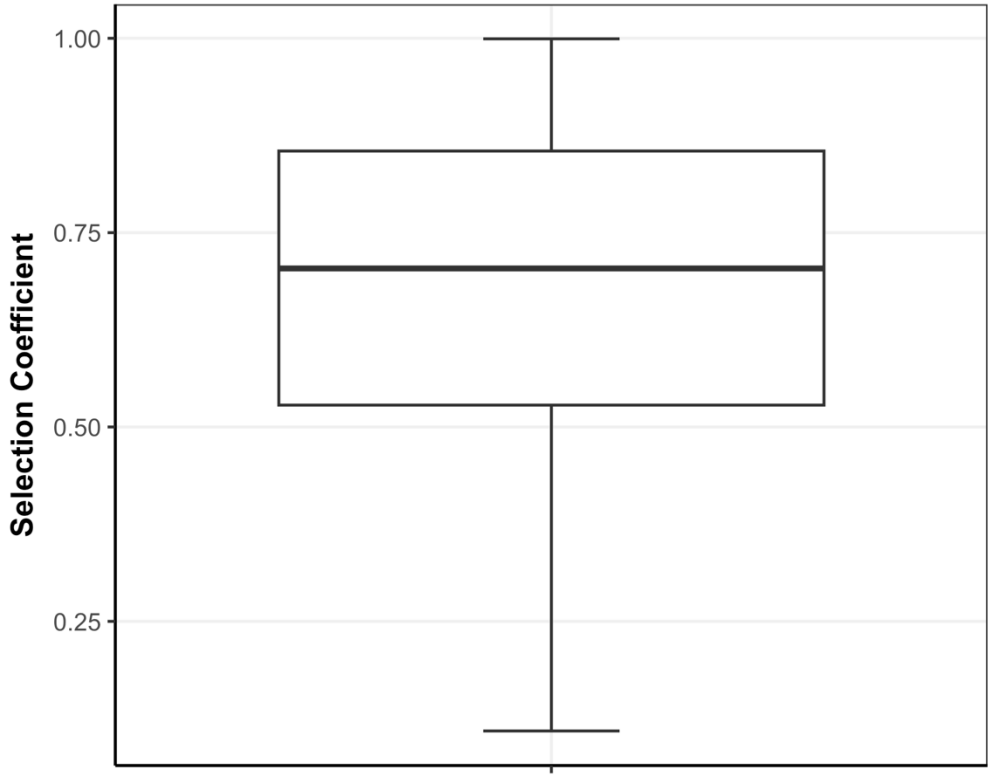
Selection intensity of F1534S



- Selection coefficients (s) are related to relative fitness between alleles.

