

Eradication efforts and research successes (and failures) in the ongoing battle against the Asian longhorned beetle in South Carolina

SREF Forest Health Webinar Series

25 September 2024

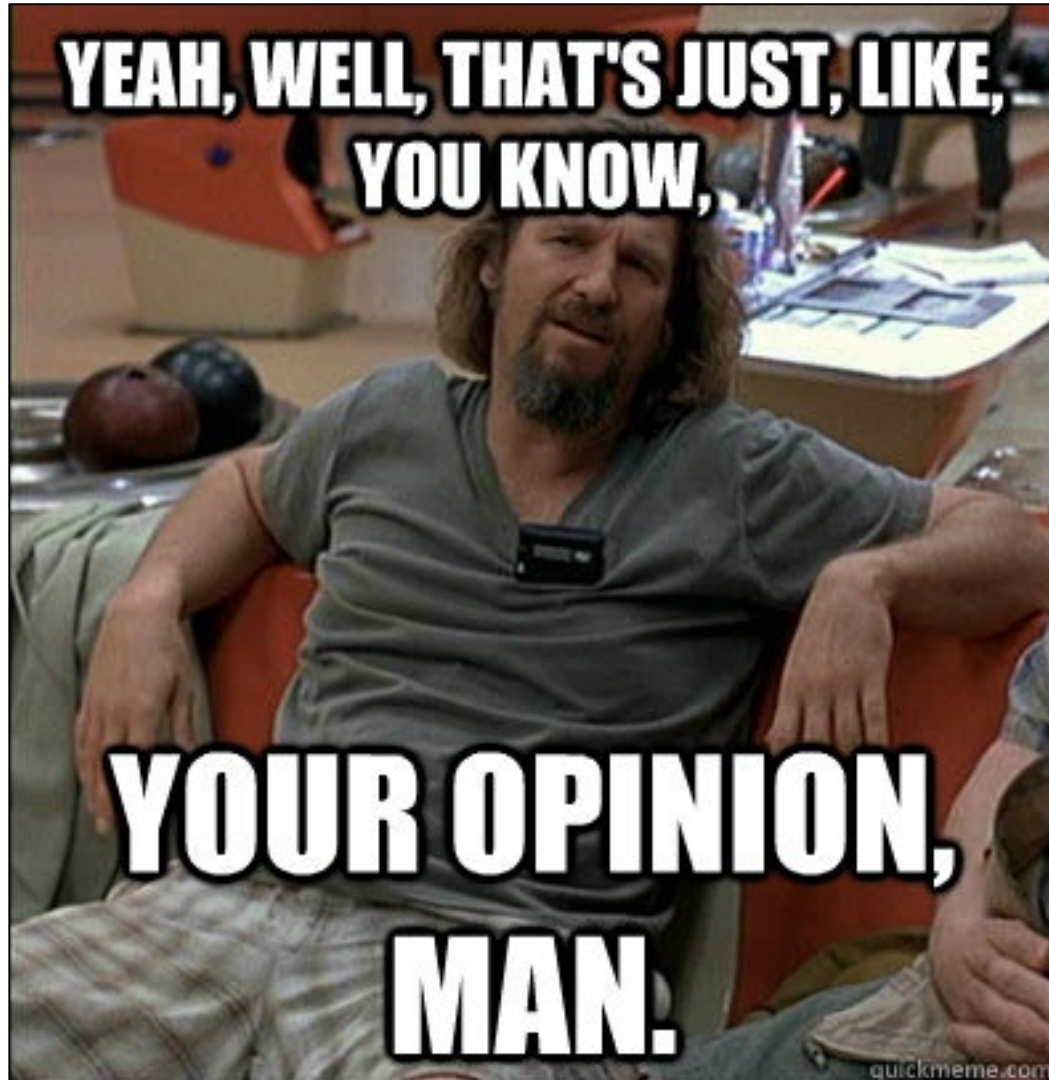
Dr. Dave Coyle

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@drdavecoyle

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But first...a disclaimer...



SC ALB Research Program Overview

Dr. Dave Coyle
Clemson University

Technicians

Katy Crout Moretti '21-now
Robert Ritger '21-'22
Alex Helman '21
Crystal Bishop '22-'23
Caleb Davis '24-now



Postdoc

Dr. Ethan Doherty '24-now

M.S. students

Meredith Bean, M.S. '22
Lena Schmitt, M.S. '23
Marina Lupu, M.S. '24
Lindsey Stone, M.S. exp. '25

Dr. Kelly Oten
NC State University

M.S. students

Abby Ratcliff, M.S. '22

PhD students

Kristin Hilborn, exp. '25
Courtney Johnson, exp. '26



ALB interns

Millar Elferdink '22
Beth Peebles '23
Nathan Rumph '23
Will Scheper '24



Asian longhorned beetle

(*Anoplophora glabripennis*)

Native to Asia

Highly polyphagous

Eradication efforts

Large, bluish feet

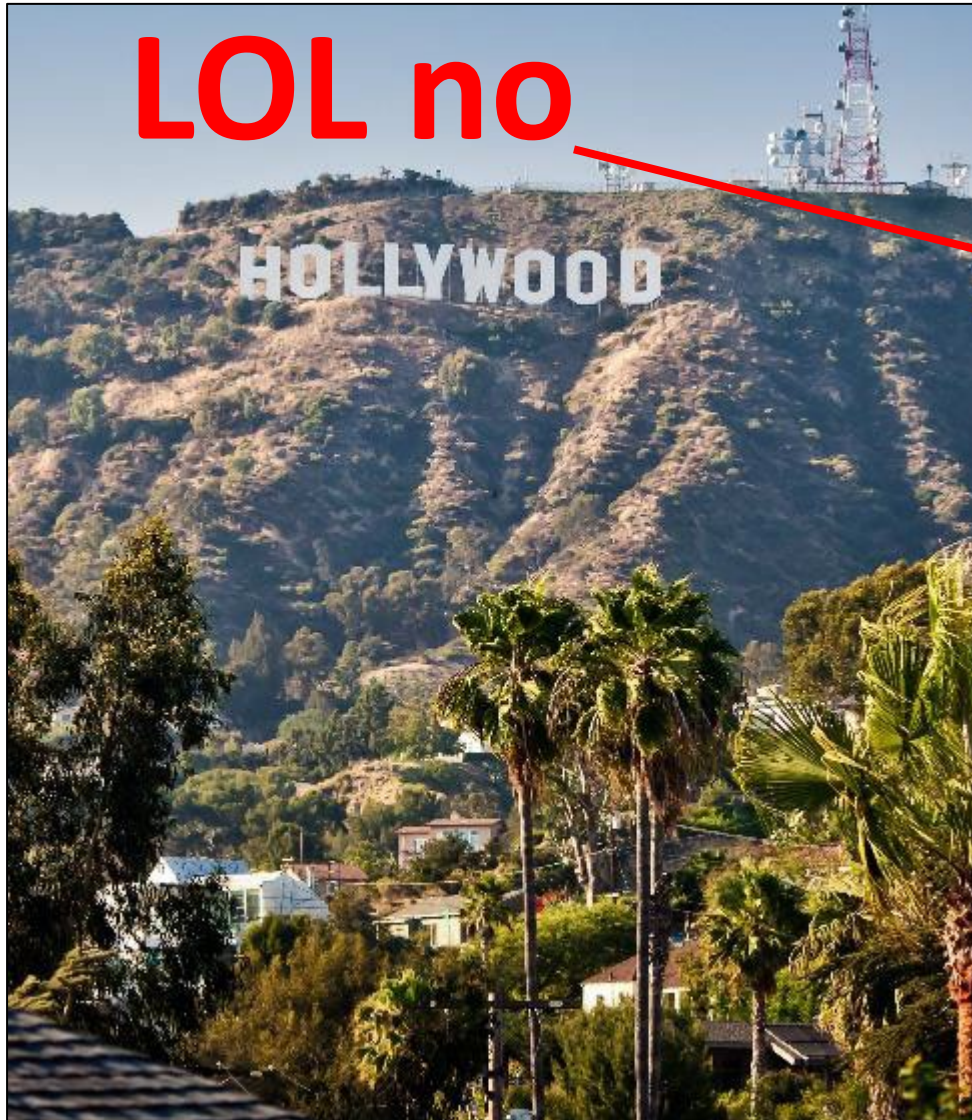
White bands on antennae



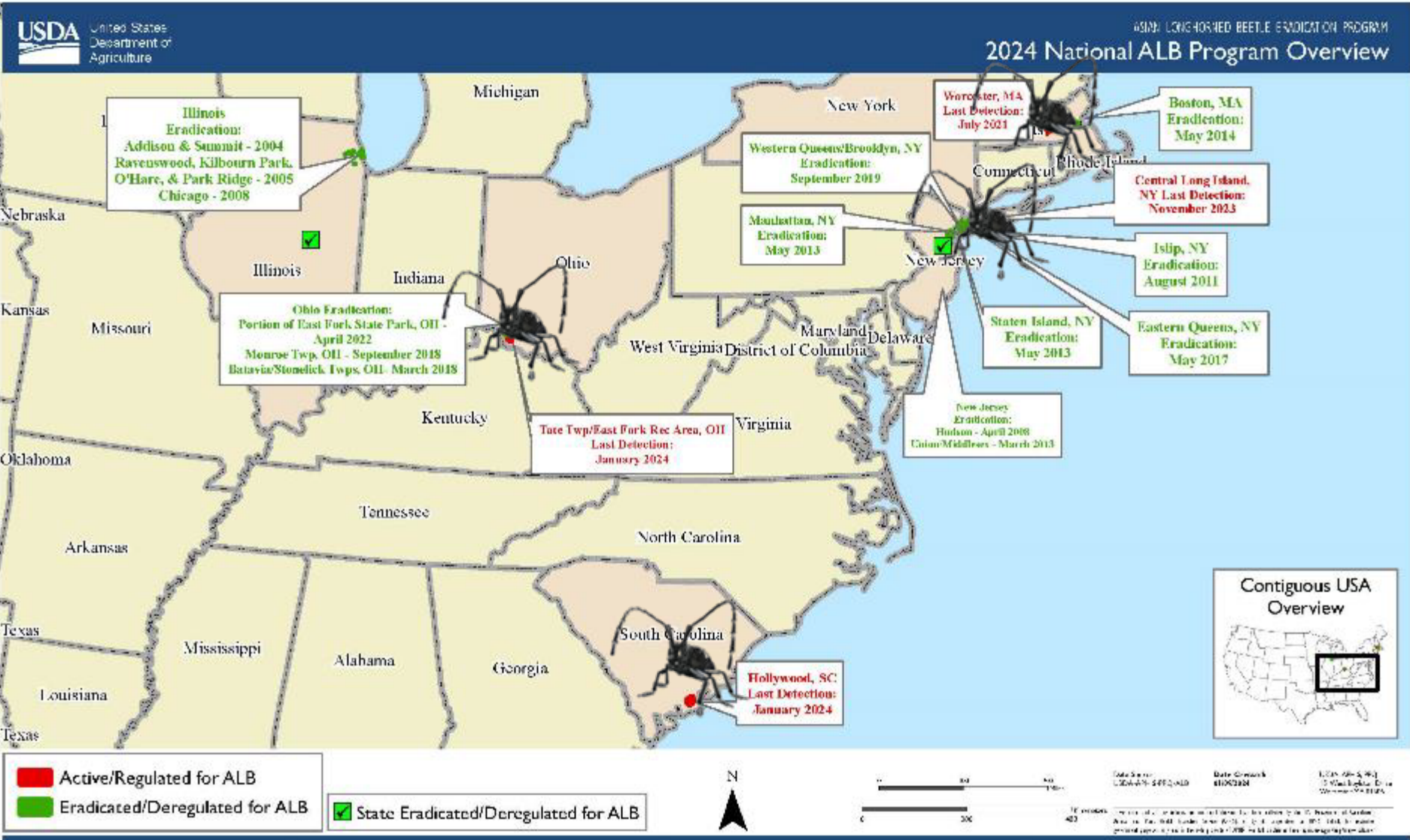
ALB – found in SC in May 2020



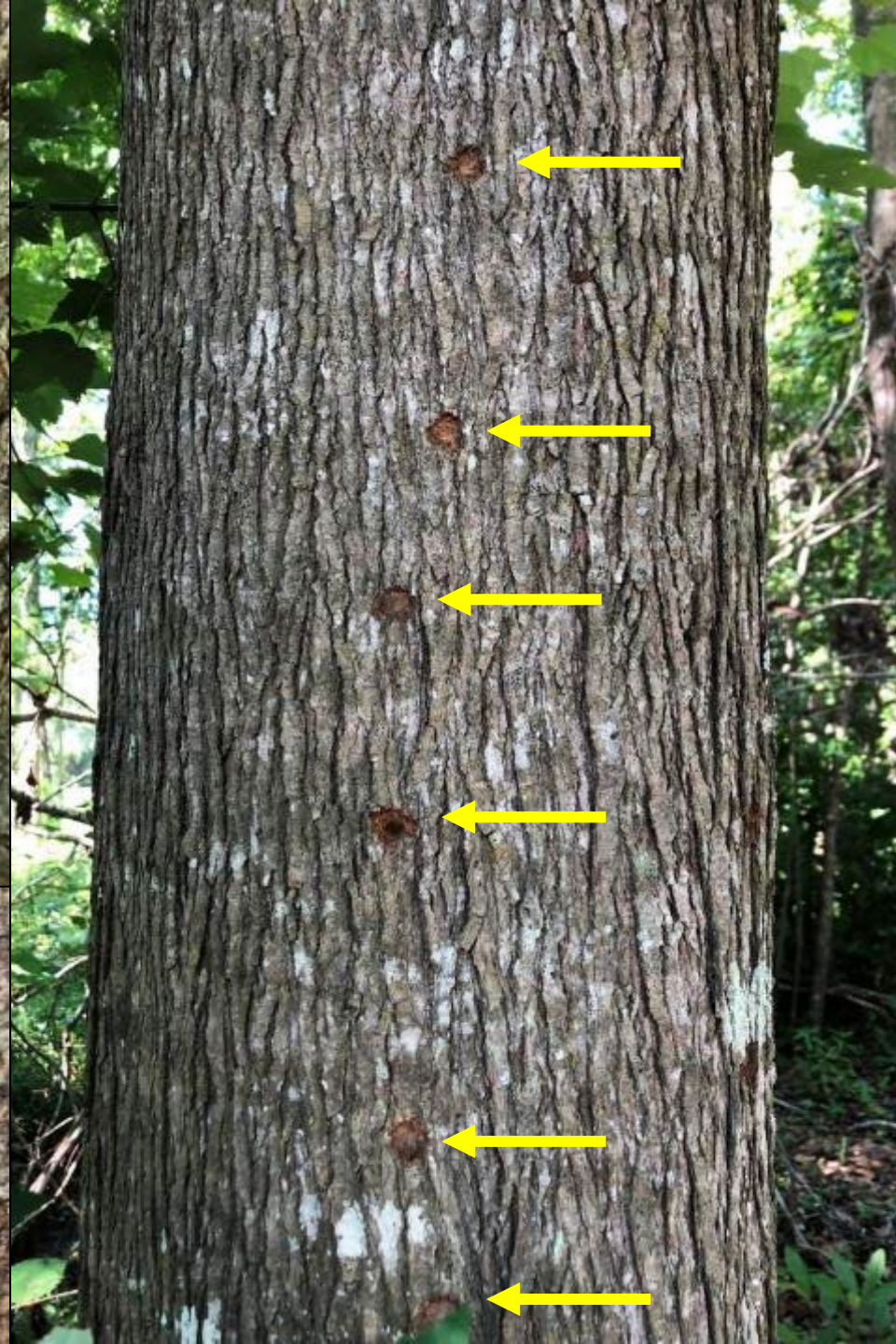
We're going to Hollywood!



ALB: where is it?



