The role of environmental temperature and larval habitat on mosquito ecology: From the lab to the backyard

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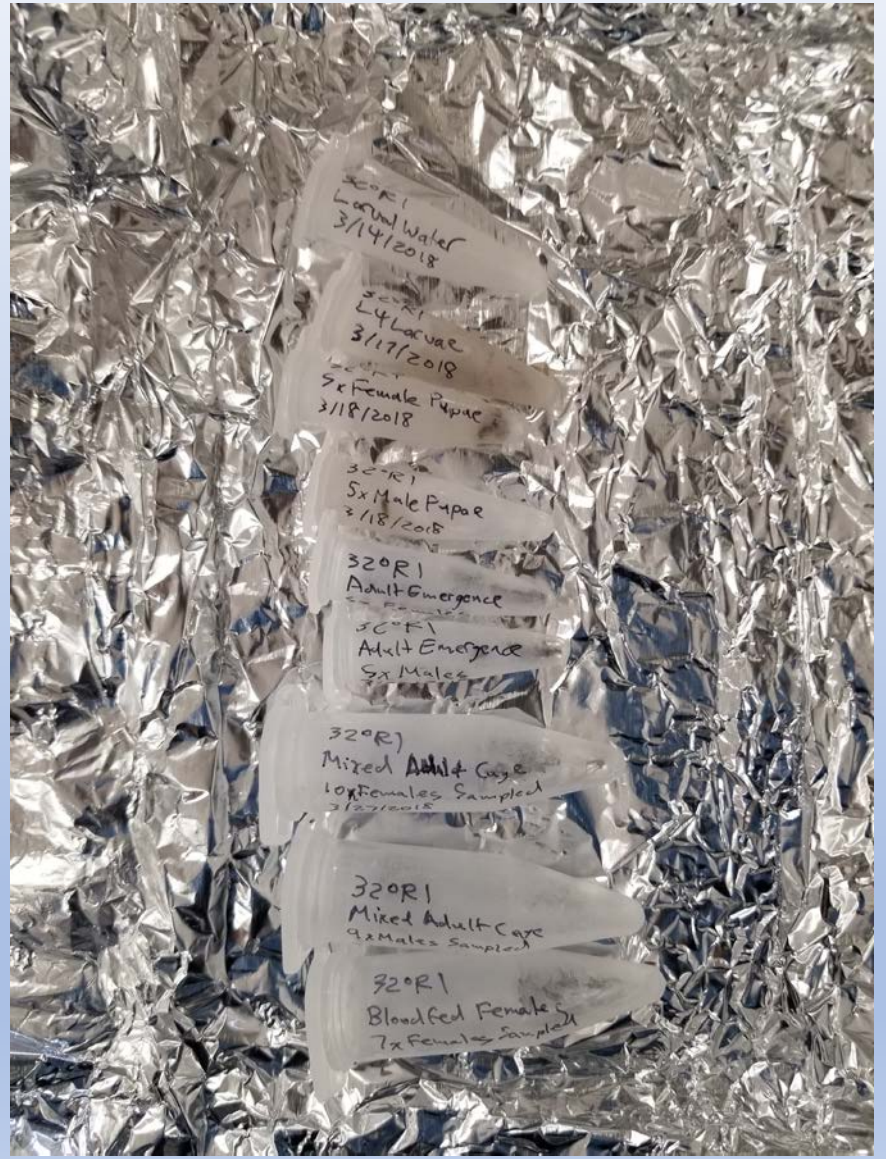
Interdisciplinary Disease Ecology Across Scales

Microbiome

- Why is this important?
- Environmental variables matter for disease transmission
- Abiotic factors (humidity, temp, precipitation) well established as important variables
- Biotic factors are underexplored in their role for disease transmission.



Objectives

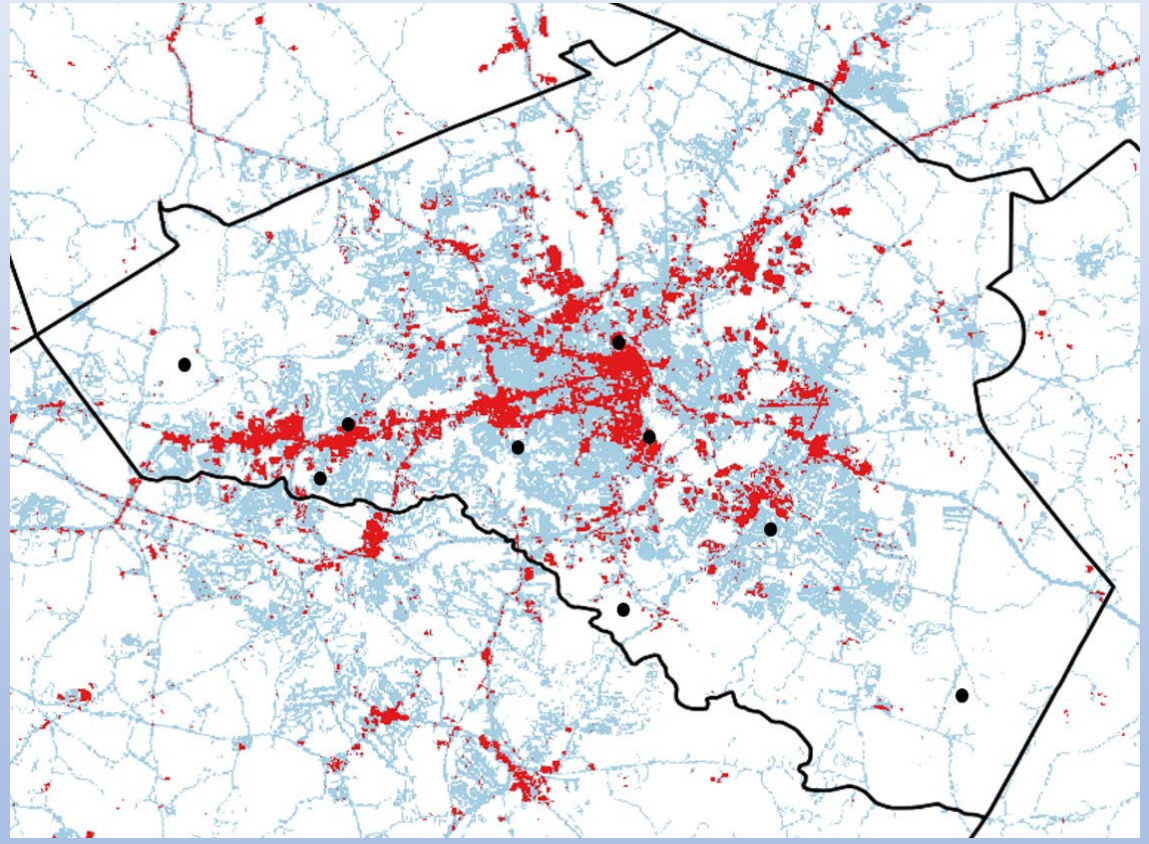
- Connect field data to laboratory temperature results
- Understand larval habitat turnover at the microclimate scale
- Observe implications for mosquito control using life cycle x temperature x larval habitat data.
- Microbial characterization across scales
- Data collection ongoing

Microbiome and Disease Transmission

- MB effects fitness and disease transmission
- MB vary greatly across landscape, lots of variation
- Is there signal in the noise?
- We could failing to explain heterogeneity in transmission if we ignore this biotic factor that is important to mosquito transmission.