- s = 0, no selection pressure
- s = 1, complete selection pressure

Selection intensity of F1534S



Selection for resistance mutation is *very* high

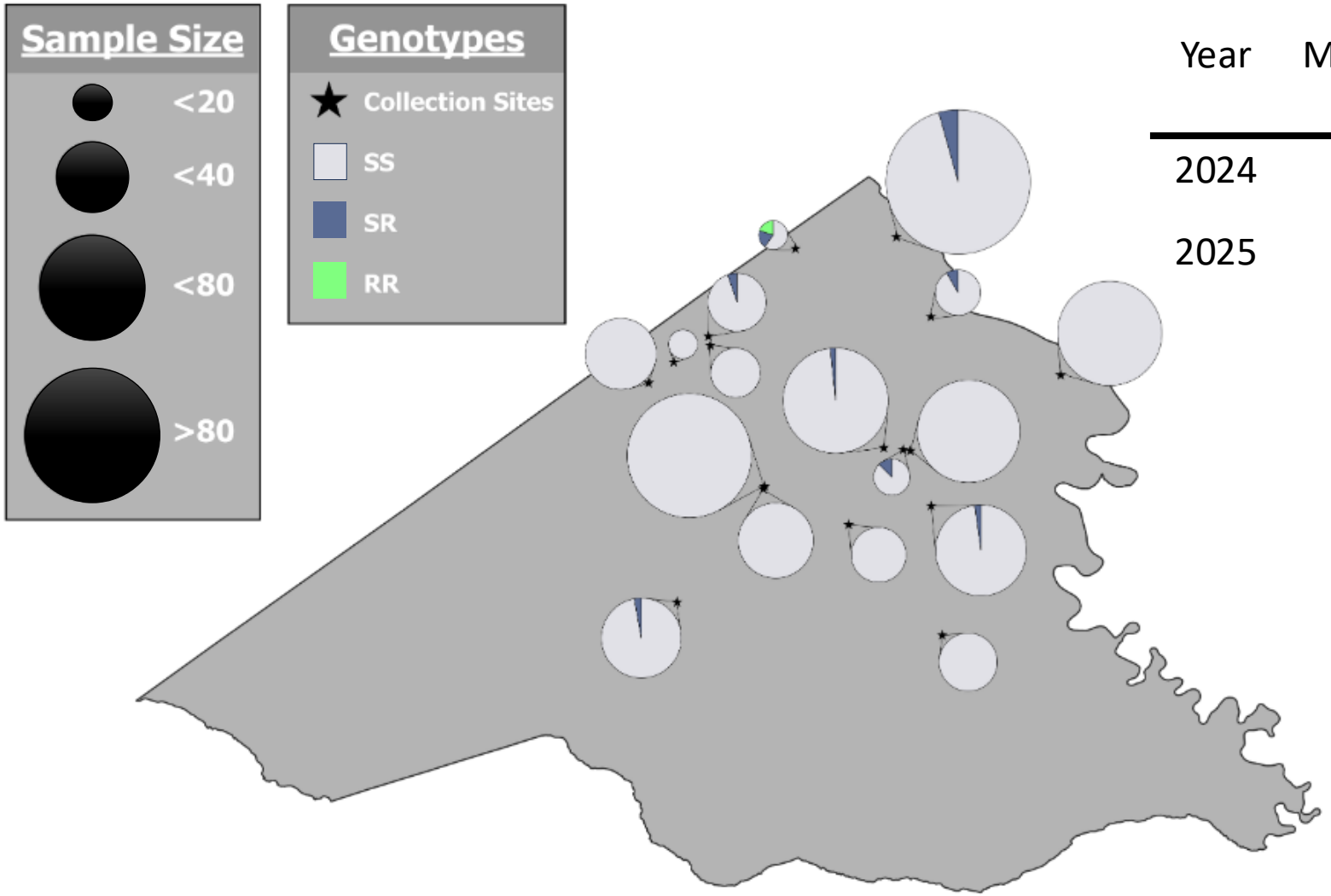
What about Georgia?



- Started at Augusta University
  - Fall 2024
- Collaboration with Richmond County Mosquito Control Department
- Sample 16 sites total sampled bi-weekly
  - 8 on alternating weeks
- Private + Public mosquito control

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KDR in Augusta, GA



Year	Mosquitoes (n)	Frequency of R	95% CI Lower	95% CI Upper
2024	40	0.013	0.002	0.067
2025	565	0.012	0.007	0.020

- KDR present at low freq.
  - Most heterozygous
- KDR higher in more densely populated regions
- Standing genetic variation?

Conclusions

- Once emerged KDR increases in frequency and spreads rapidly
  - With continued pyrethroid use
- F1534S is a sentinel allele
  - Warns that resistance is building
  - Monitoring for this allele is relatively easy
  - Chemicals remain effective



Thank you!

- Augusta University
  - Jamesia Henderson
  - Ant Jones
  - JT Wicker III
  - Erin Pryzwara
  - Kierra Dennison
  - Aiden Srull
- RCMCD
  - Mindy Kruty-Crothers
  - Shelby Durkin
  - Sean Durkin
  - Joel Marlow
- NCSU
  - Martha Burford Reiskind
  - Michael Reiskind
  - Cole Butler (now @ UGA)
  - Jessica Ding



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