Oviposition sites



Bleeding at
oviposition sites



Shavings/frass from larval feeding

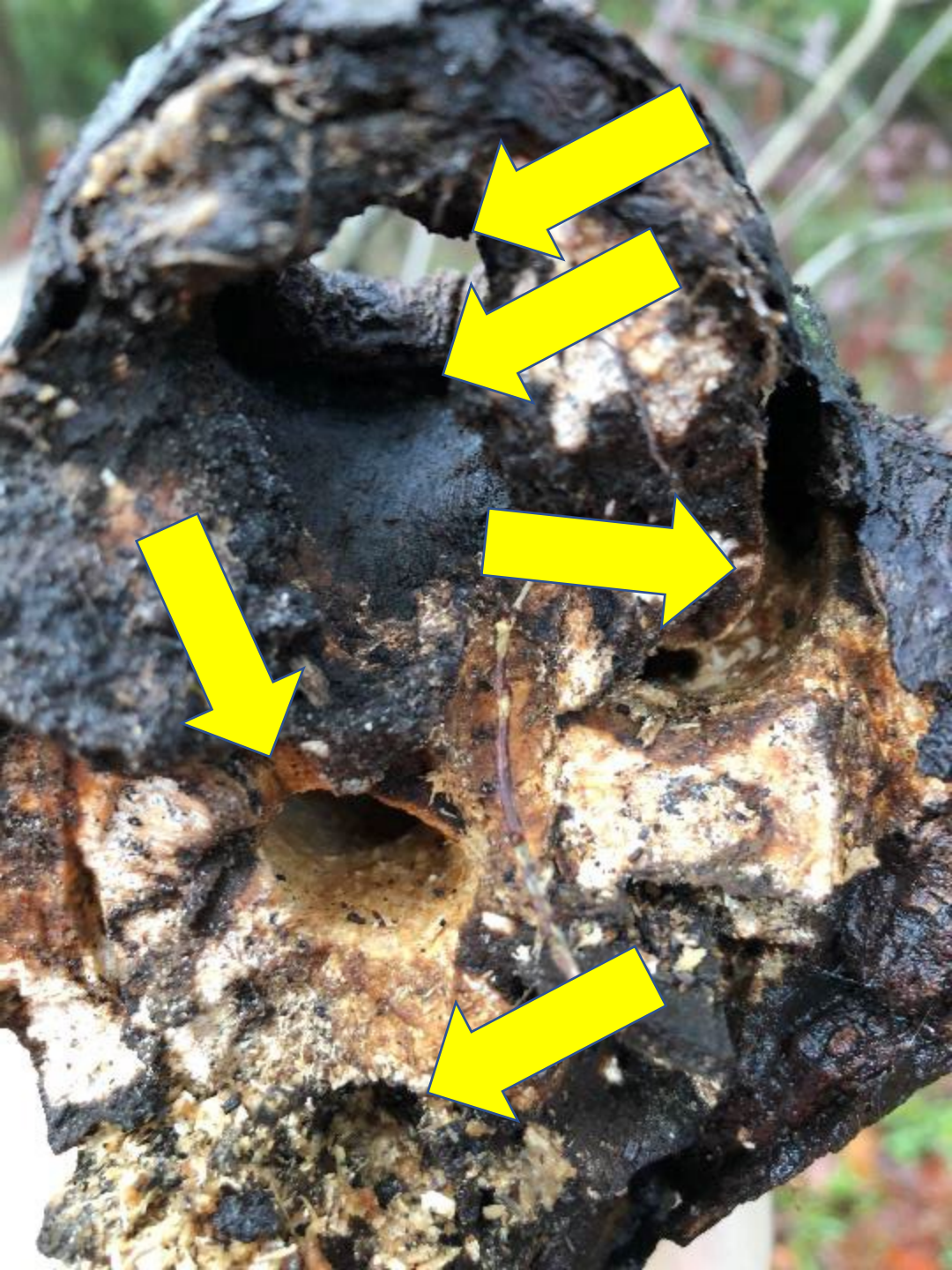


Larval feeding damage



Broken/falling branches





Broken/falling branches



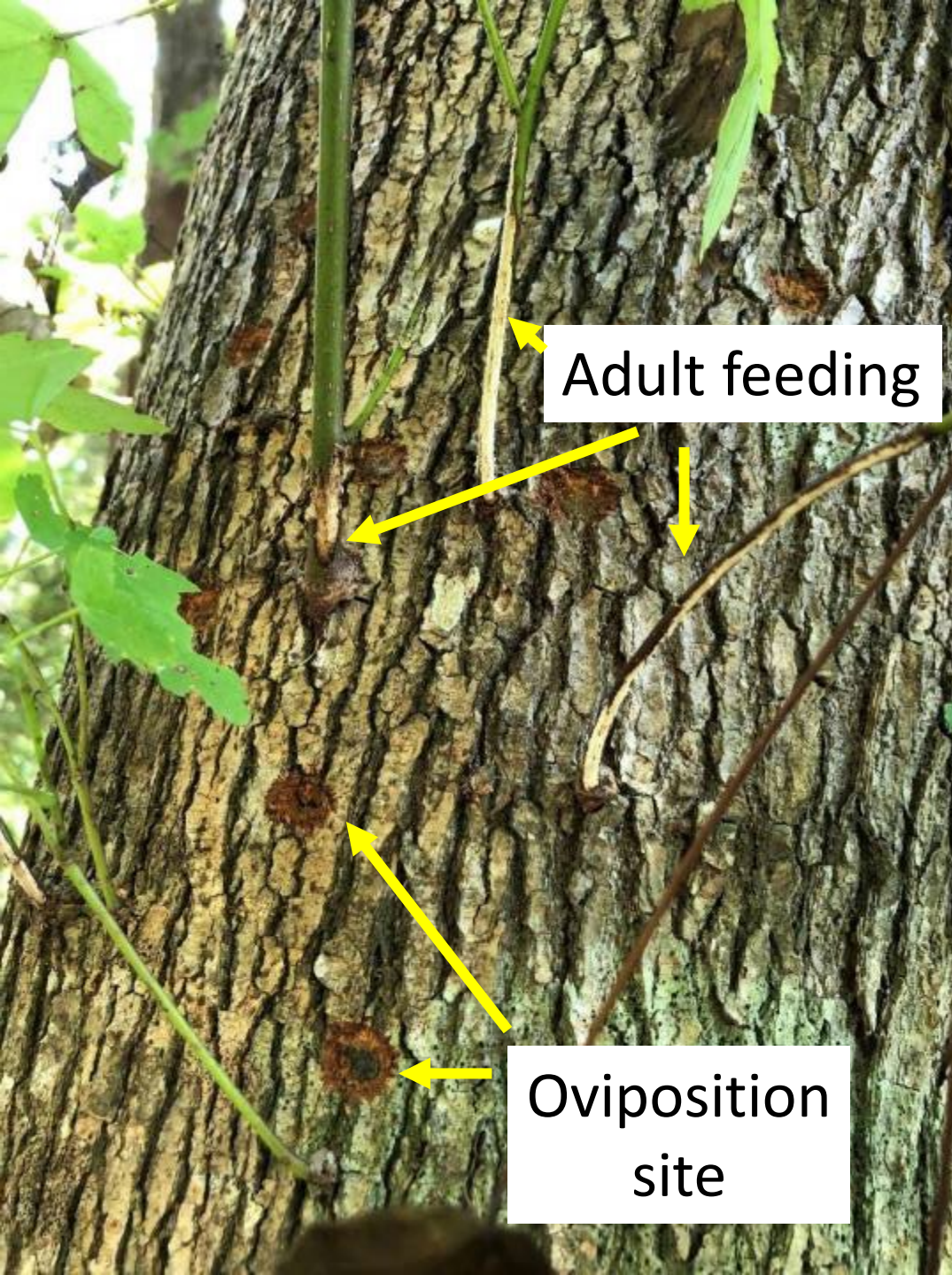


Pencil test!

Photo by Dr. Eric Benson, Clemson University



Exit hole



Adult feeding

Oviposition
site

Adult feeding
damage =
negligible

Management
Prevent? Yes.
Save? No.

ALB Look-alikes



Alaus oculatus
Eastern eyed click beetle



Plectrodera scabra
Cottonwood borer
G.J. Lenhard, Louisiana State University
Bugwood.org.



Chamaeophorus titillator
Eastern pine sawyer beetle
G.J. Baker, North Carolina State University

Think you saw an ALB?

<https://www.clemson.edu/public/regulatory/plant-industry/plant-pest-regulations/state-plant-pest-information/alb.html>

The screenshot shows the website interface for the Asian Longhorned Beetle reporting tool. At the top, the Clemson.edu logo and navigation links are visible. The main header features the 'REGULATORY SERVICES' logo and a purple navigation bar with categories: PESTICIDE REGULATION, PLANT INDUSTRY (selected), AG SERVICE LAB, FERTILIZER & SEED, PLANT & PEST DIAGNOSTIC CLINIC, and STATE ENTOMOLOGIST. The page title is 'Asian Longhorned Beetle'. A large image of the beetle on a tree trunk is shown, with a purple overlay at the bottom that reads 'ASIAN LONGHORNED BEETLE REPORTING TOOL' and includes the text 'Follow this link to report ALB in South Carolina ->'. A sidebar on the left contains a list of links: Apiary Inspection Program, Ornamental Cotton, Invasive Species, Nursery and Dealer Licensing Program, Organic Certification, Staff, State Quarantines, Bradford Pear and Elmagnum, Frequently Asked Questions, Asian Longhorned Beetle (highlighted), District Map, and State Plant Pest List. The footer contains a search bar and social media icons.

Jacob Beach
Asian Longhorned Beetle
Program Manager
843-973-8329
stopalb@clemson.edu

Regulatory details

Total quarantine area: ~76 mi²

Total trees surveyed: ~451,000

Infested trees detected: ~11,100

Infested trees removed: ~5,900

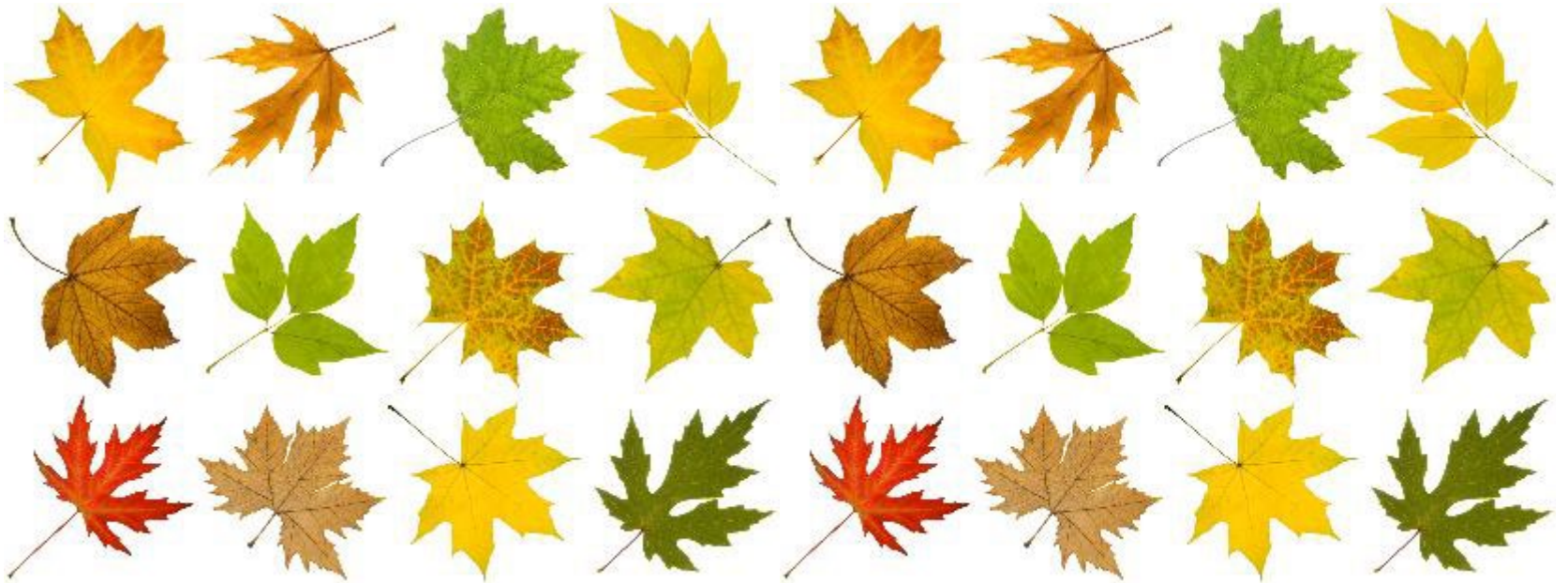
High risk hosts removed: ~3,500



ALB hosts

~98% maple

Remaining = poplar, willow, elm, sycamore, birch



Where is ALB in SC?

Lots and lots and lots of boots on the ground surveys

But it sure would be easier to just set up traps, yes?



Let's talk about trapping...

>20 years of effort developing traps



ALB trapping

>20 years of effort developing traps

Trap types (colors, shapes, etc.)

Trap placement

Trap lures (chemistry, delivery method)

Trapping locations (MA, IL, OH, NY, SC)

Other methods (e.g., clay models as attractants)

ALB trapping

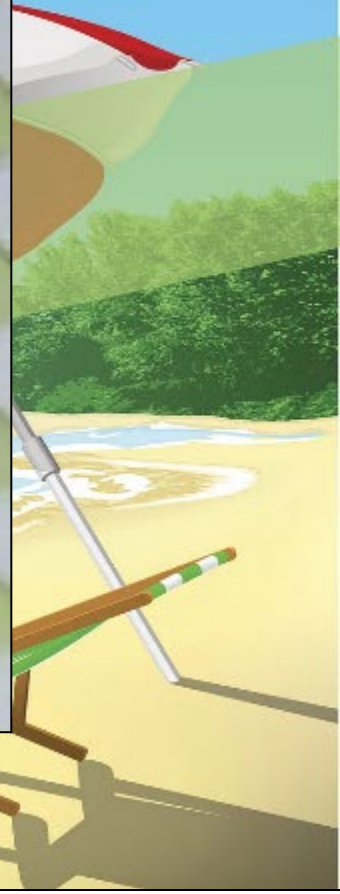
Seemed to be perpetually *this close*

One more component, one more trial, etc.

SC infestation = high populations in summer 2020

If it doesn't work here...

Summer 2020



Summer 2020



Summer 2020 trapping

10 weeks, traps checked weekly

2 treatments + control

15 traps per treatment

45 traps x 10 weeks = 450 trap weeks

Summer 2020



Summer 2020 trapping

Me in July:



Summer 2020 trapping

Me in September:



Summer 2020 trapping

Me in October:



I caught

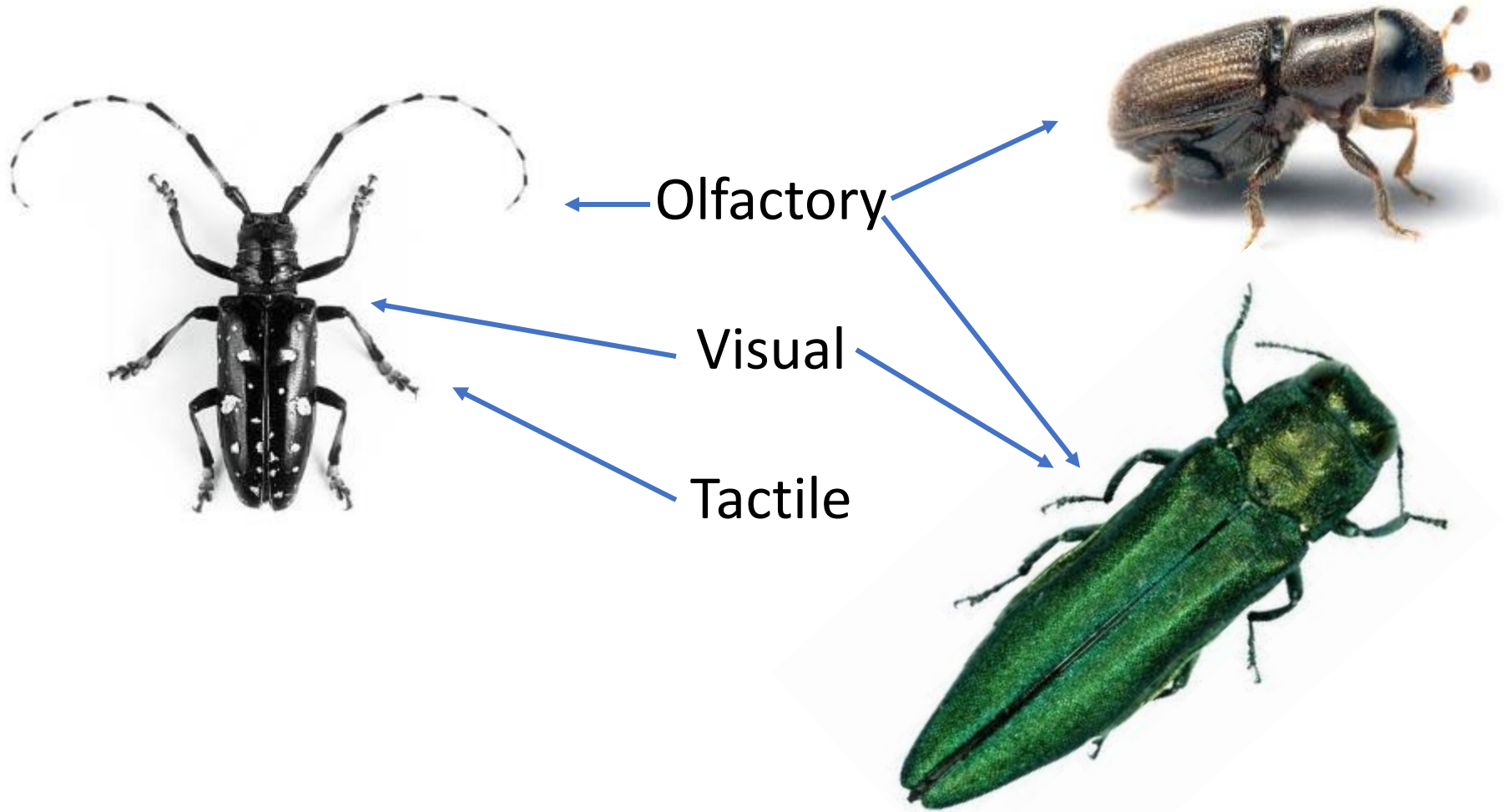


beetles

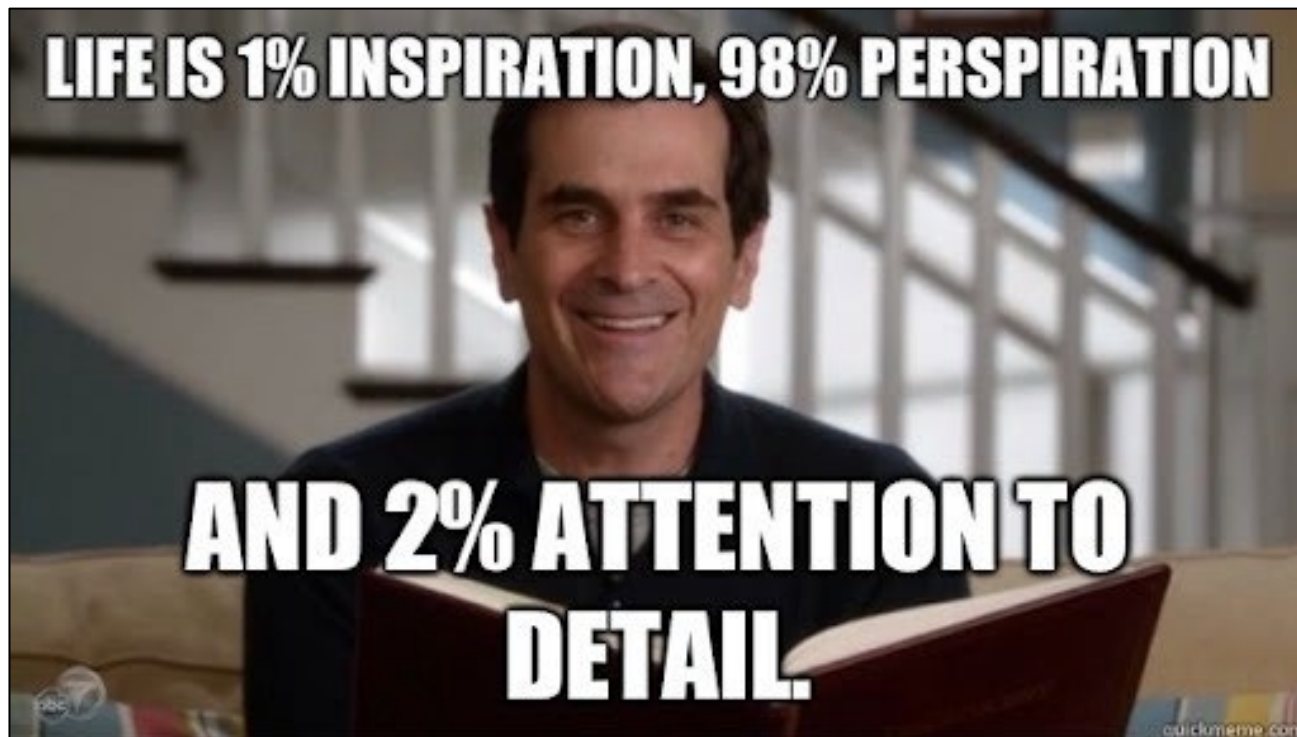
Adult trapping efforts did not work.