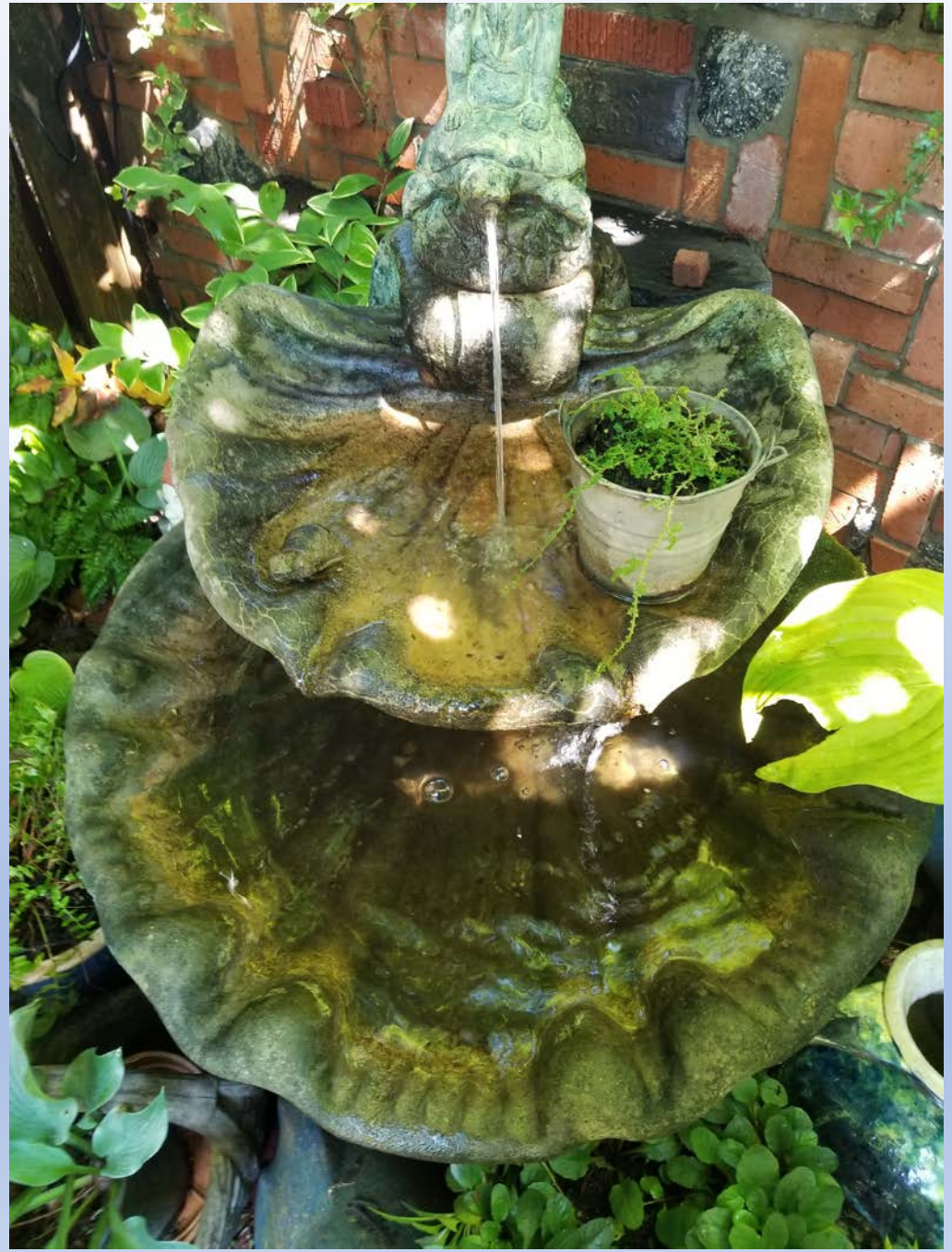
Athens Field Project

- 9x sites around Athens sampled for larvae
  - 3x rural sites
  - 3x suburban sites
  - 3x urban sites
- Sites classified by prevalence of impervious surfaces