ALB uses multiple senses to find a mate



What about all those studies showing statistically significant trap captures?



IN SUMMARY

2020: 450 trap weeks, 2 adult ALB

2023: 50 trap weeks, 0 adult ALB



ALB in SC comes with other challenges

“It’s not easy
working with ALB.”

—Kermit the Frog
(probably)





Rural

Suburb

Small town / blue collar

Island communities

How do you manage here?



Unique problems in South Carolina



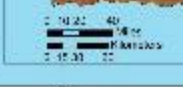
USDA Plant Hardiness Zone Map

March 15, 2021

Zone 8b & 9a



Average Date of Last Spring Frosts (1971-2000)		
Start	End	Zone
1/1-1/15	1/15-1/31	1a
1/15-1/31	1/31-2/15	1b
2/1-2/15	2/15-2/29	2a
2/15-2/29	2/29-3/15	2b
3/1-3/15	3/15-3/31	3a
3/15-3/31	3/31-4/15	3b
4/1-4/15	4/15-4/30	4a
4/15-4/30	4/30-5/15	4b
5/1-5/15	5/15-5/31	5a
5/15-5/31	5/31-6/15	5b
6/1-6/15	6/15-6/30	6a
6/15-6/30	6/30-7/15	6b
7/1-7/15	7/15-7/31	7a
7/15-7/31	7/31-8/15	7b
8/1-8/15	8/15-8/31	8a
8/15-8/31	8/31-9/15	8b
9/1-9/15	9/15-9/30	9a
9/15-9/30	9/30-10/15	9b
10/1-10/15	10/15-10/31	10a
10/15-10/31	10/31-11/15	10b
11/1-11/15	11/15-11/30	11a
11/15-11/30	11/30-12/15	11b
12/1-12/15	12/15-12/31	12



Because of all these factors,
there were questions

Life cycle implications due to climate?

Do ALB behave the same way as they do elsewhere?

How to manage in these perpetually wet areas?

Research topics addressed in SC

Adult trapping 

Phenology 

Biology

Population dynamics

Management

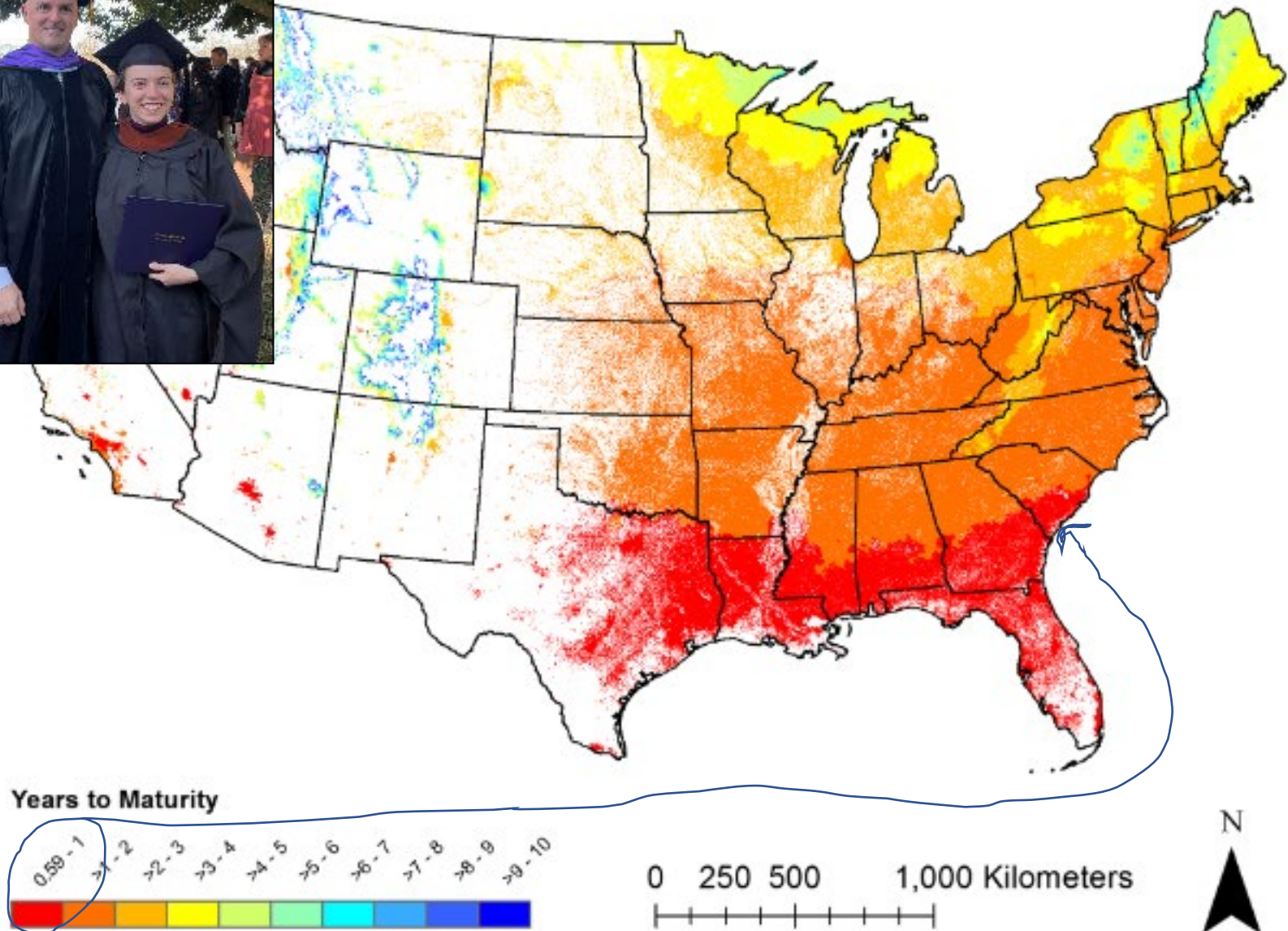
Biological control

Does the climate impact ALB phenology?



Lena Schmitt

ALB phenology in SC



ALB phenology in SC

Monthly
collections



Extract all ALB life
stages

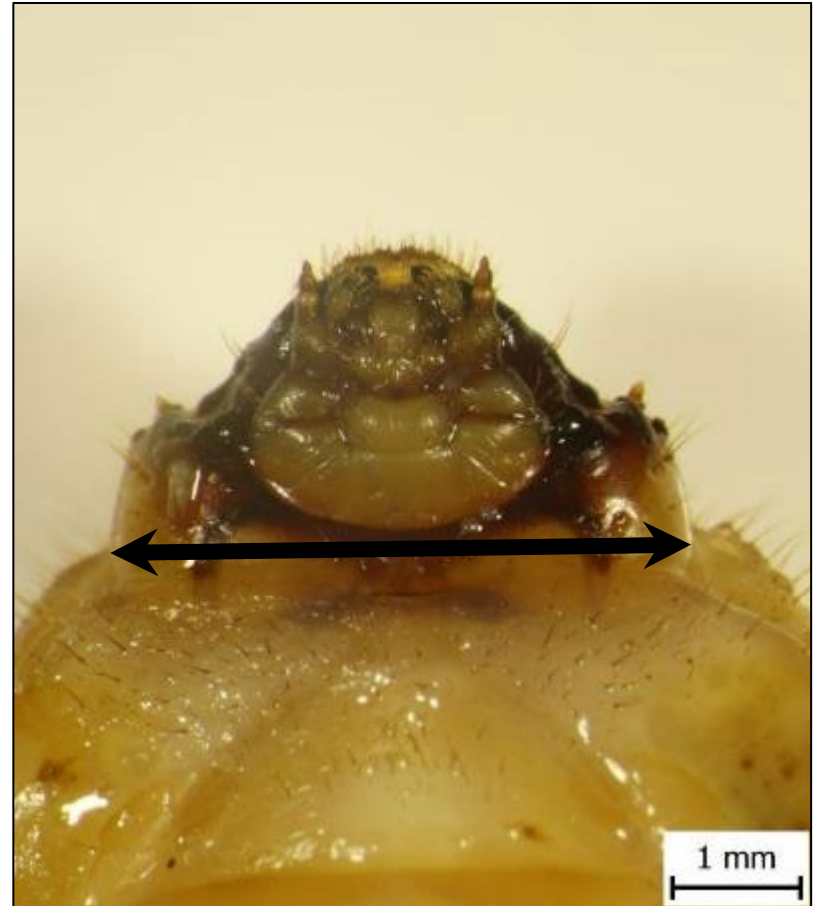


ALB phenology in SC

Measured larval head capsule width to determine instar

Collected eggs/pupae

Recorded adult presence



ALB phenology in SC



August 2021 - July 2023

148 eggs

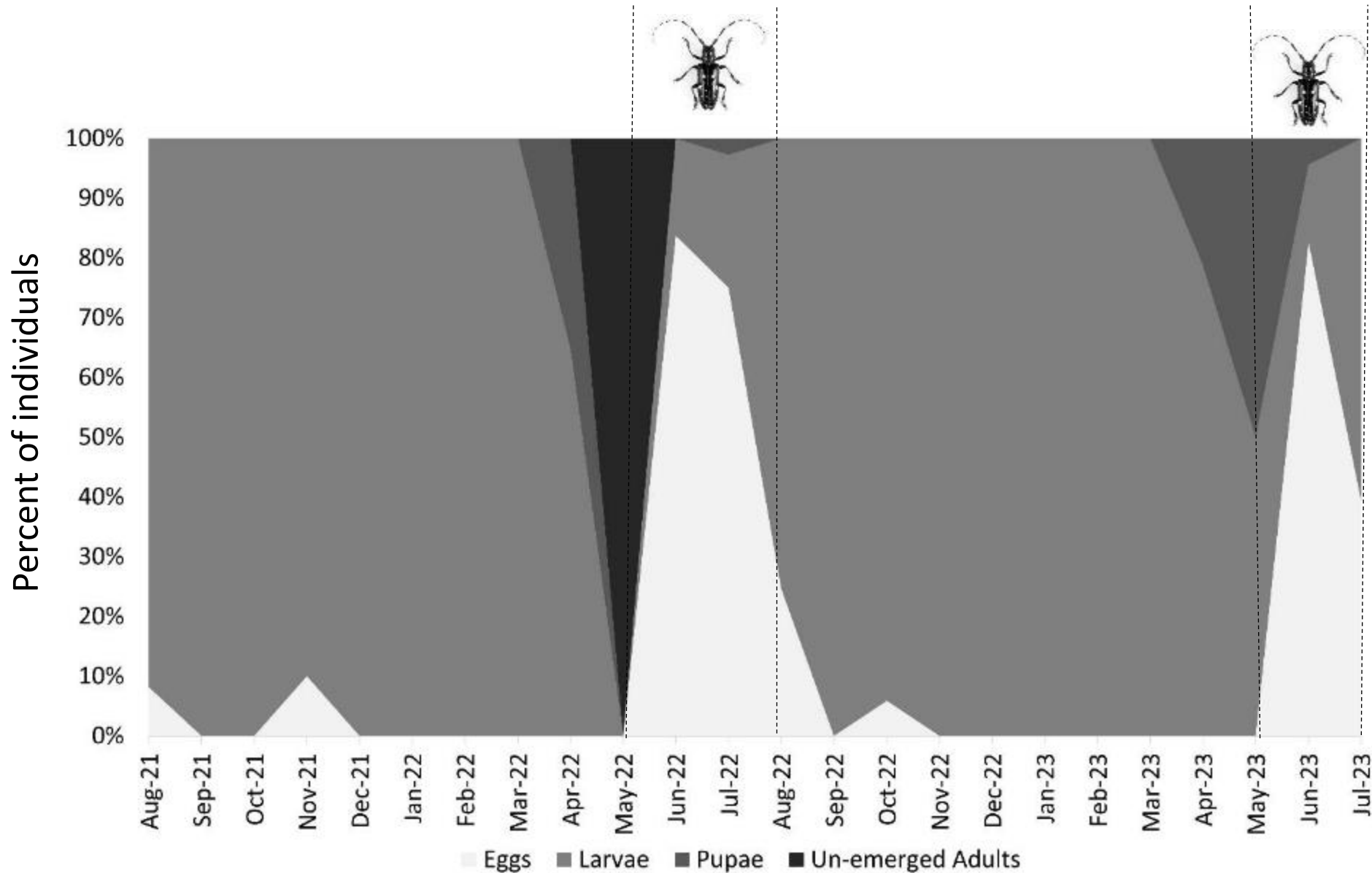
819 larvae

38 pupae

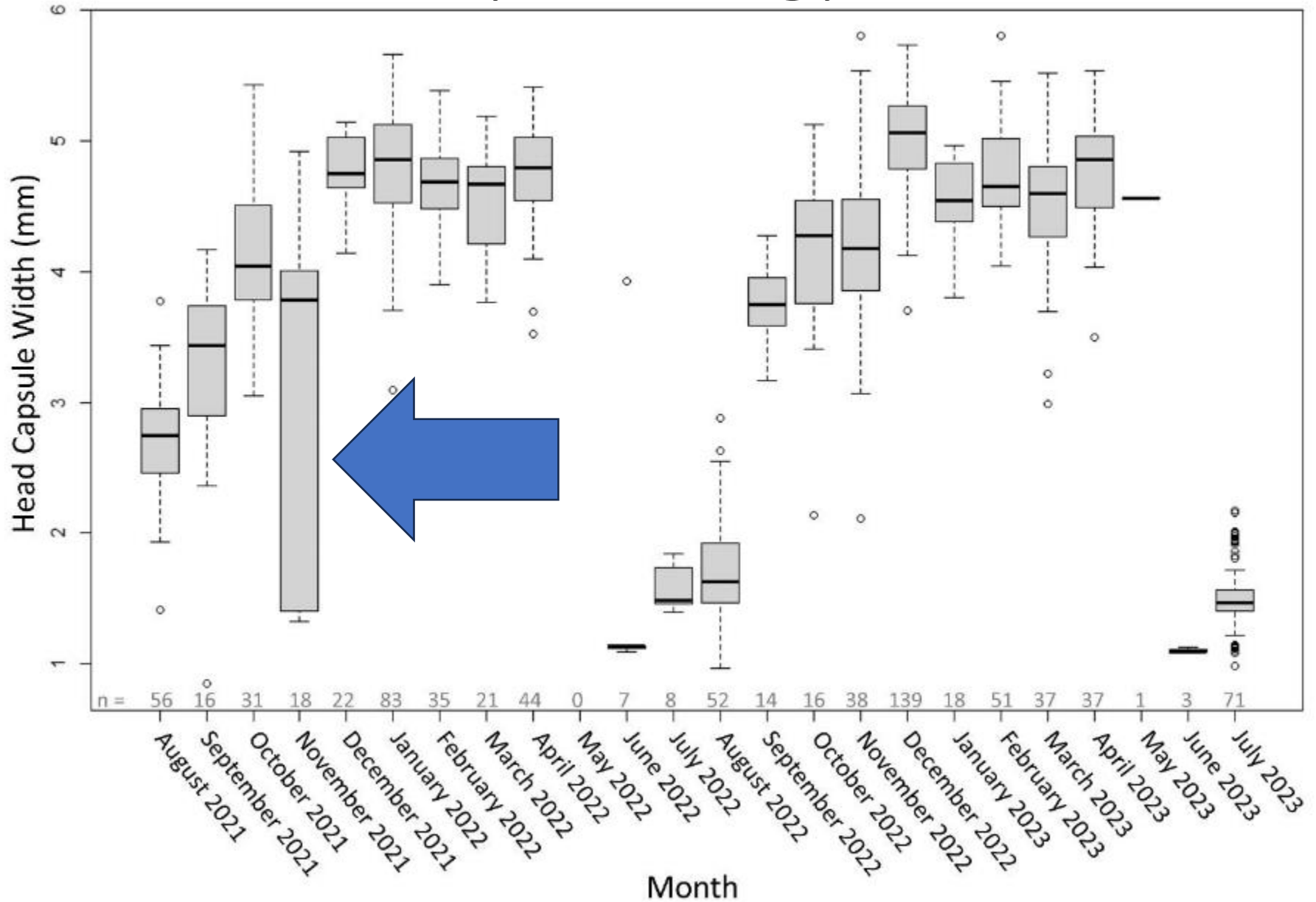
1 unemerged adult

(Emerging/flying adults data gathered from USDA APHIS and Clemson DPI sightings)

ALB phenology in SC



ALB phenology in SC



Lots of developmental plasticity

November 2021

~4.5 mm
headcapsule
width

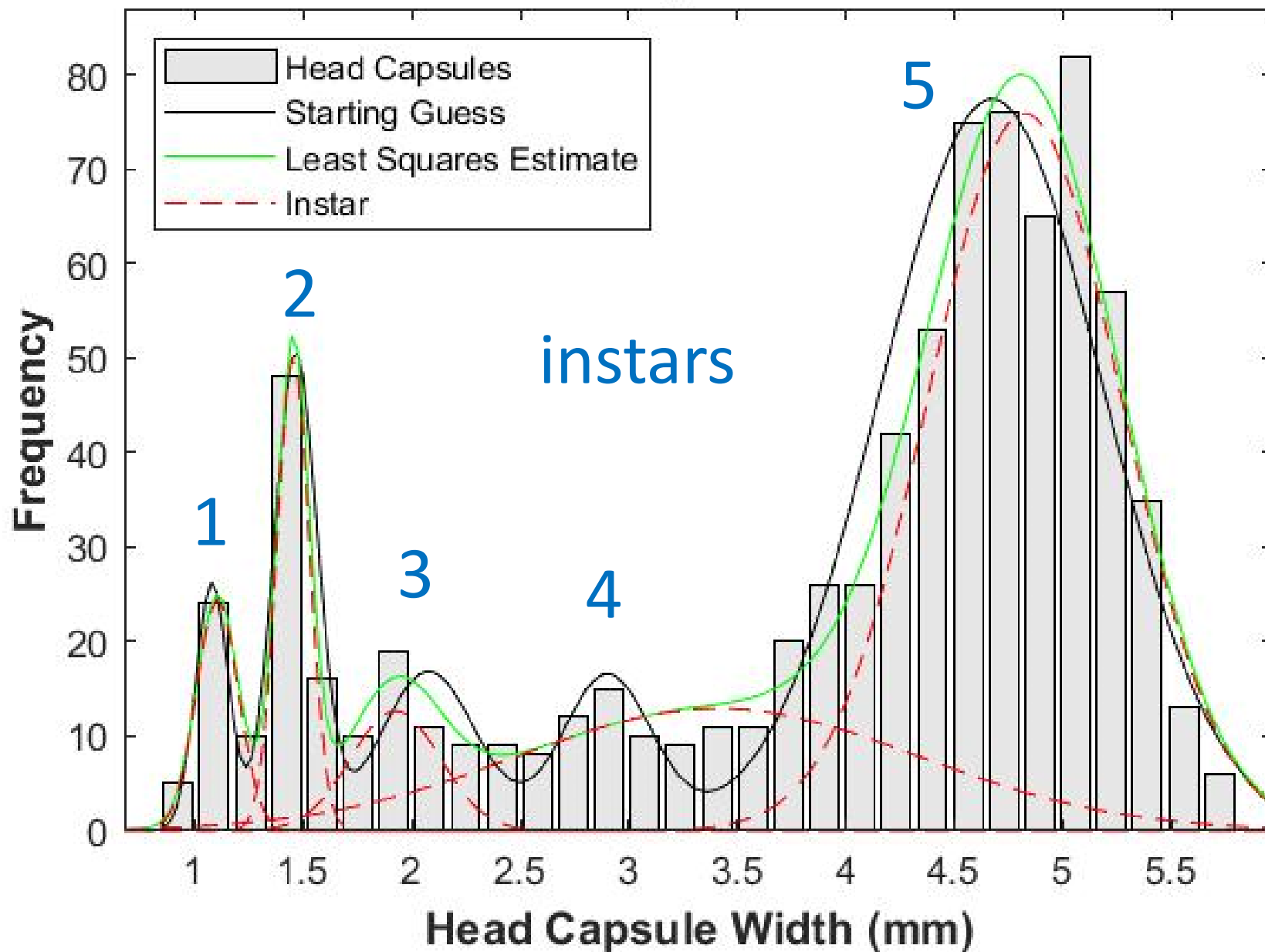
~1.3 mm
headcapsule
width



Lots of developmental plasticity



All Headcapsule Widths



Conclusions

Appears to be a 1-year life cycle BUT with variation

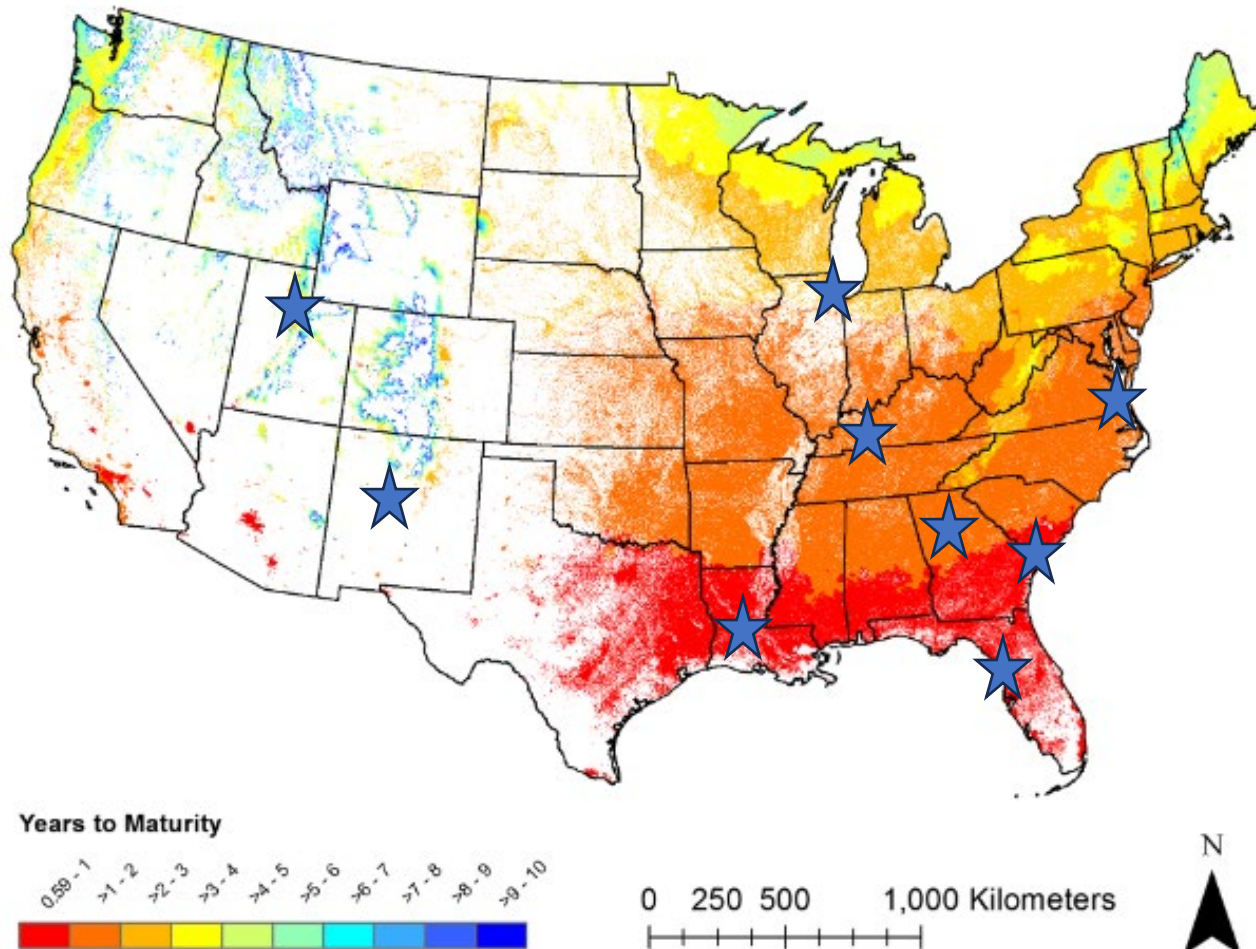
Flight season seems to be May – September with a peak
from late May – early July

ALB in SC most likely has 5 instars

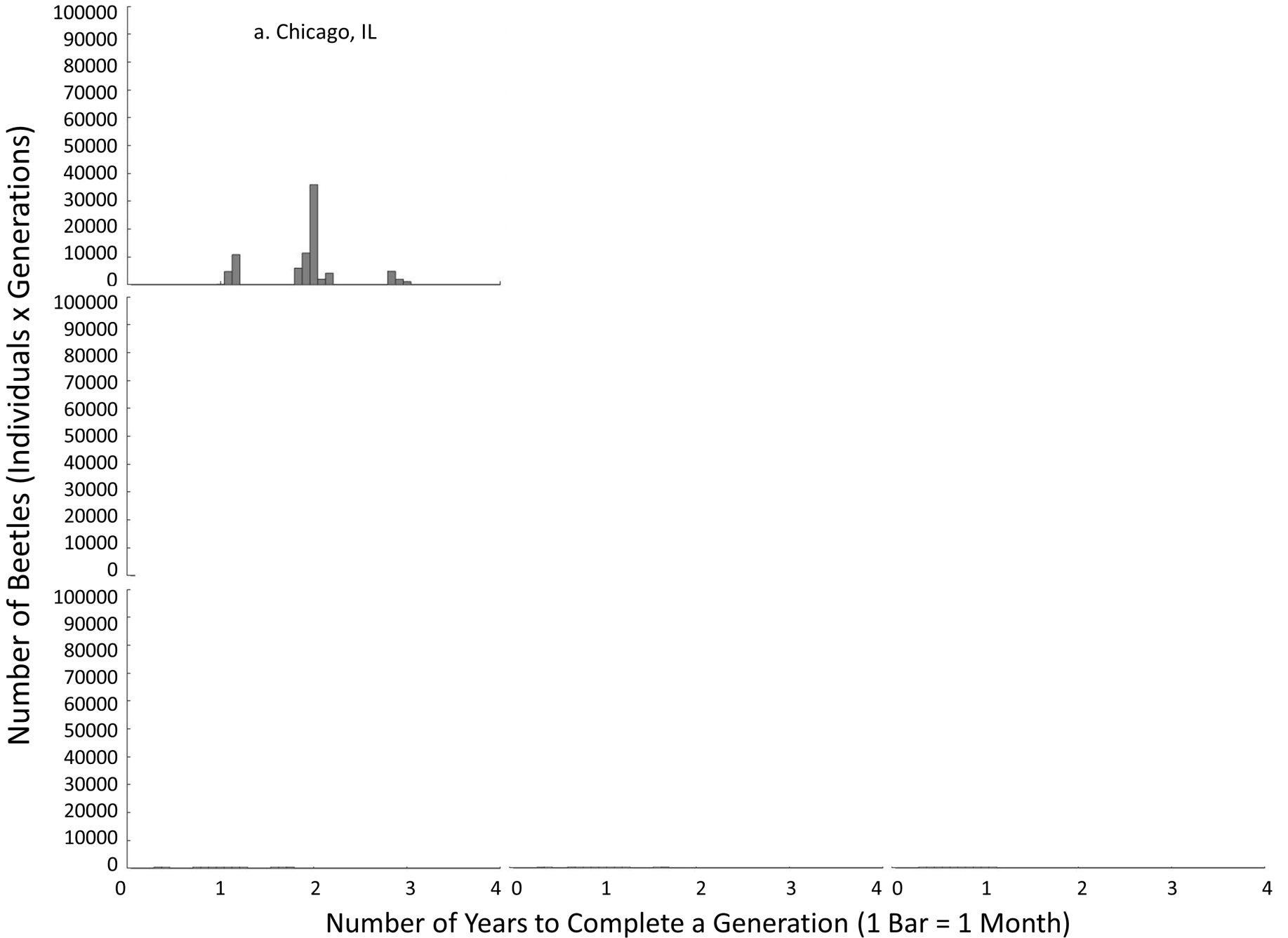
ALB in SC appears to have a required pupal diapause / cold
period

ALB phenology beyond SC

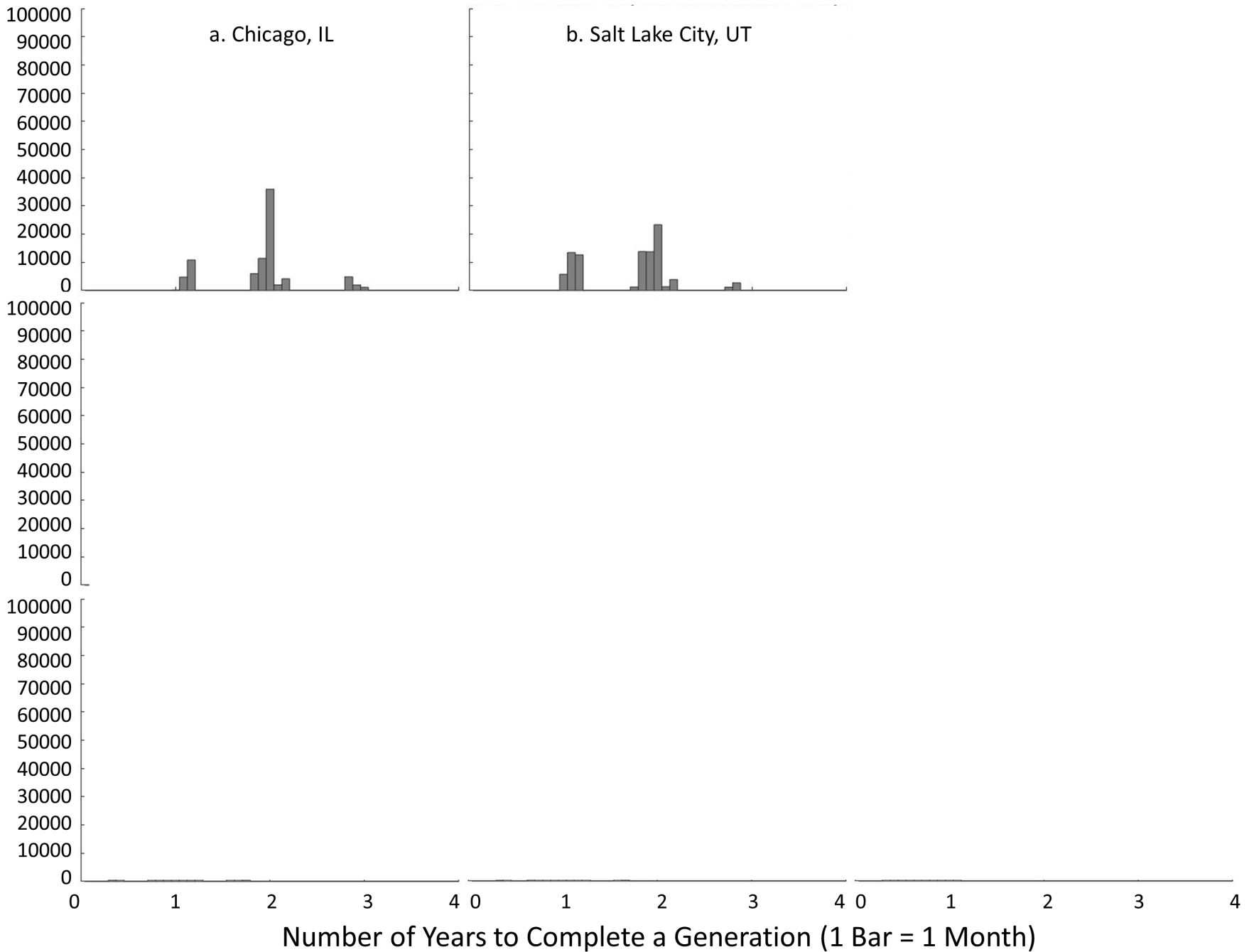
Using the new data, we ran the HCAP model in 8 other locations in the US