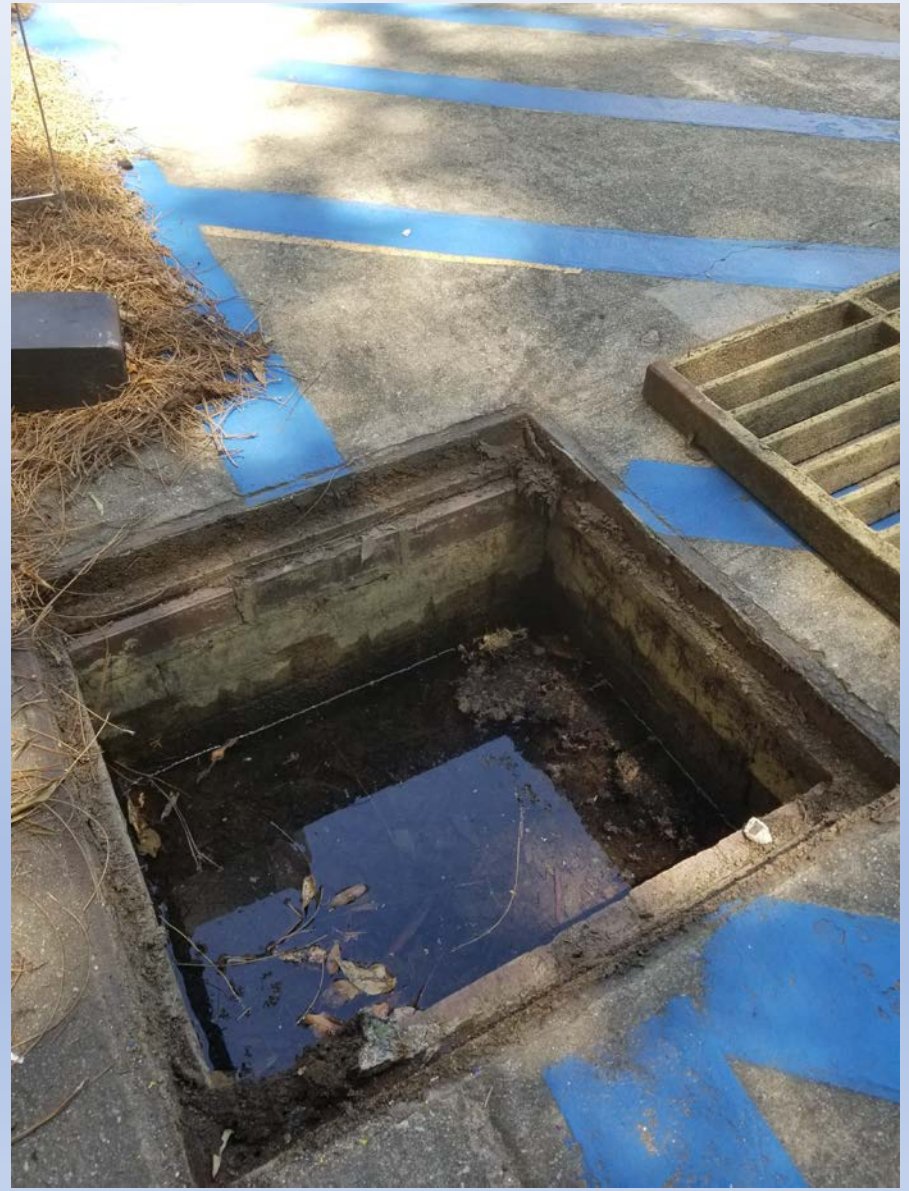


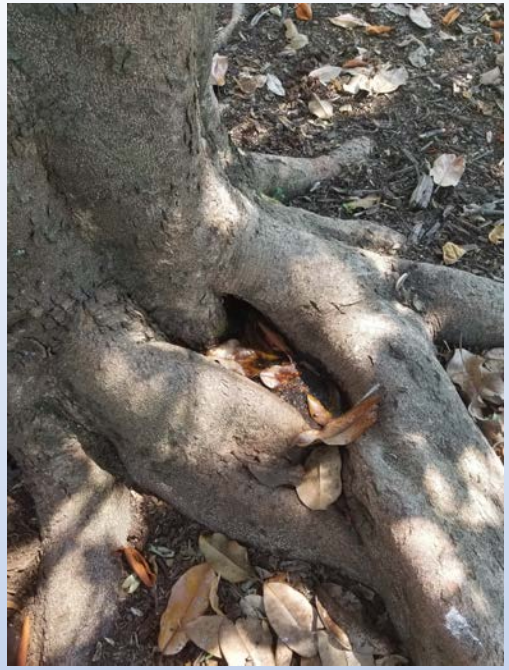
What is a larval habitat?

- Container breeders
- Tree holes
- Discarded Equipment
- Waste
- Still water
- Wide variety of habitats crossing land uses (urban-suburban-rural)
- Surveillance exposes cryptic locations



Urban Examples





Suburban

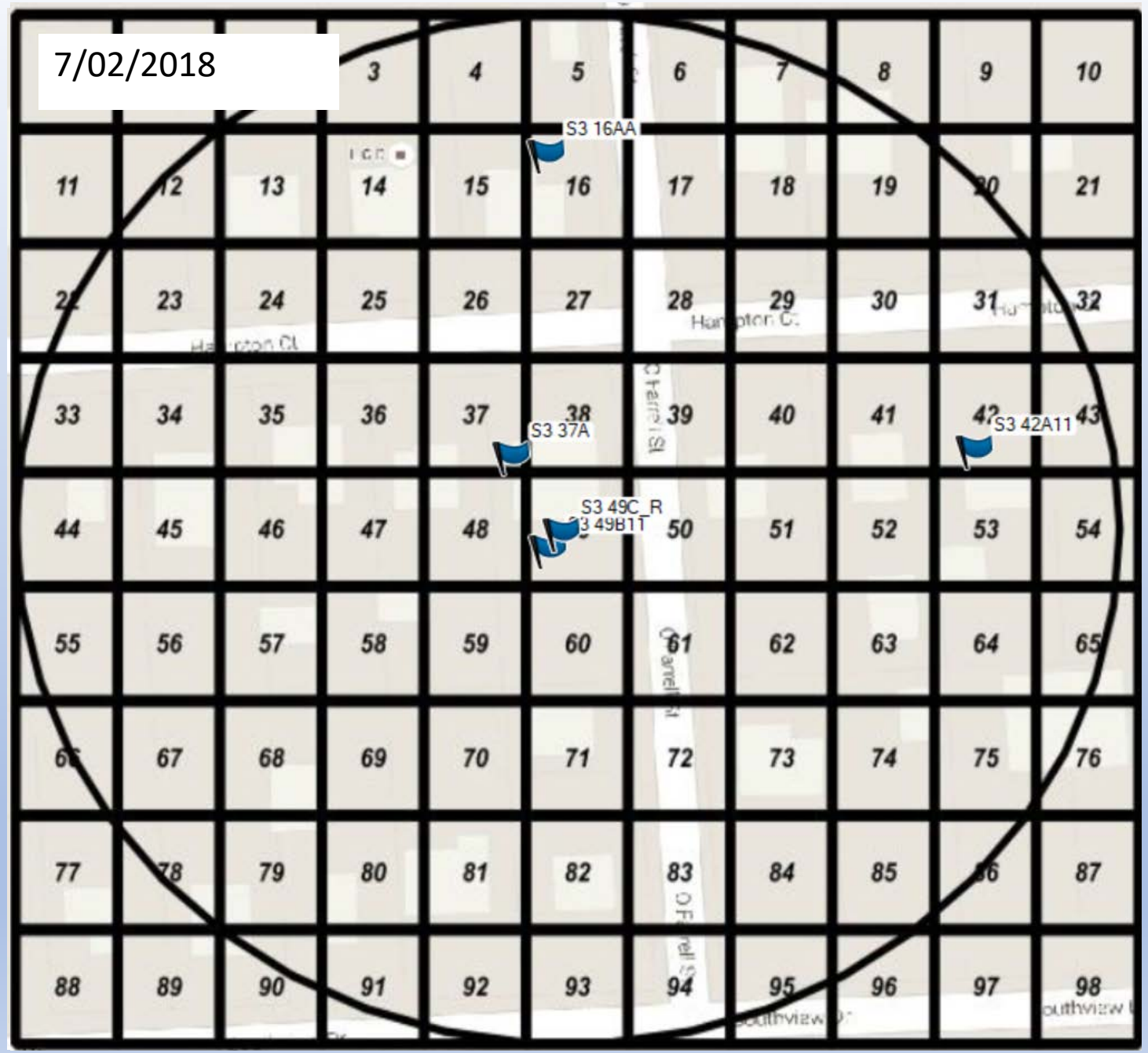
Rural

Habitat Turnover at the Backyard Scale

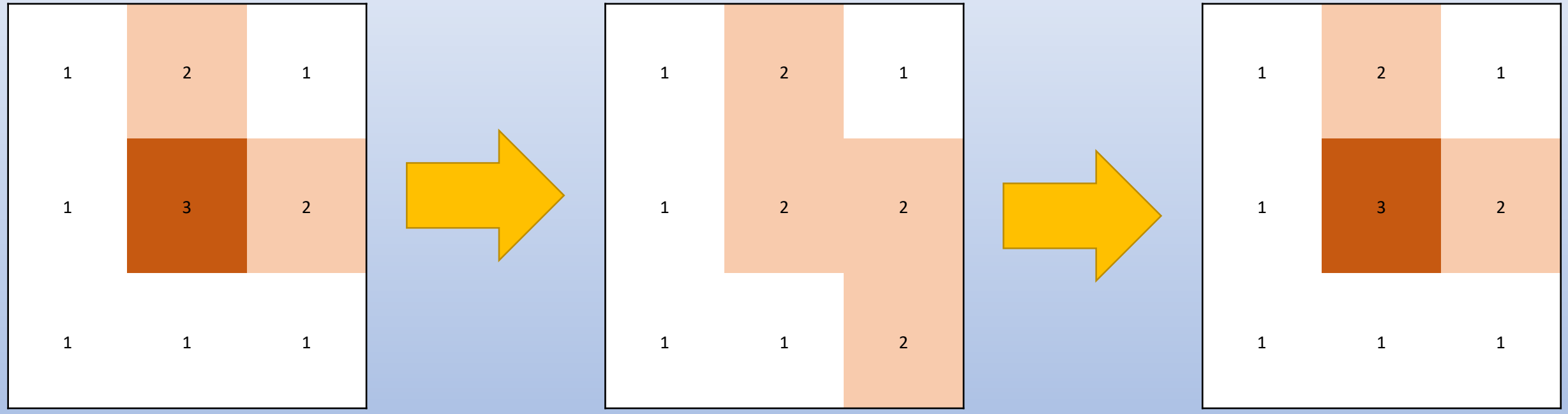
- Rapid turnover due to the environment (tipped over, dries up)