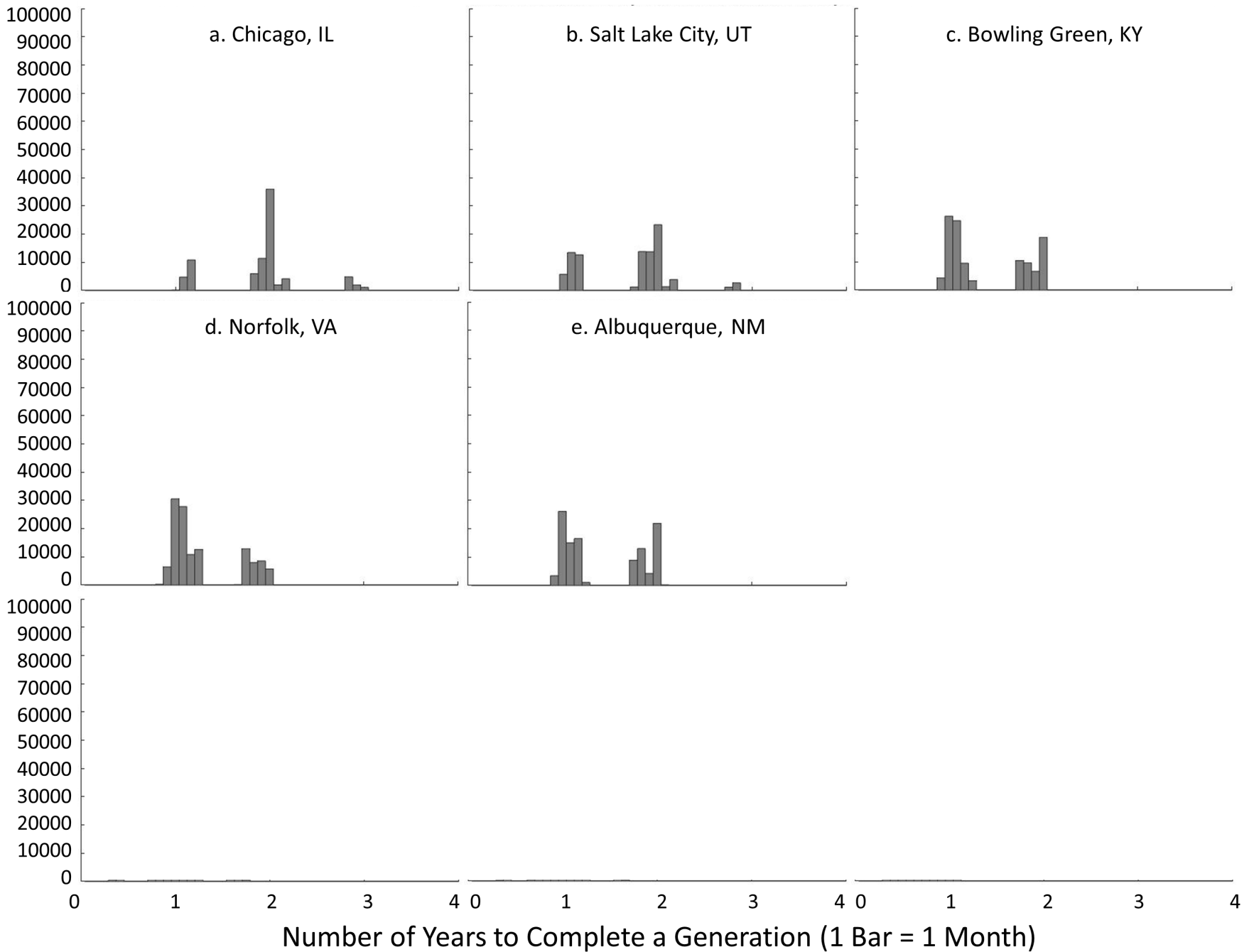
a. Chicago, IL



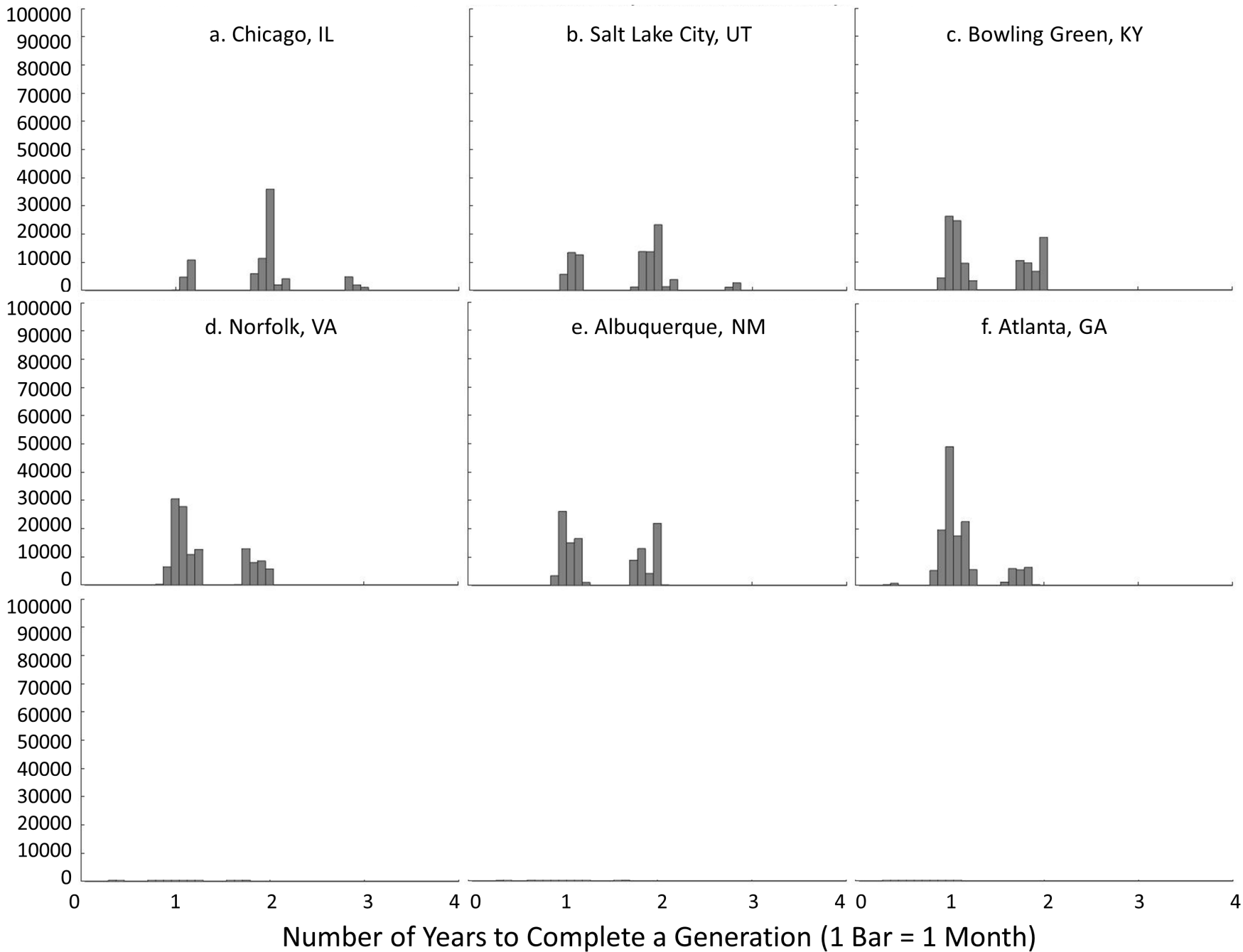
Number of Beetles (Individuals x Generations)



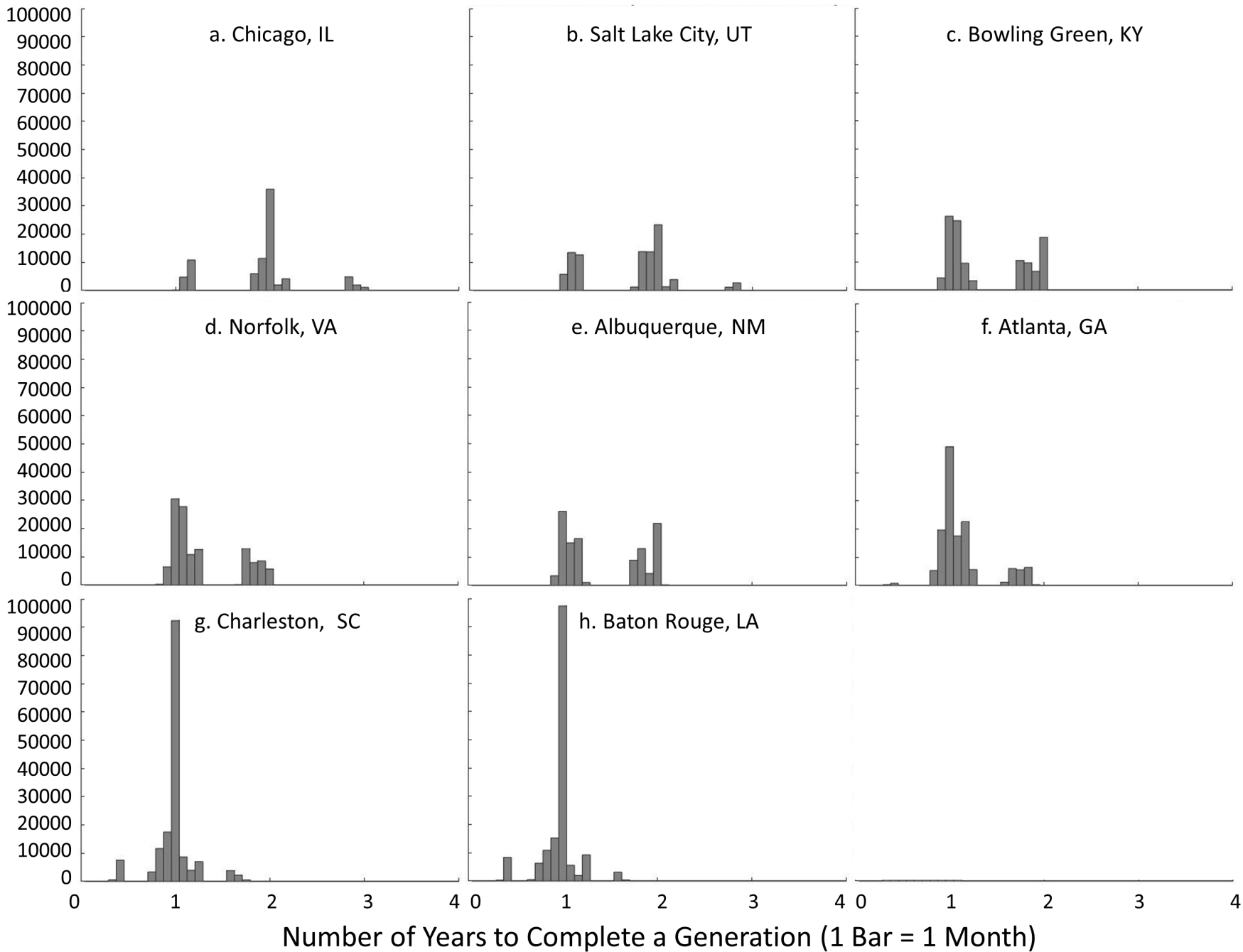
Number of Beetles (Individuals x Generations)



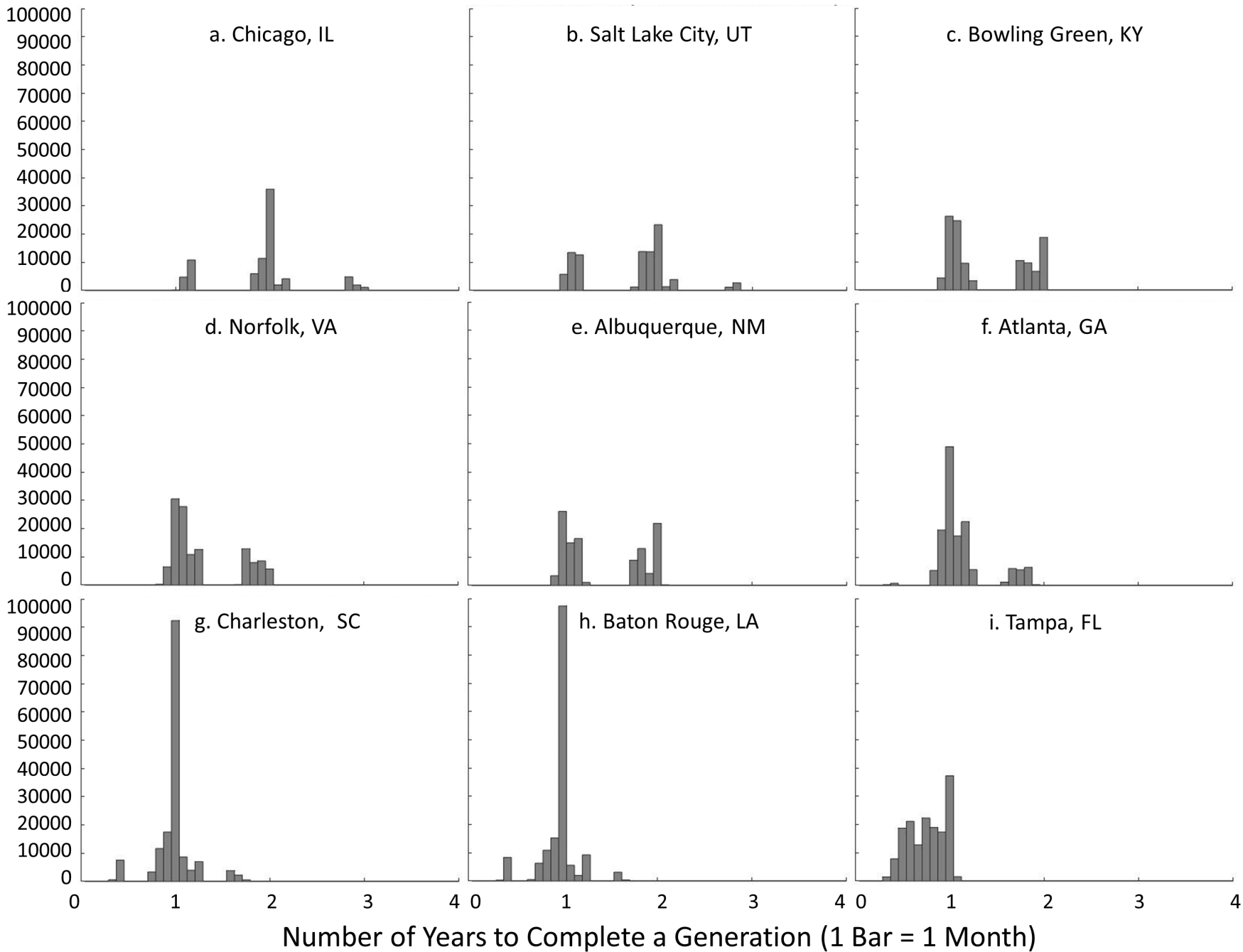
Number of Beetles (Individuals x Generations)



Number of Beetles (Individuals x Generations)



Number of Beetles (Individuals x Generations)



Conclusions

Kappel et al. 2017 map is pretty accurate

Coastal Plain infestations likely have similar phenology to SC

Extreme southern infestation could come with new challenges

Research topics addressed in SC

Adult trapping 

Phenology 

Biology 

Population dynamics

Management

Biological control

ALB phenology and biology



Lindsey Stone
M.S. student (Clemson)

Determining larval weight –
head capsule relationship

Expanding phenology work i.e.,
when do larvae leave phloem?

Relate known growth to under
bark temps

Working

Caged ALB studies to determine
precise development time??

on it

Biology – larval growth

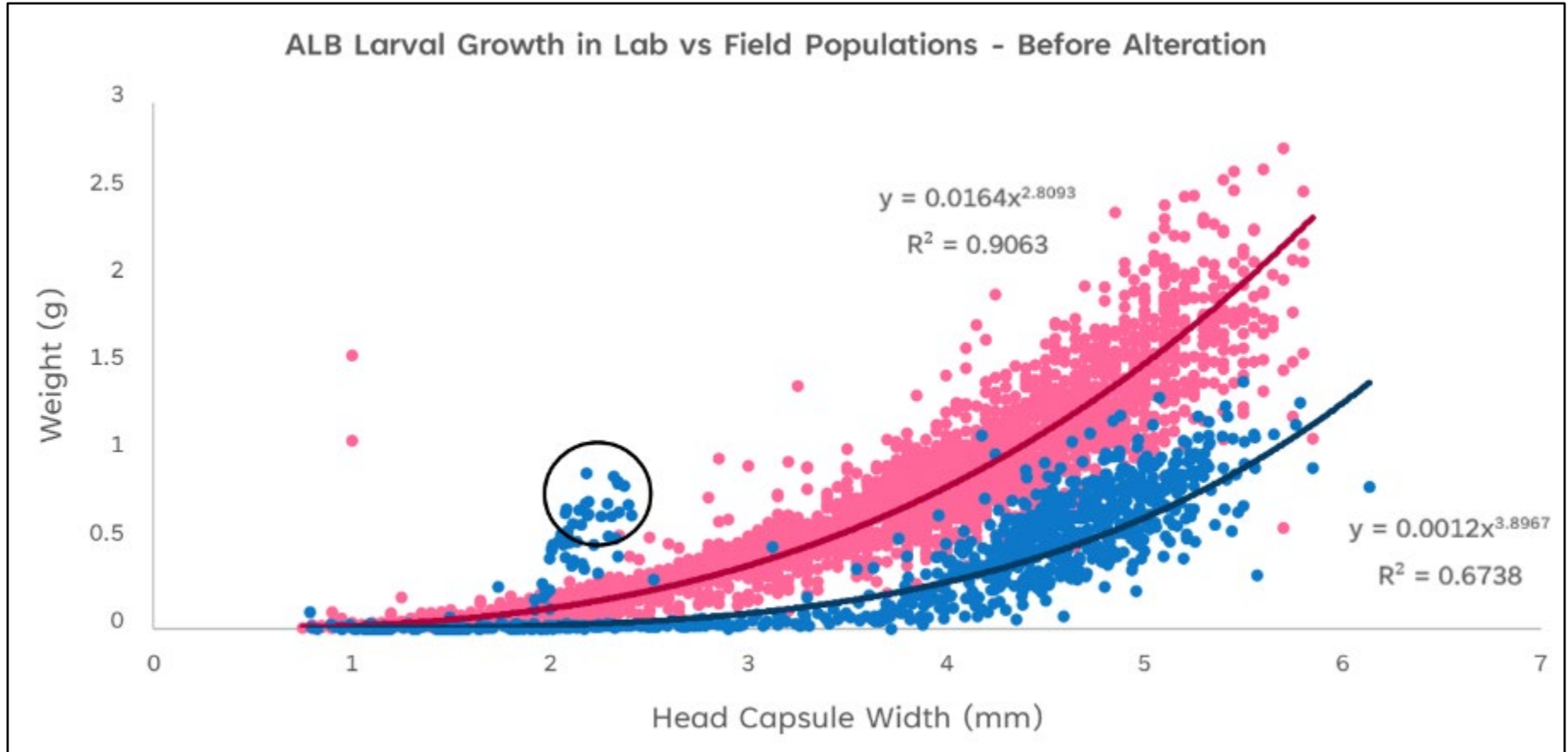
Is larval ALB growth in the lab similar to the field?

Growth data from lab-reared IL and NY populations

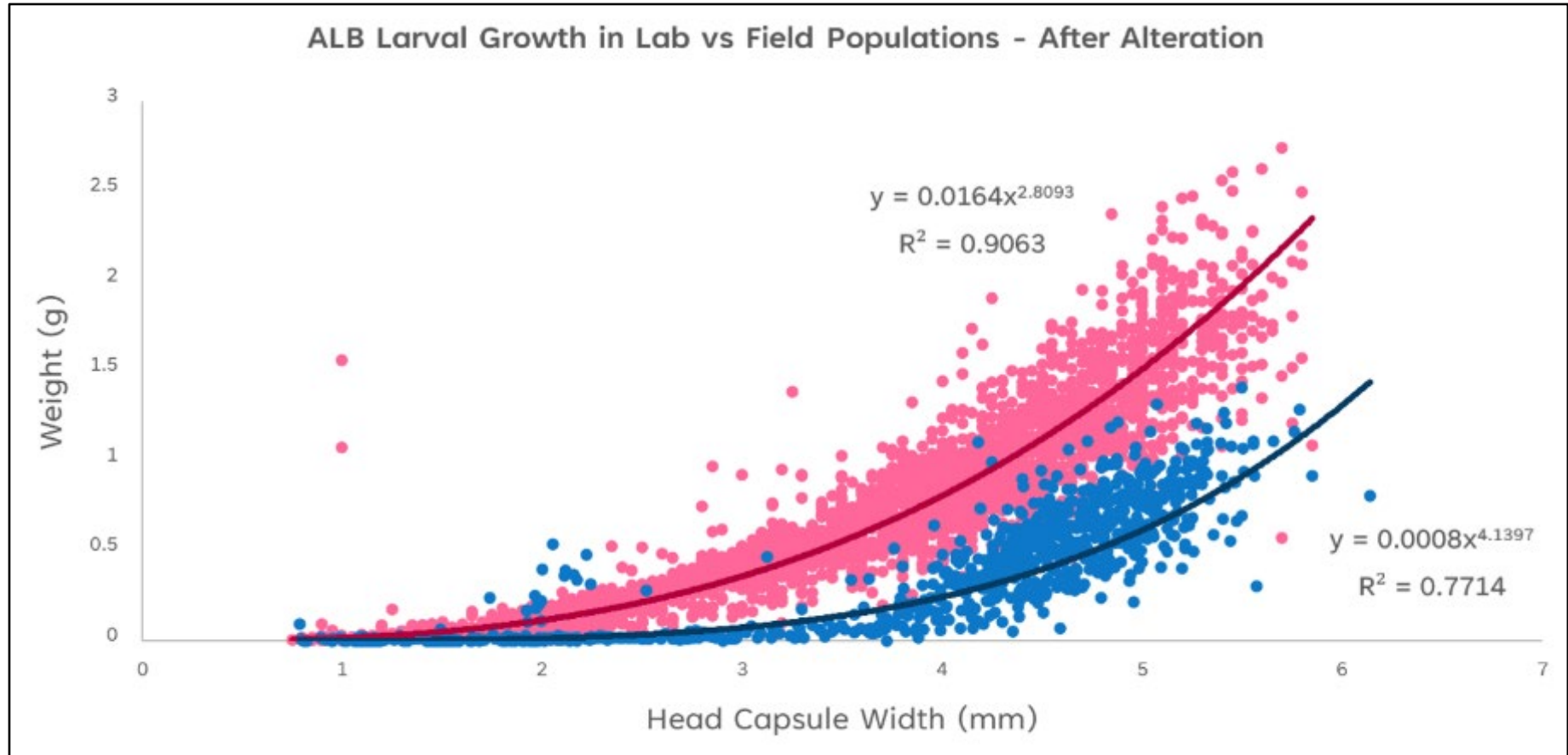
Field collected SC population

Relationship between head capsule width and dry (IL, NY) and wet (SC) weight

Biology – larval growth



Biology – larval growth



Conclusions – larval growth

Both groups exhibited the same relationship between head capsule width and weight

We are examining the relationship between wet and dry weight (suspect a strong relationship)

Outliers from only 2 trees...what's their deal?

*these larvae will also feed into the phenology/developmental model

Biology – oviposition/eggs

How many egg niches have eggs?

How many eggs hatch?

Does host diameter matter?

Red maple garden



Ovi/eggs garden study

19 red maple trees (~3" dbh)

One mating pair/tree

Oviposition sites recorded and
marked daily

Trees destructively sampled one
month after female died

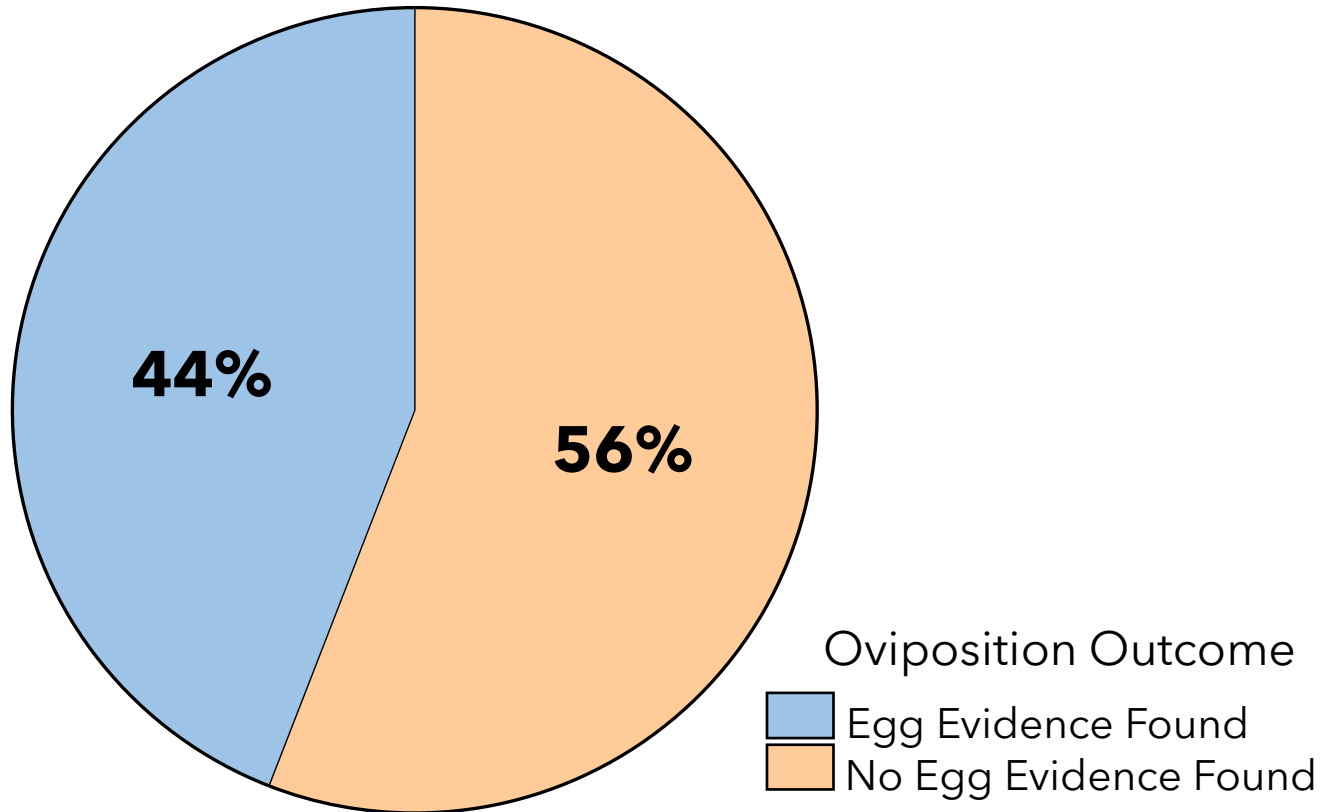
Fate of every egg site recorded



Ovi/eggs garden study

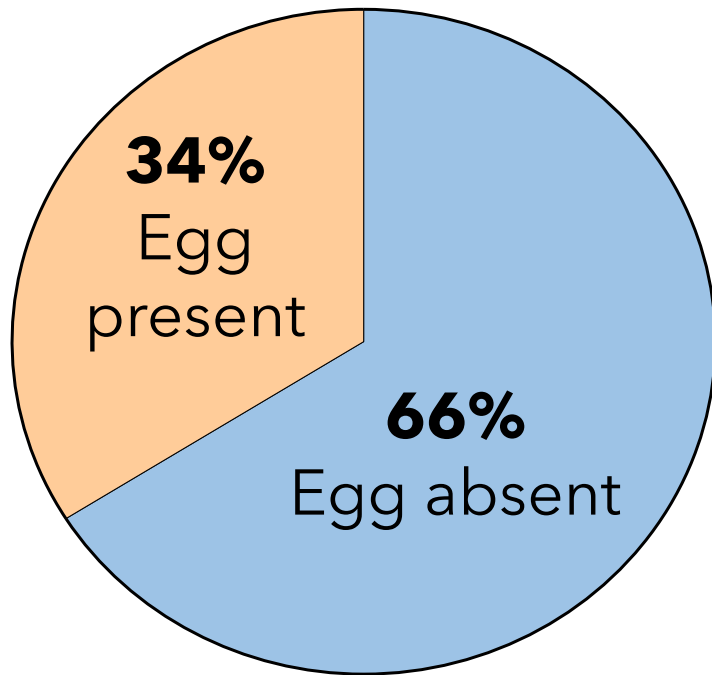


Ovi/eggs garden study

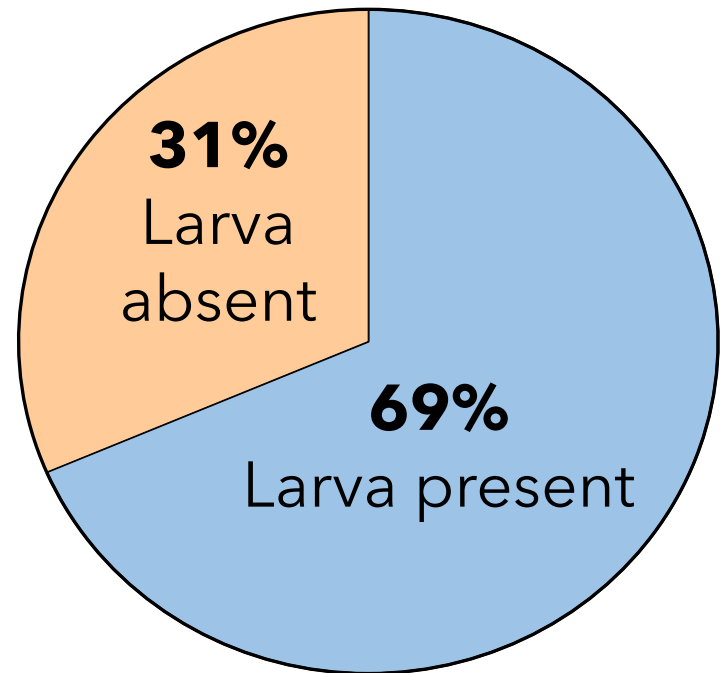


Ovi/eggs garden study

Egg survival



Larval survival



Ovi/eggs field study

Collected material from quarantine zone (e.g., from removals crew or direct sampling)

Fate of every egg site recorded

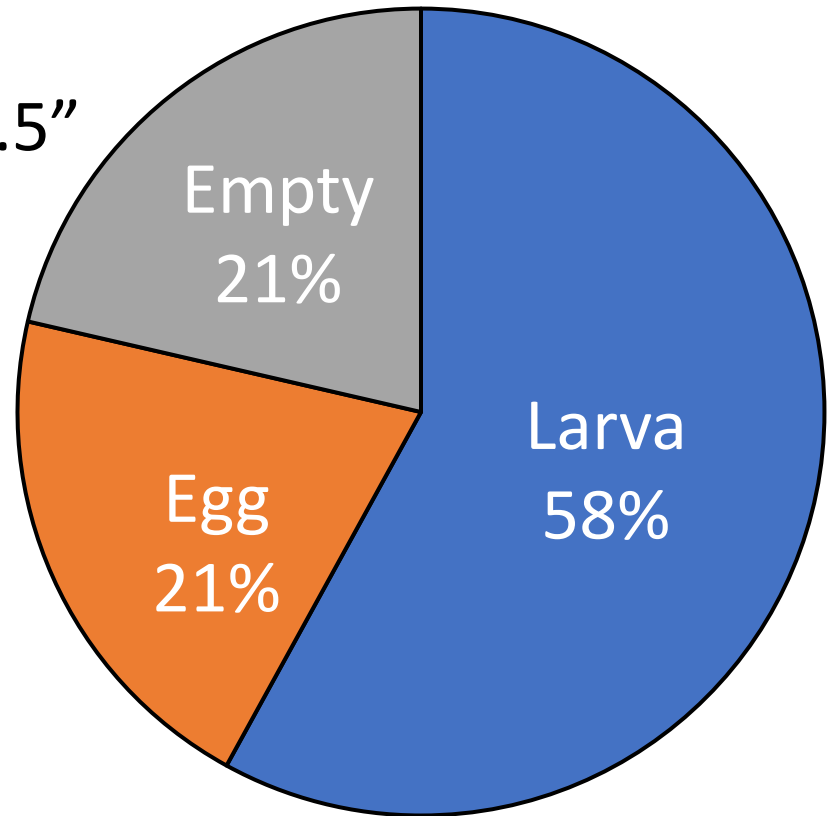




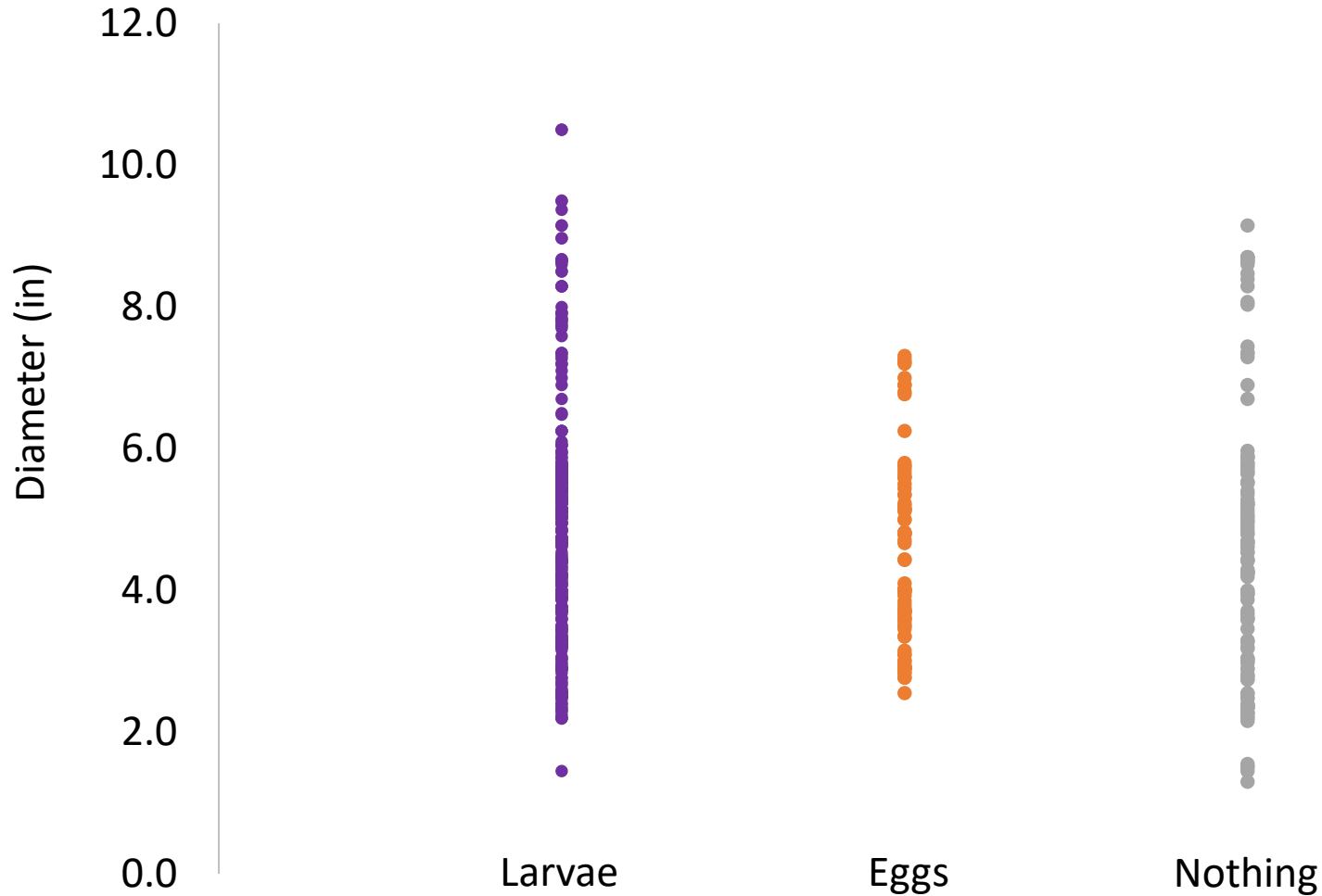
Ovi/eggs field study

N = 631 egg sites

Diameter range = 1.3" to 10.5"



Ovi/eggs field study



(Very preliminary) Conclusions

Higher prevalence of eggs in egg sites from field collected material

Is this an artifact of the host quality?