Habitat Turnover

- Example Suburban Site
- Most habitats are flower pots, plastic jars
- Sampling effect: surveillance efforts expose habitats, landowners destroy habitats



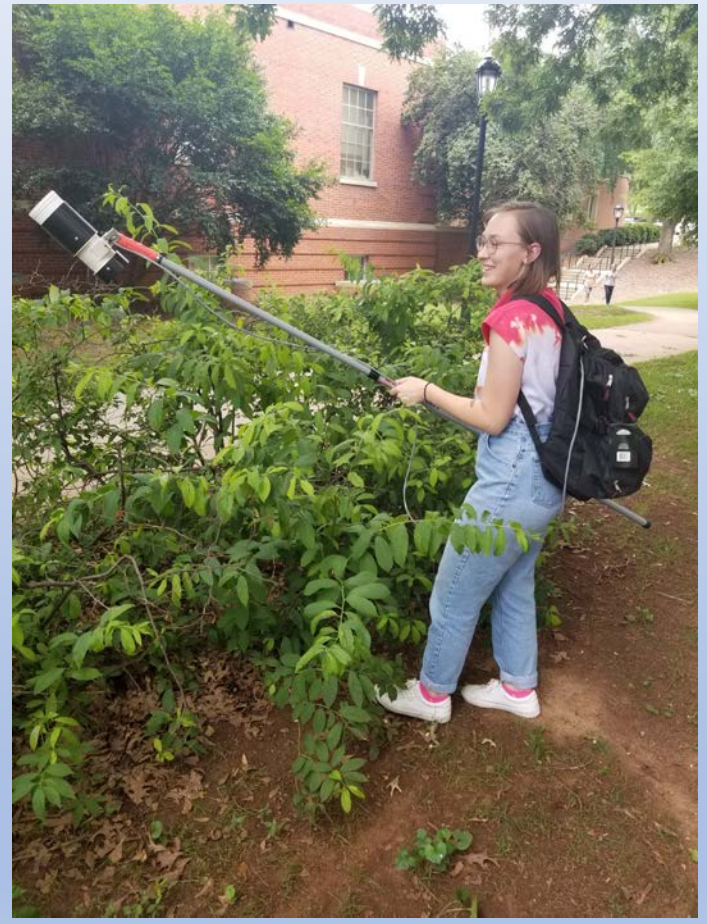
Modelling Habitat Turnover



Parameters (following 32 °C Data):
0.93 of larvae pupate
0.86 of larvae emerge as adults
5 days to pupation
6 days to emergence

Adult Surveys

- Targeting *Aedes albopictus* with backpack aspirator
- Mix of sampling in vicinity of oviposition sites, traversing sample site, and capturing landing specimens
- *Aedes albopictus* are preserved for midgut microbiome analysis.



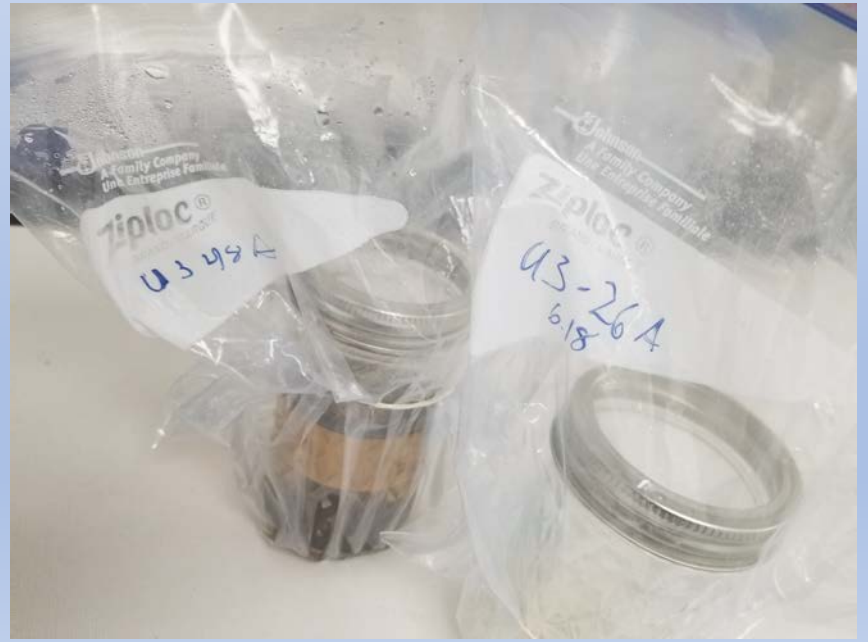
Species Composition

- *Aedes albopictus* is of particular concern.
- Potential vector for arboviruses.

Larval Species Composition

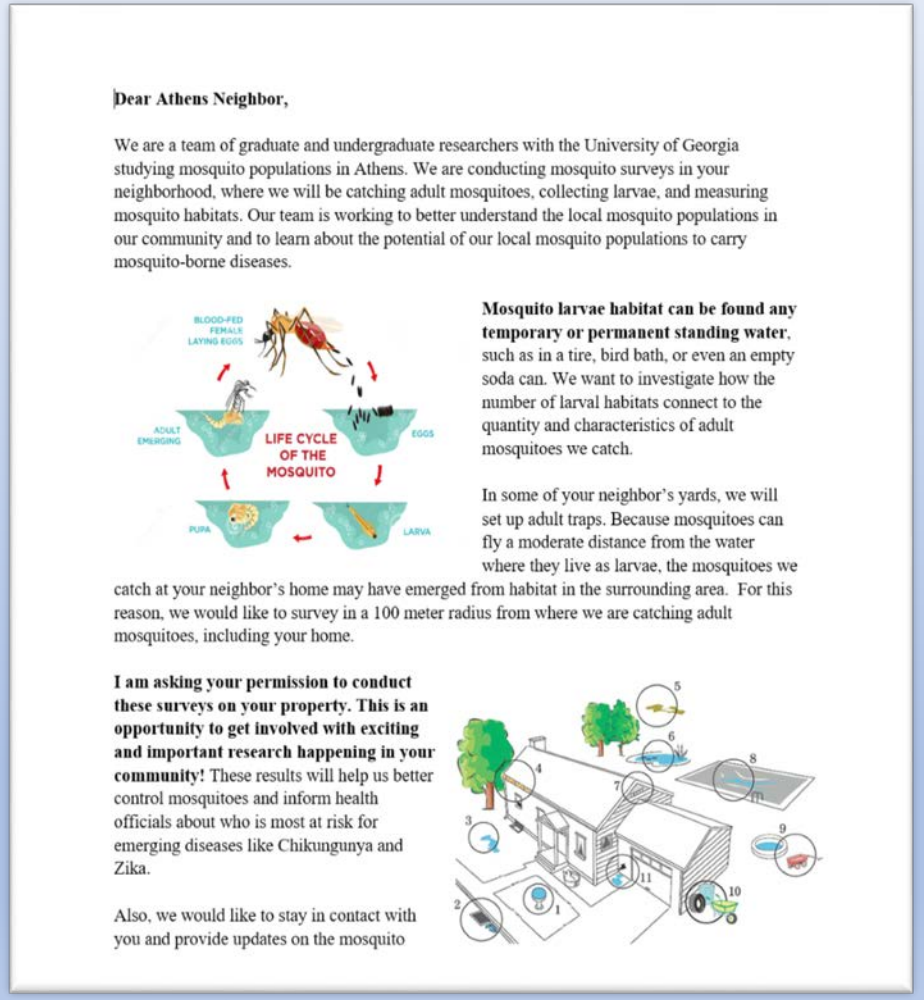
- *Aedes albopictus* larvae subsampled on day of collection, preserved for microbiome analysis
- Rest are reared to adulthood in sealed larval emergence containers.

- *Aedes japonicus* dominant early in summer season, *Aedes albopictus* most dominant mid summer
- Also *Aedes triseriatus*, *Culex quinquefasciatus*, *Toxorhynchites sp*, and *Culex nigripalpus*, and *Culex restuans*



Connection with the General Public

- Keep landowners informed of our activities
- Generate interest by explaining mosquito diversity in the area
- Educate people on potential habitats
- Create a positive image of scientific research in the community.



Dear Athens Neighbor,

We are a team of graduate and undergraduate researchers with the University of Georgia studying mosquito populations in Athens. We are conducting mosquito surveys in your neighborhood, where we will be catching adult mosquitoes, collecting larvae, and measuring mosquito habitats. Our team is working to better understand the local mosquito populations in our community and to learn about the potential of our local mosquito populations to carry mosquito-borne diseases.

Mosquito larvae habitat can be found any temporary or permanent standing water, such as in a tire, bird bath, or even an empty soda can. We want to investigate how the number of larval habitats connect to the quantity and characteristics of adult mosquitoes we catch.

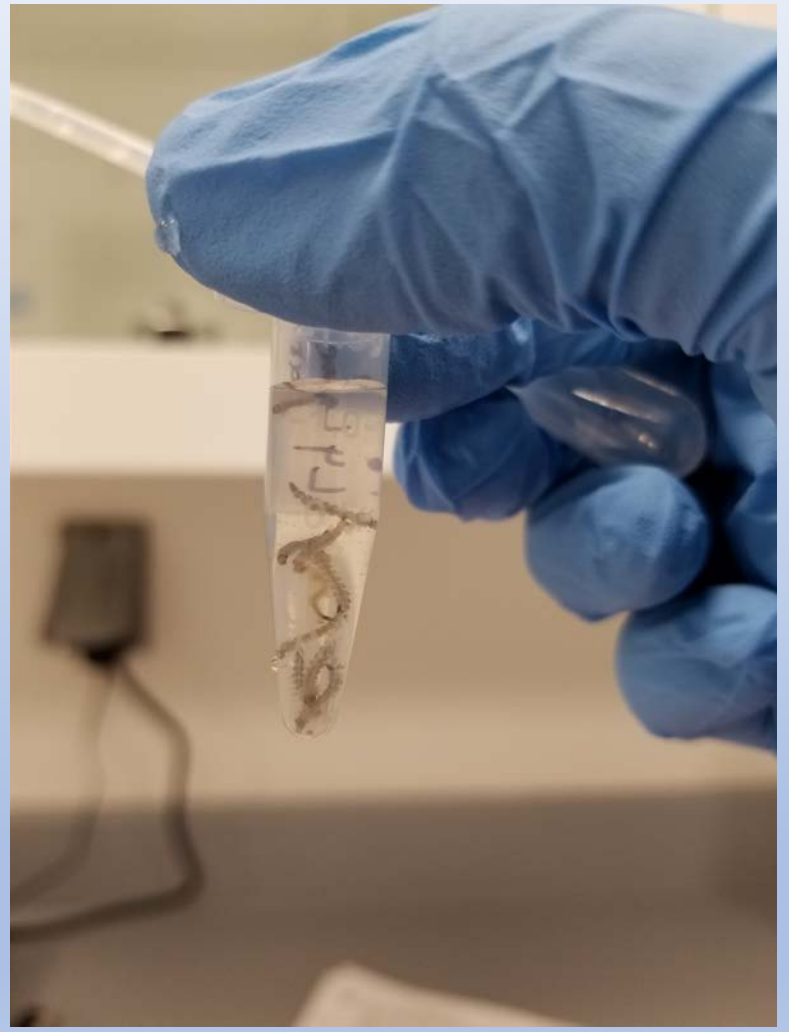
In some of your neighbor's yards, we will set up adult traps. Because mosquitoes can fly a moderate distance from the water where they live as larvae, the mosquitoes we catch at your neighbor's home may have emerged from habitat in the surrounding area. For this reason, we would like to survey in a 100 meter radius from where we are catching adult mosquitoes, including your home.

I am asking your permission to conduct these surveys on your property. This is an opportunity to get involved with exciting and important research happening in your community! These results will help us better control mosquitoes and inform health officials about who is most at risk for emerging diseases like Chikungunya and Zika.

Also, we would like to stay in contact with you and provide updates on the mosquito