High (66%) egg absences in garden study suggests high predation rate (ants!)

Still much more to explore in these data

Research topics addressed in SC

Adult trapping 

Phenology 

Biology 

Population dynamics 

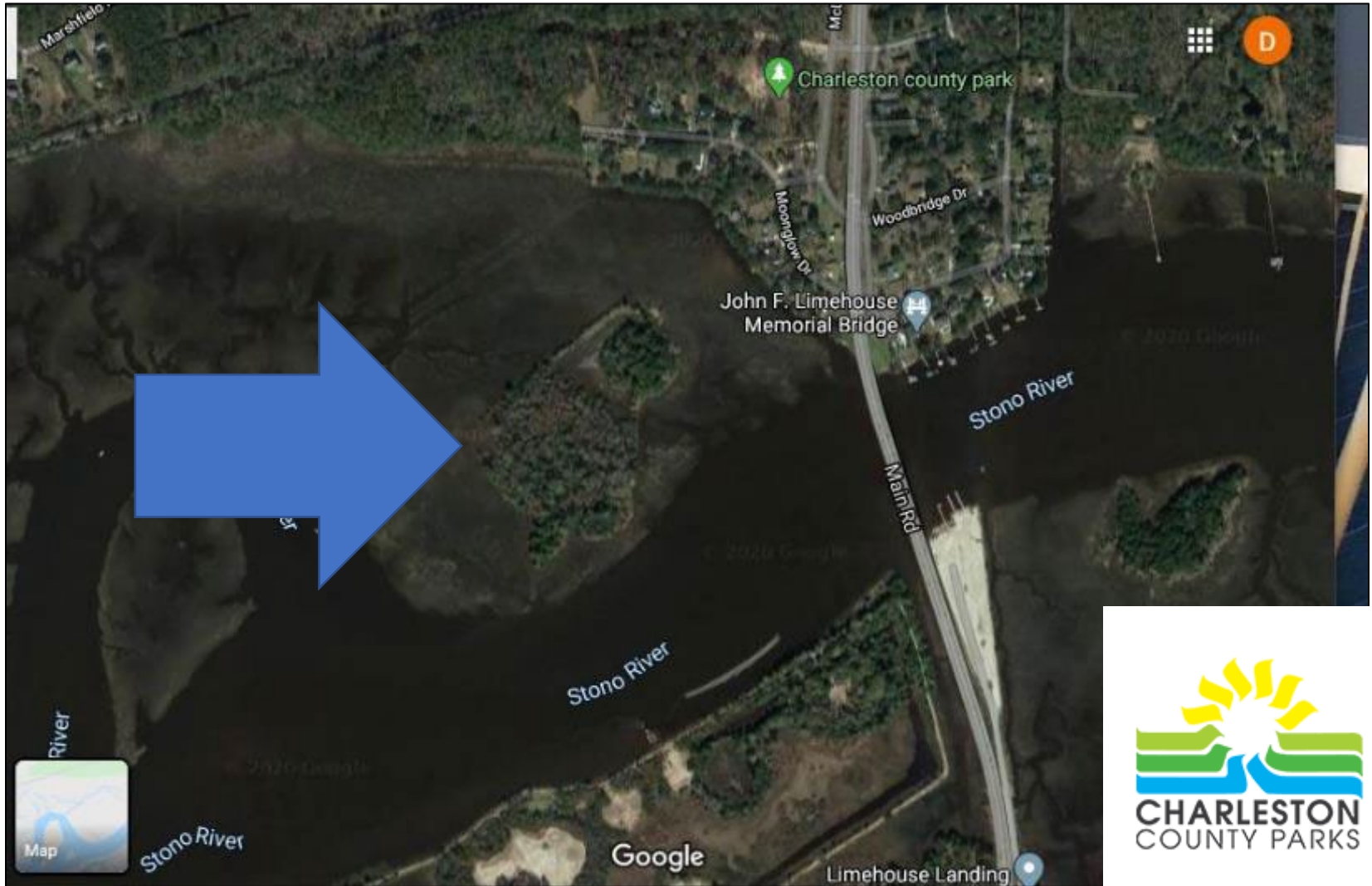
Management

Biological control

How do ALB populations expand on the landscape? Or within a tree?



ALB population dynamics



ALB population dynamics

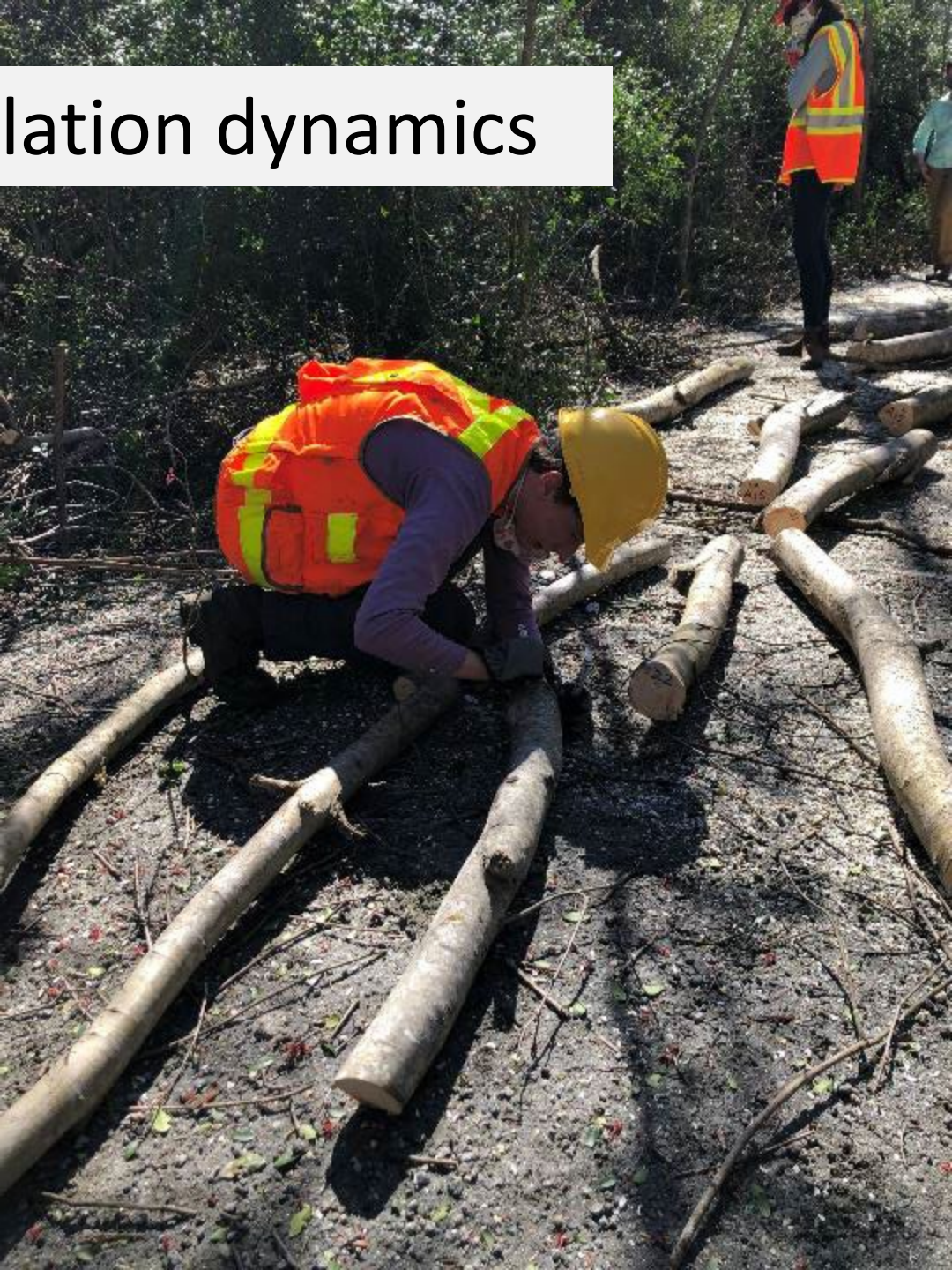
Meredith Bean



Heavy/light/uninfested
host trees



ALB population dynamics



ALB population dynamics



ALB population dynamics

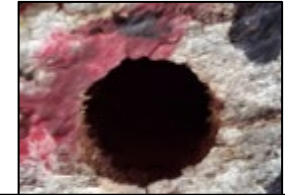


Vertical and spatial spread



Vertical and spatial spread

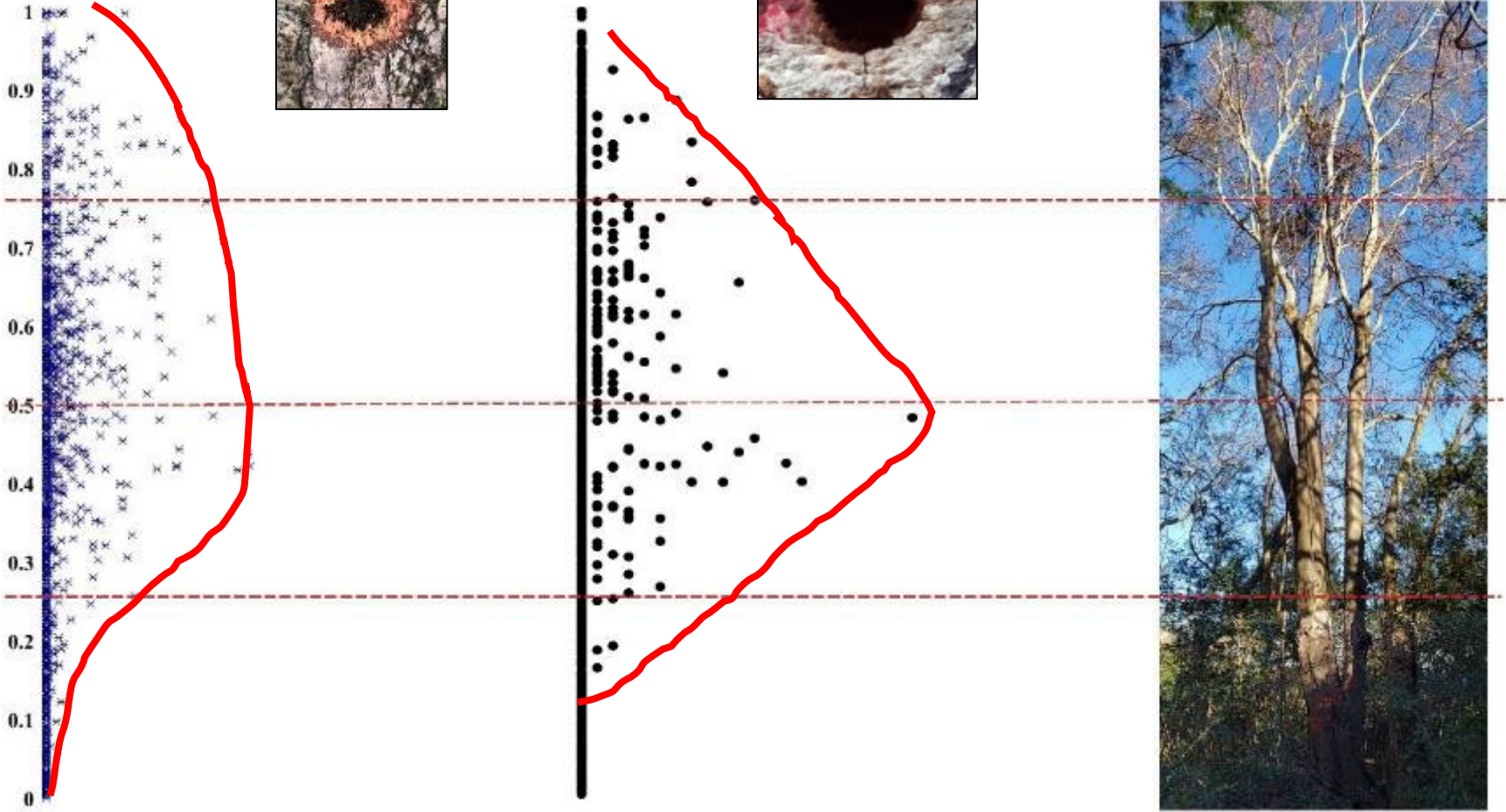
	Trees	Average Diameter (in)	Egg Niches	Exit Holes *
C-level <100	6	22.5	7,988	885
B-level <10	10	19.5	6,243	707
A-level 0	8	14.4	442	16
'Uninfested'	10	13.1	156	13
Total	34		14,829	1,621



Single stemmed trees

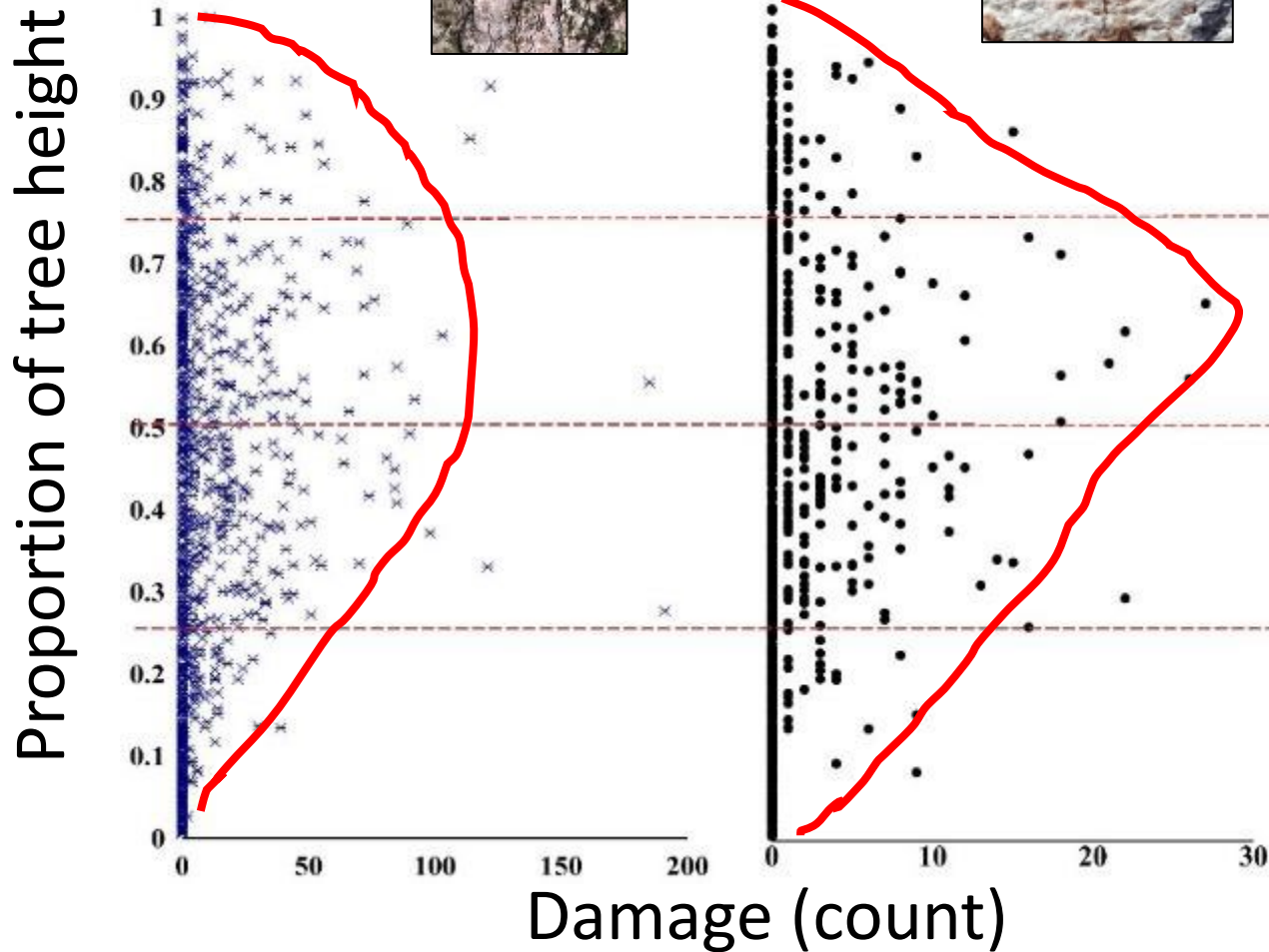
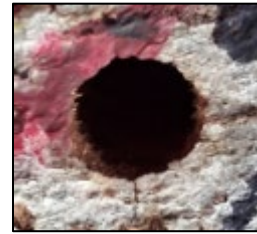


Proportion of tree height



Damage (count)

Multi-stemmed trees



Conclusions

Multi-stemmed trees received over 2.5 times more oviposition damage and over 3.5 times more exit holes than single-stemmed trees.

Most damage occurs in the middle 50% of a host tree's canopy or wood stems OR branches smaller than 10" diameter.