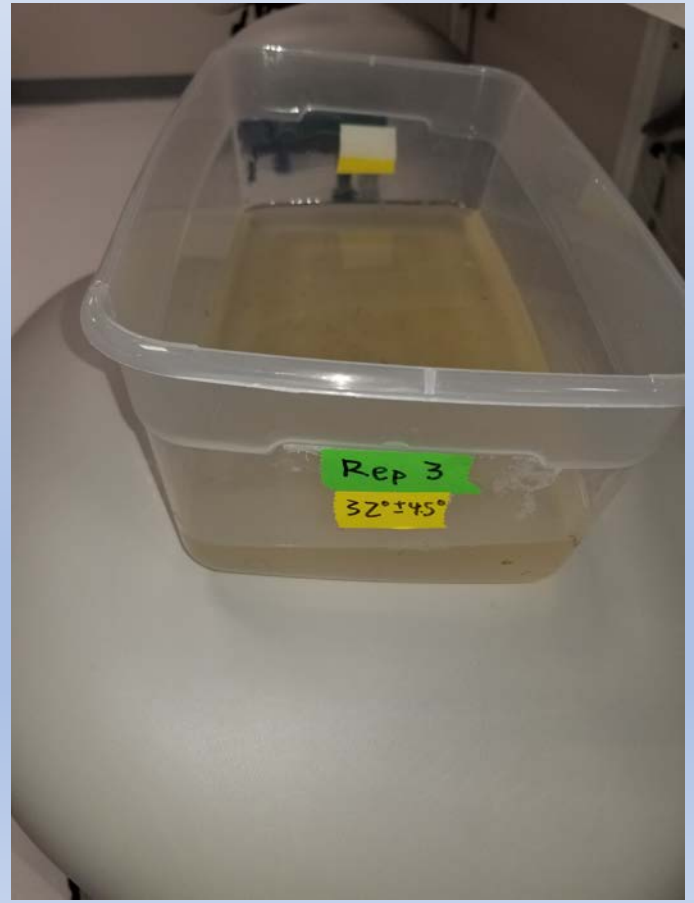
This is where we are going

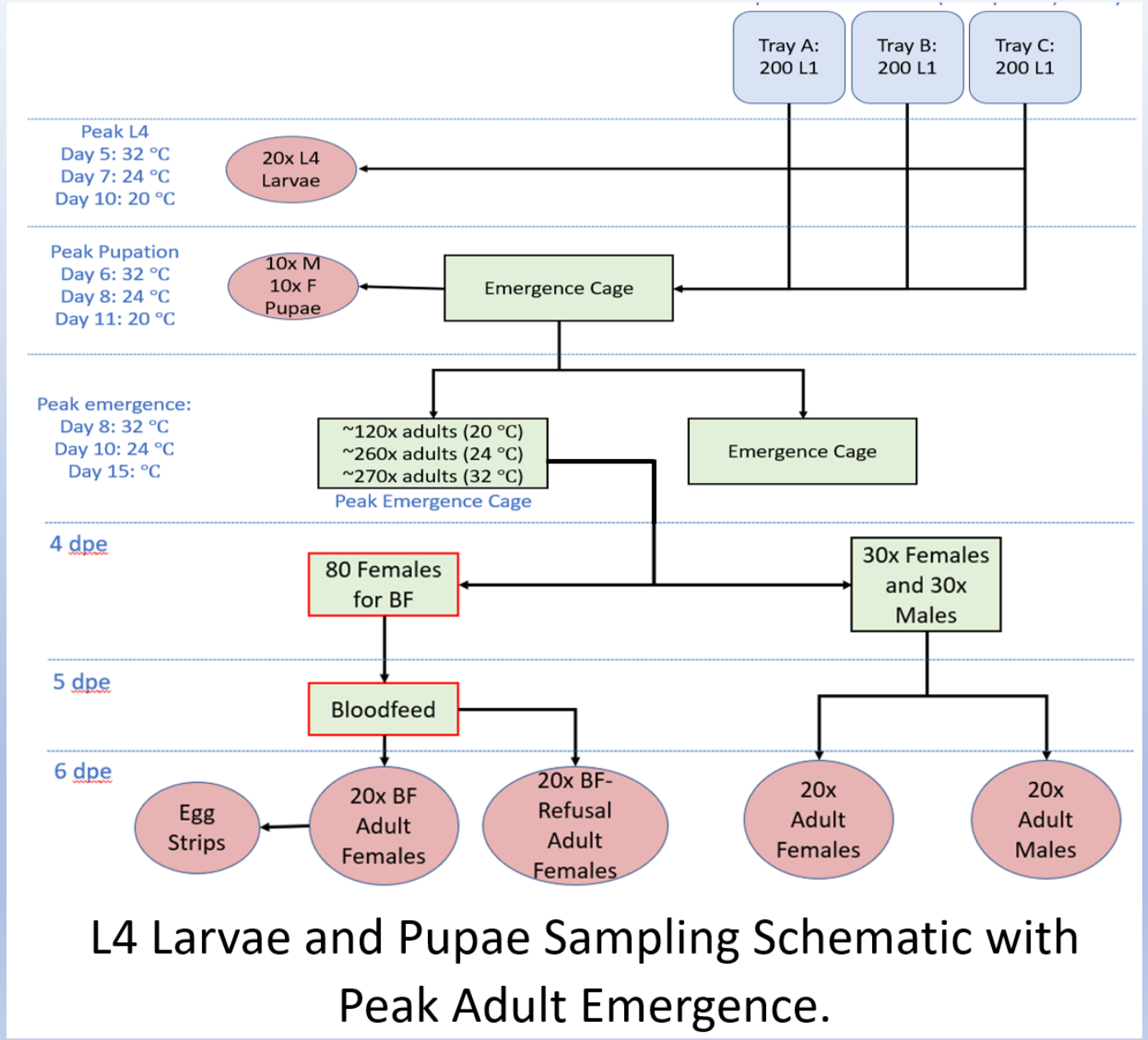
- Preserving microbial communities so we can recreate these microbial habitats in controlled laboratory conditions
- Destructively sample individuals at different life stages so we can identify the MB that colonizes
- This connects to empirical lab work, connecting field surveys with expermiment



Experimental Design

Final Study with 32°C, 24 °C, and 20°C, all with DTR of 9 °C





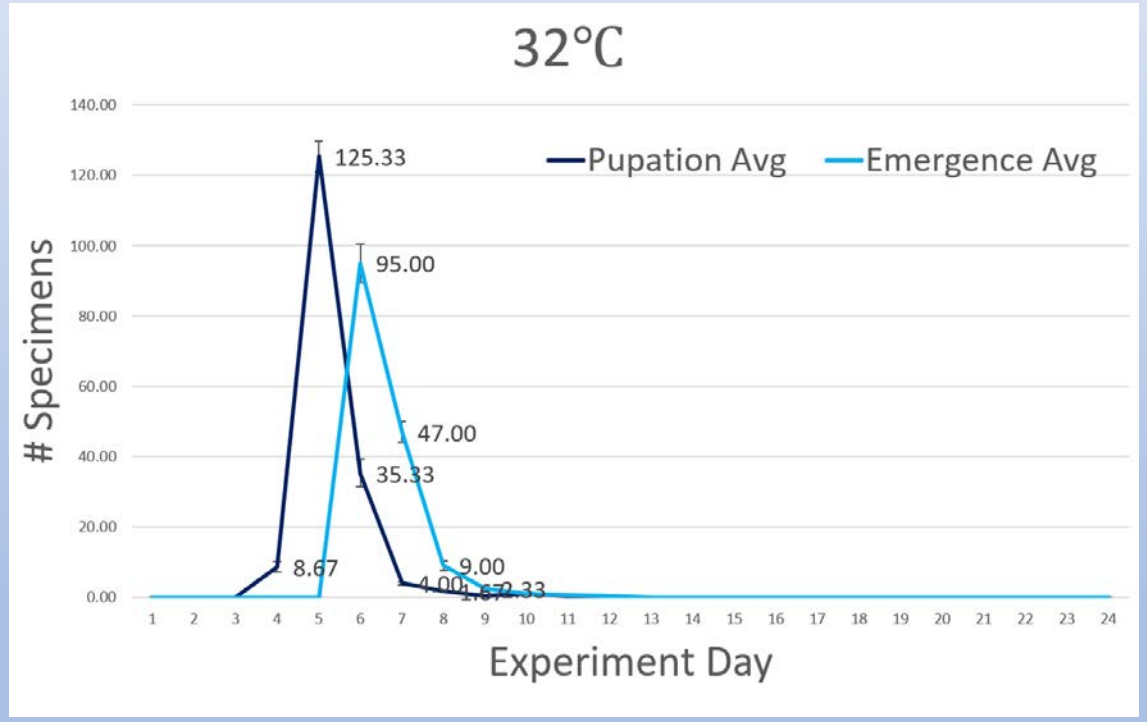
L4 Larvae and Pupae Sampling Schematic with Peak Adult Emergence.

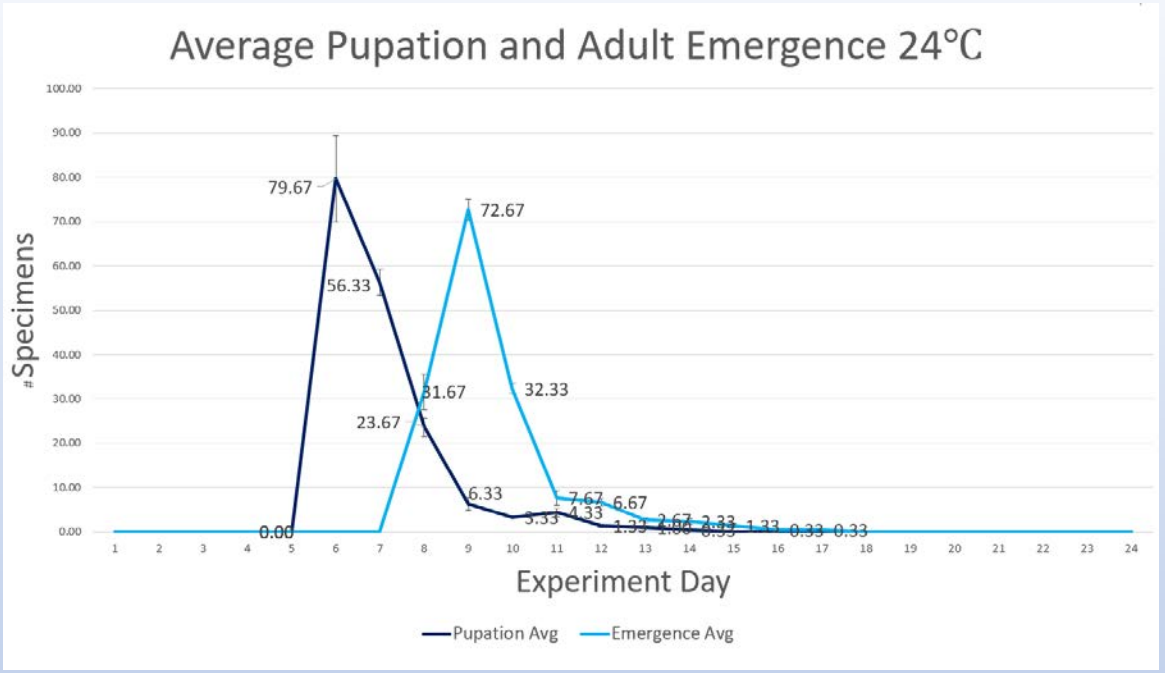
Empirical trials

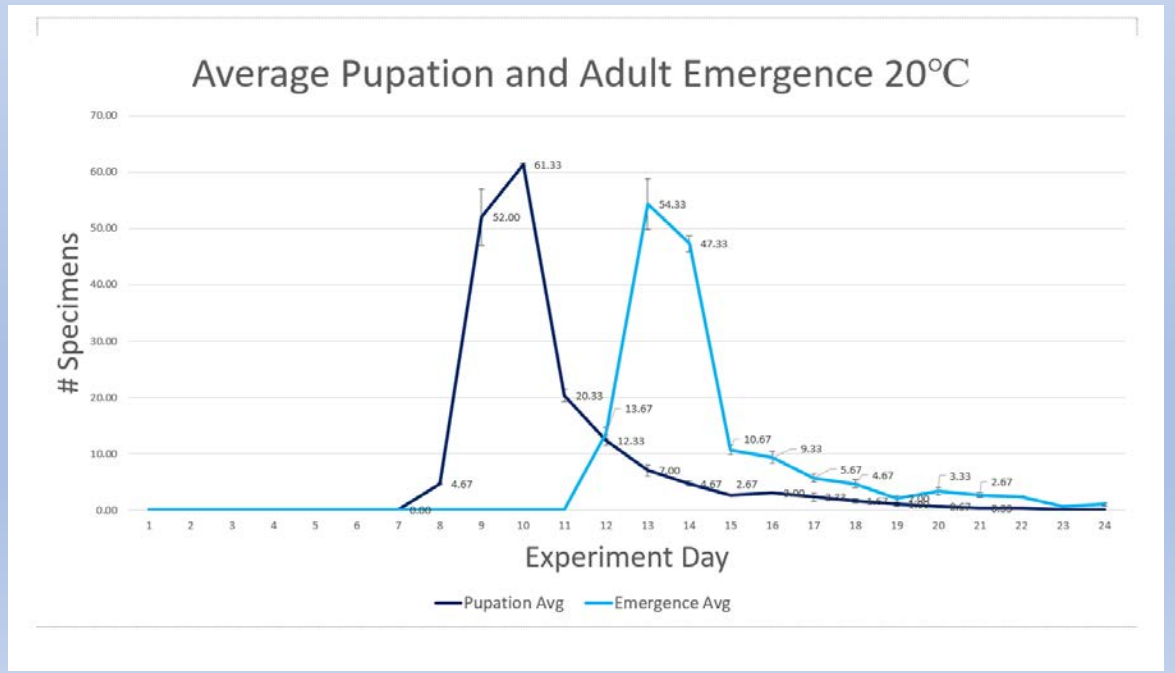
- Use Temperature Fluctuation to simulate realistic conditions for *Aedes aegypti*
- 32°C, 24 °C, and 20°C
- Use Parton Logan Model

20±4.5℃.			24±4.5℃			32±4.5℃		
STEP	TIME	TEMP	STEP	TIME	TEMP	STEP	TIME	TEMP
1	0	21.0	1	0	21.0	1	0	29.0
2	6	20.0	2	6	20.0	2	6	28.0
3	9	25.3	3	9	25.3	3	9	33.3
4	11.5	28.2	4	11.5	28.2	4	11.5	36.2
5	13	29.0	5	13	29.0	5	13	37.0
6	14	29.0	6	14	29.0	6	14	37.0
7	15.5	28.2	7	15.5	28.2	7	15.5	36.2
8	18	25.3	8	18	25.3	8	18	33.3
9	20	23.1	9	20	23.1	9	20	31.1
10	22	21.8	10	22	21.8	10	22	29.8

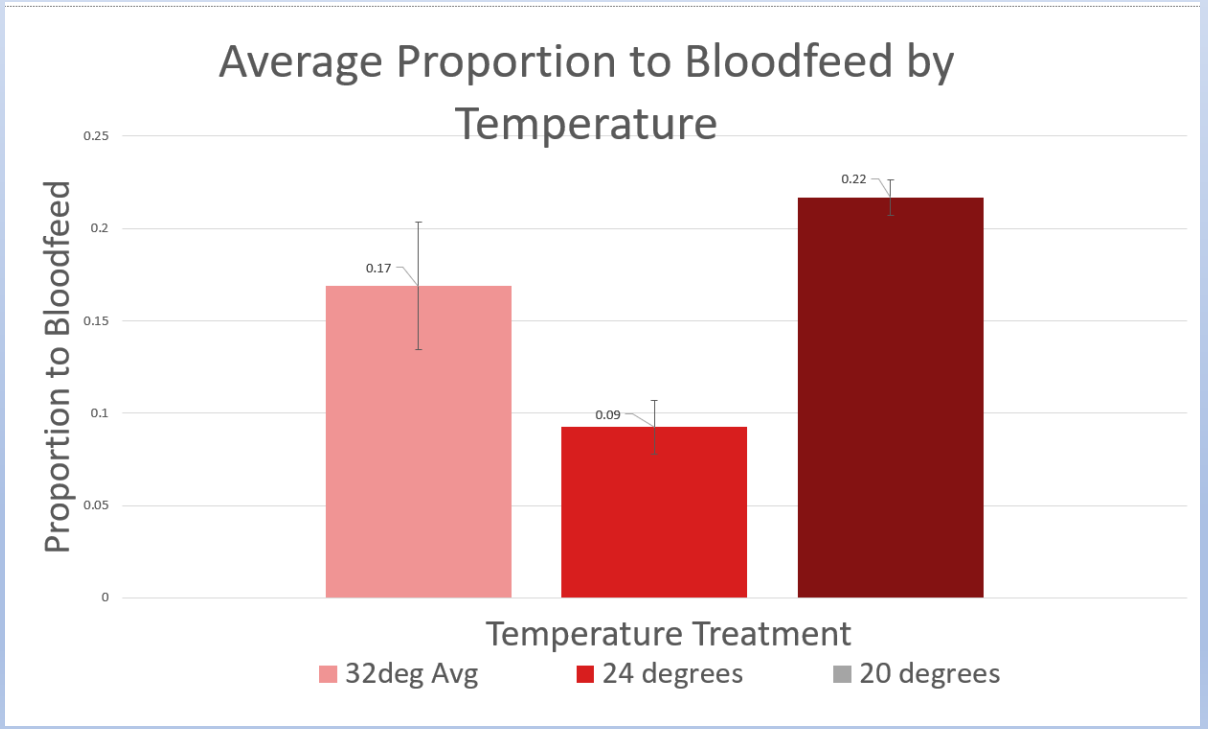
Temperature Treatments and Pupation/Emergence for *Aedes aegypti*