Vertical and spatial spread

Stono Co River Park

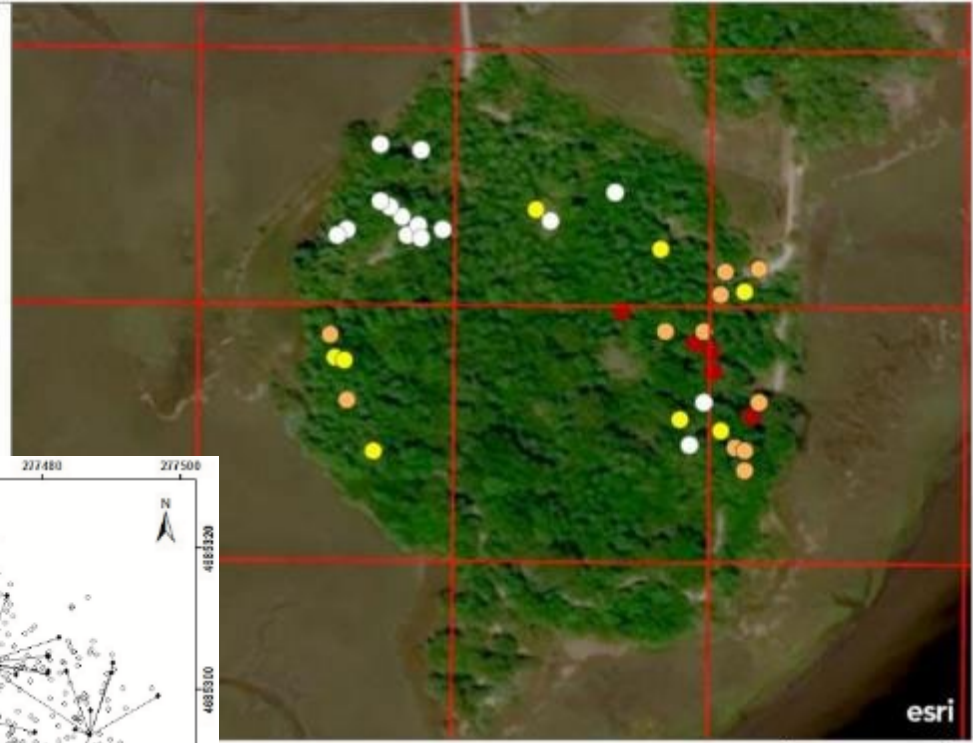
Updated-Tree-Inventory-uninfested



U.S. National Grid - USNG
100m

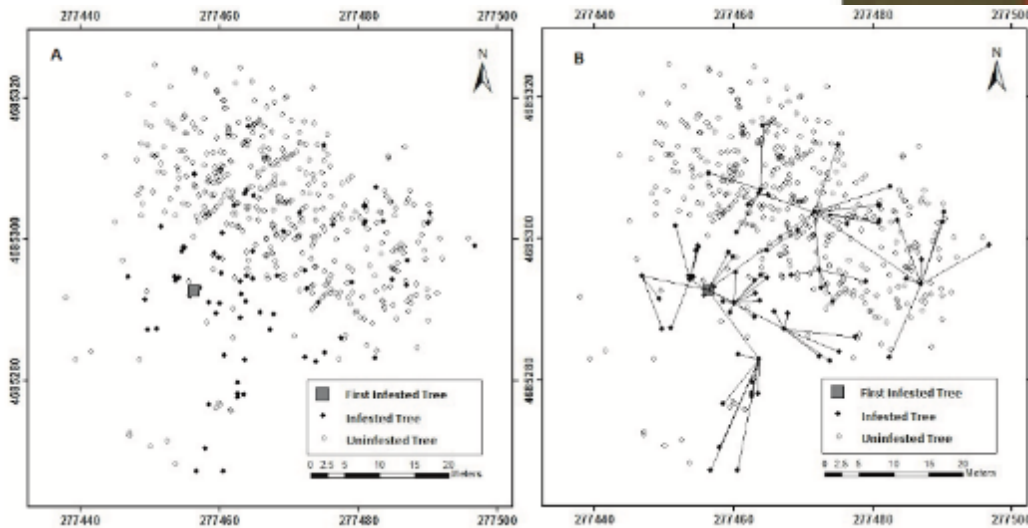


Updated-Tree-Inventory-infested



200ft

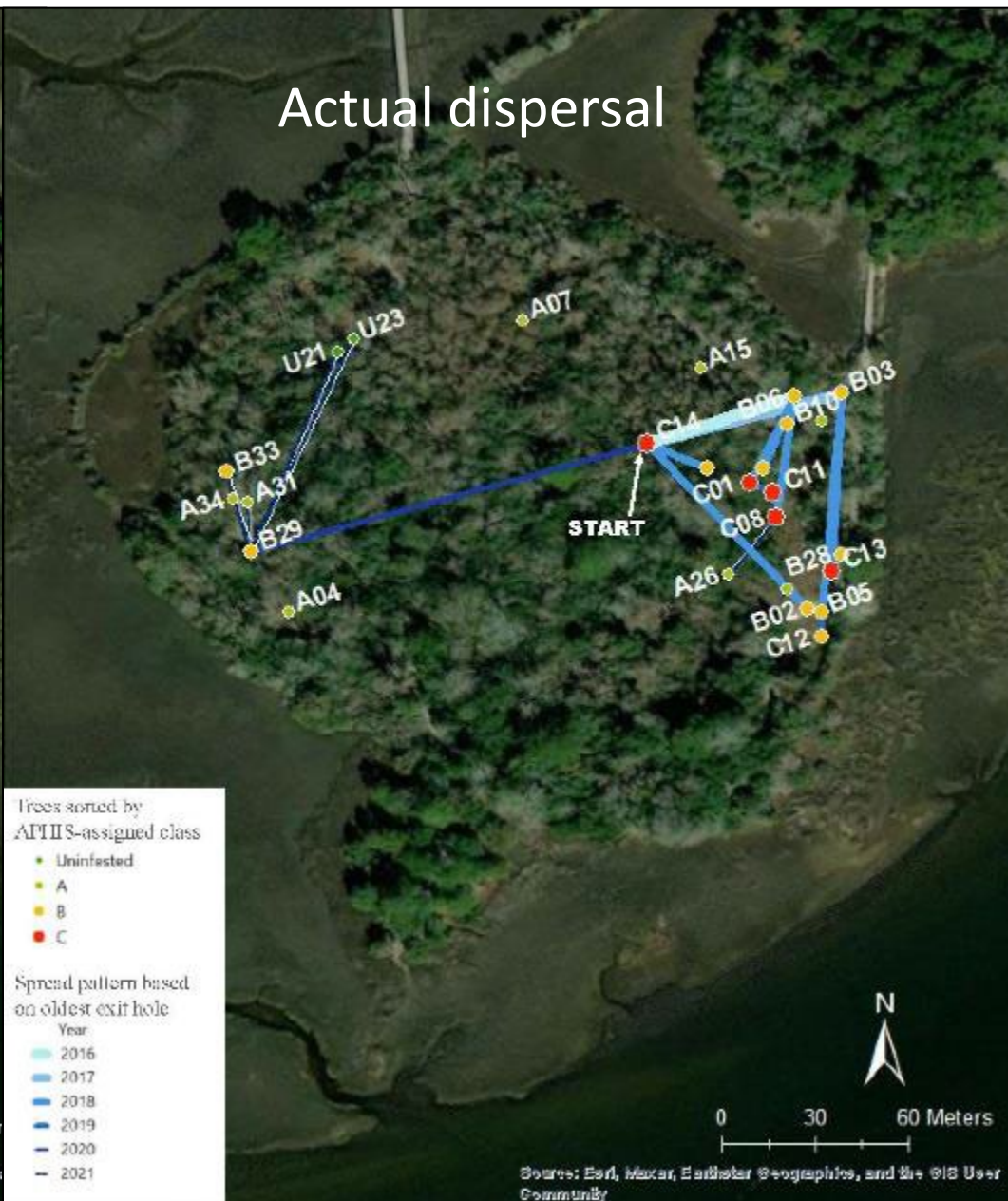
Maxar, Microsoft | National Geospatial-Intelligence Agency (NGA); Delta State University; Esri



Modeled dispersal using ALBRisk tool



Actual dispersal



Conclusions

Multi-stemmed trees received over 2.5 times more oviposition damage and over 3.5 times more exit holes than single-stemmed trees.

Most damage occurs in the middle 50% of a host tree's canopy or wood stems OR branches smaller than 10" diameter.

The average distance between ALB host trees was over 38m, which was greater than predicted by the ALBRisk model (Trotter et al. 2021).

Research topics addressed in SC

Adult trapping 

Phenology 

Biology 

Population dynamics 

Management 

Biological control

ALB management strategies

Remove and chip = standard

Cut and leave?

Herbicide treatment?



ALB management strategies



ALB management strategies

Dr. Kelly Oten, NCSU

Abby Ratcliff (M.S. 2022, NCSU)

12 trees/trt

May 2021 – May 2022

Quarterly sampling



ALB management strategies



ALB management strategies



Management alternatives

(again, but more this time)

Is drop and leave a viable management tactic?



Courtney Johnson
PhD student (NC State)

3 sites, 2 years (2023, 2024)

30 trees/site dropped
operationally in June

30 more dropped in August

180 trees/year

360 total trees









Will drop and leave work?

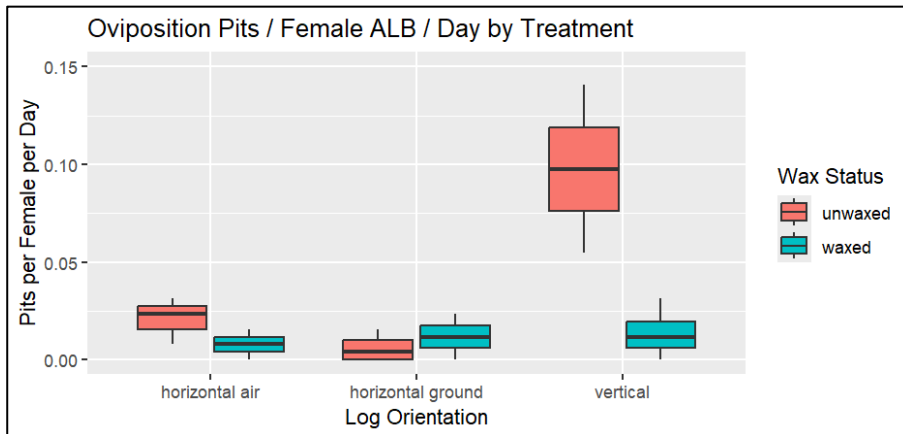
I think so!

No viable adults after
year 1

Few larvae, none appear to
be ALB

Why might this work?

ALB prefers to oviposit on vertical material



Decomposition by secondary insects and fungi



ALB management strategies



A final note on hack and squirt

Could be a viable option for
high-risk host removal in
natural areas

Fast, cheap, easy

Timing is important

Snags = wildlife habitat

Research topics addressed in SC

Adult trapping 

Phenology 

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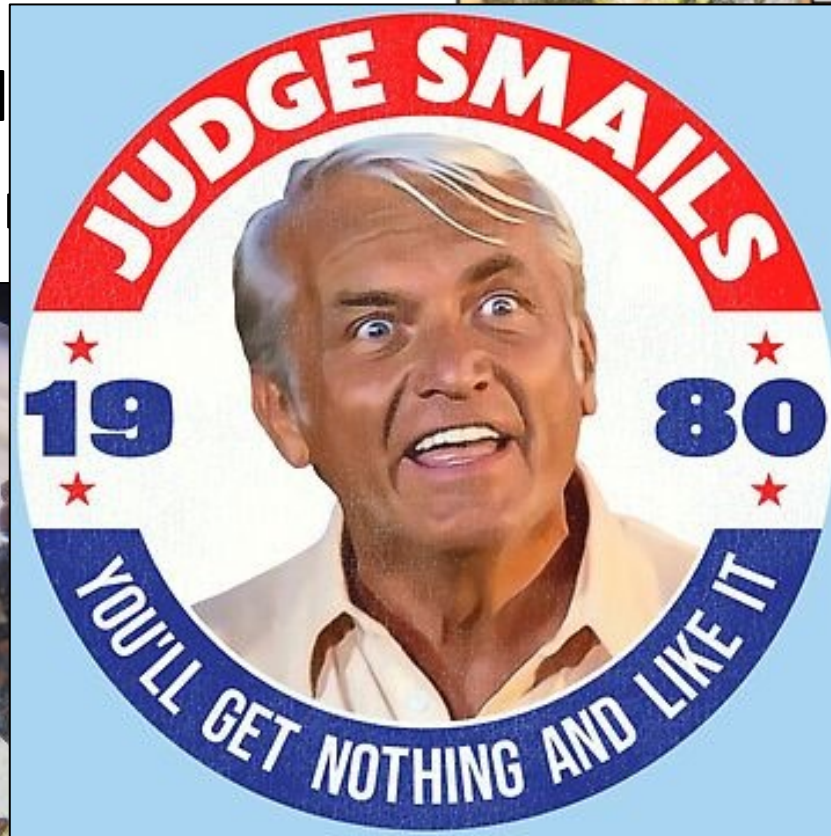
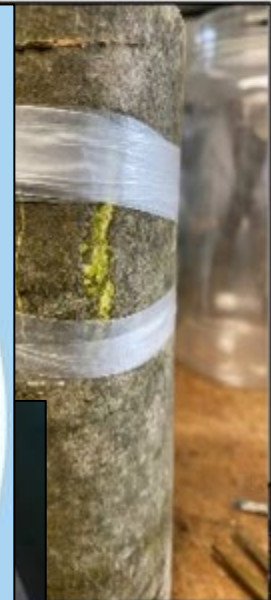
ALB biocontrol

Marina Lupu



ALB biocontrol

Larval
Senti



Ontsira mellipes releases

Released ~1,200 in July 2023

Released ~700 in August 2023

Released ~1,000 in June 2024

Released ~800 in July 2024

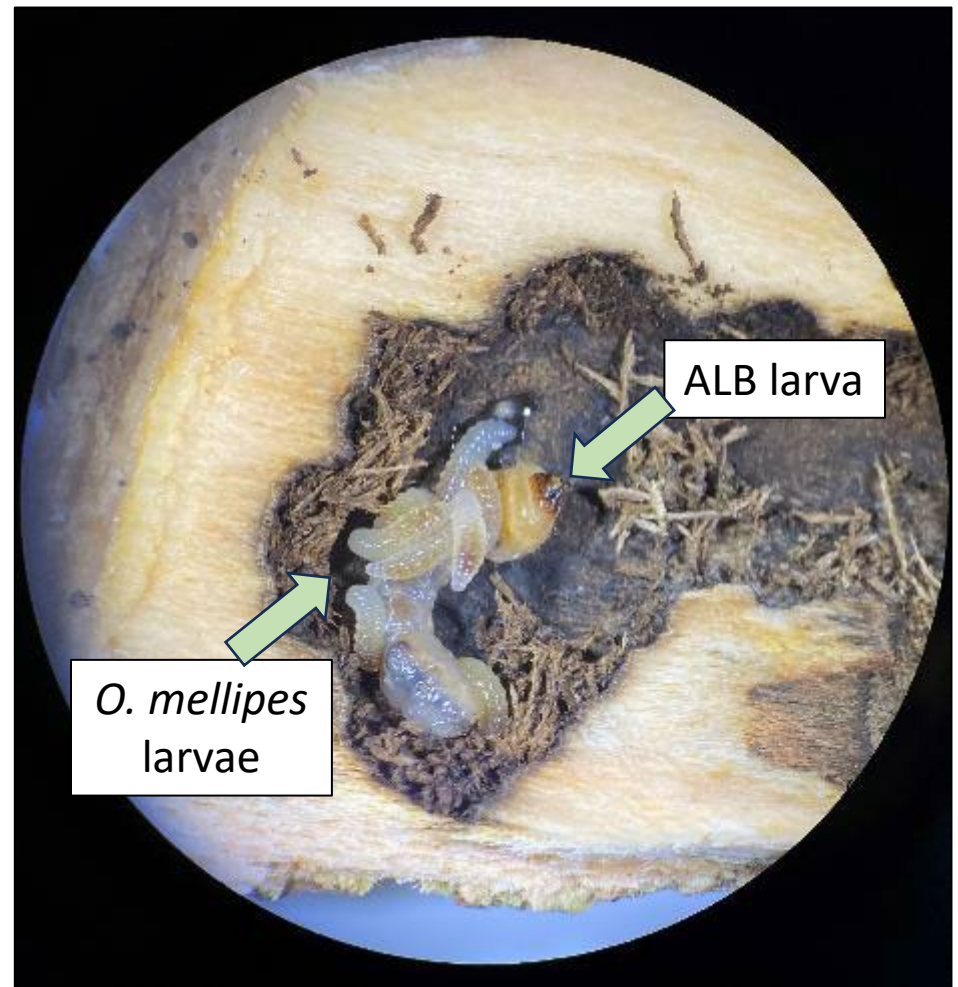
Trees destructively harvested
3 weeks post-release



Ontsira mellipes releases

The bad news: only 1 parasitized larva

The good news: first ever field validation of the technique



Conclusions

Some native parasitoids and natural enemies will probably impact some ALB

This is very unlikely to have any measurable impact on ALB populations

Maybe (juuuuuust maybe) there's potential for *O. mellipes*

Relevant theses

Marina Lupu, M.S., Clemson University, “An Evaluation of Potential Biocontrol Agents for *Anoplophora glabripennis* (Coleoptera: Cerambycidae) in South Carolina, U.S.A.”, May 2024

Lena Schmitt, M.S., Clemson University, “Phenology of Asian longhorned beetle (*Anoplophora glabripennis*, Coleoptera: Cerambycidae) in South Carolina, U.S.A.”, December 2023

Abby Ratcliff, M.S., NC State University, “Analysis of alternative control methods for the eradication of the Asian longhorned beetle (*Anoplophora glabripennis* Motschulsky) in infested bottomland sites of Charleston, South Carolina”, December 2022

Meredith Bean, M.S., Clemson University, “If you give a beetle a maple: population dynamics of the Asian longhorned beetle on an island in South Carolina”, December 2022

Questions?

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Department of

**FORESTRY AND ENVIRONMENTAL
CONSERVATION**



COOPERATIVE EXTENSION

College of Agriculture, Forestry and Life Sciences