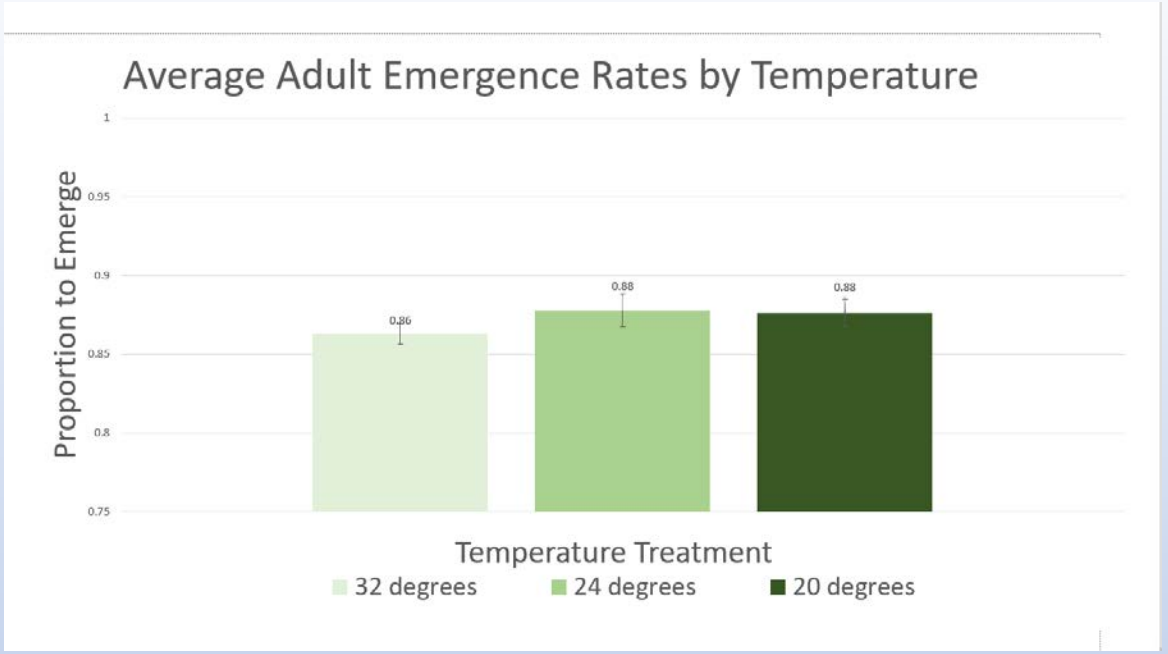


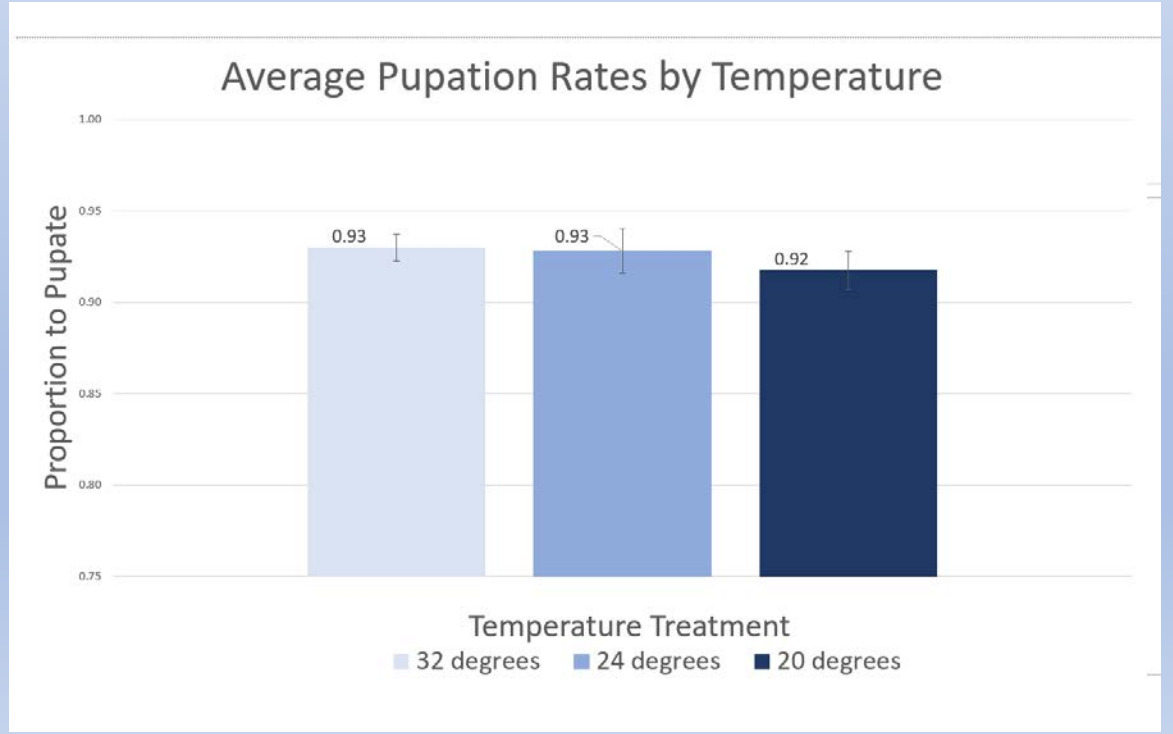




Temperature Treatments and Average Pupation-Emergence-Bloodfeed Rates for *Aedes aegypti*







What does this mean for our backyard data?

- Hypothesize that warmer temps may allow for Aedes albopictus to succeed in a larval environment before it dries or is dumped.
- Warmer temperatures may lead to faster evaporation
- May counteract this effect
- Avenue for further investigation

Microbiome Investigation

- This is a work in progress
- 16S rRNA microbial analysis ongoing for the temperature fluctuation lab trial
- Specimens for the field surveys pending
- Next step is recreate larval habitats in lab

Questions?