

# Surveillance and Control of *Aedes aegypti* and *Aedes albopictus* in California: An Update

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***Aedes albopictus* and *Aedes aegypti*  
have arrived AND become established  
in California**

***Aedes albopictus***

2011: Los Angeles County



***Aedes aegypti***

2013: Madera, Fresno,  
San Mateo Counties



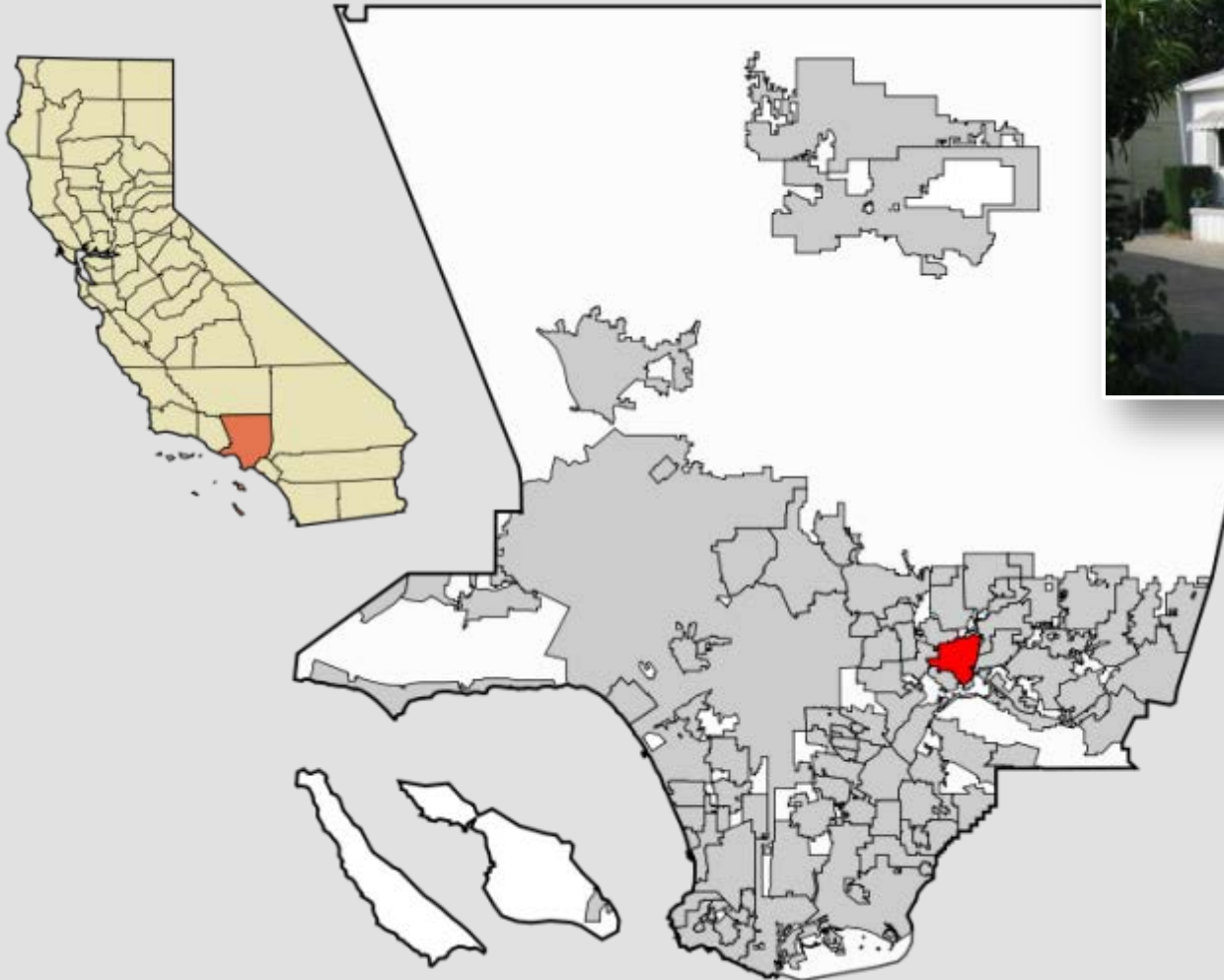
# *Aedes albopictus*: Previous Detections in CA

- **1946:** Los Angeles
  - Military cargo ship from Philippines
- **1971:** Oakland
  - Cargo ship with tires from Vietnam
- **1987:** Oakland
  - Tires shipped from Hawaii
- **2001:** Los Angeles County
  - Lucky Bamboo shipped from China
  - 15 infestations in 6 counties at nurseries; federal embargo
  - Local eradication efforts were successful...sort of
- **2004:** Orange County
  - Boat shipped from Hawaii

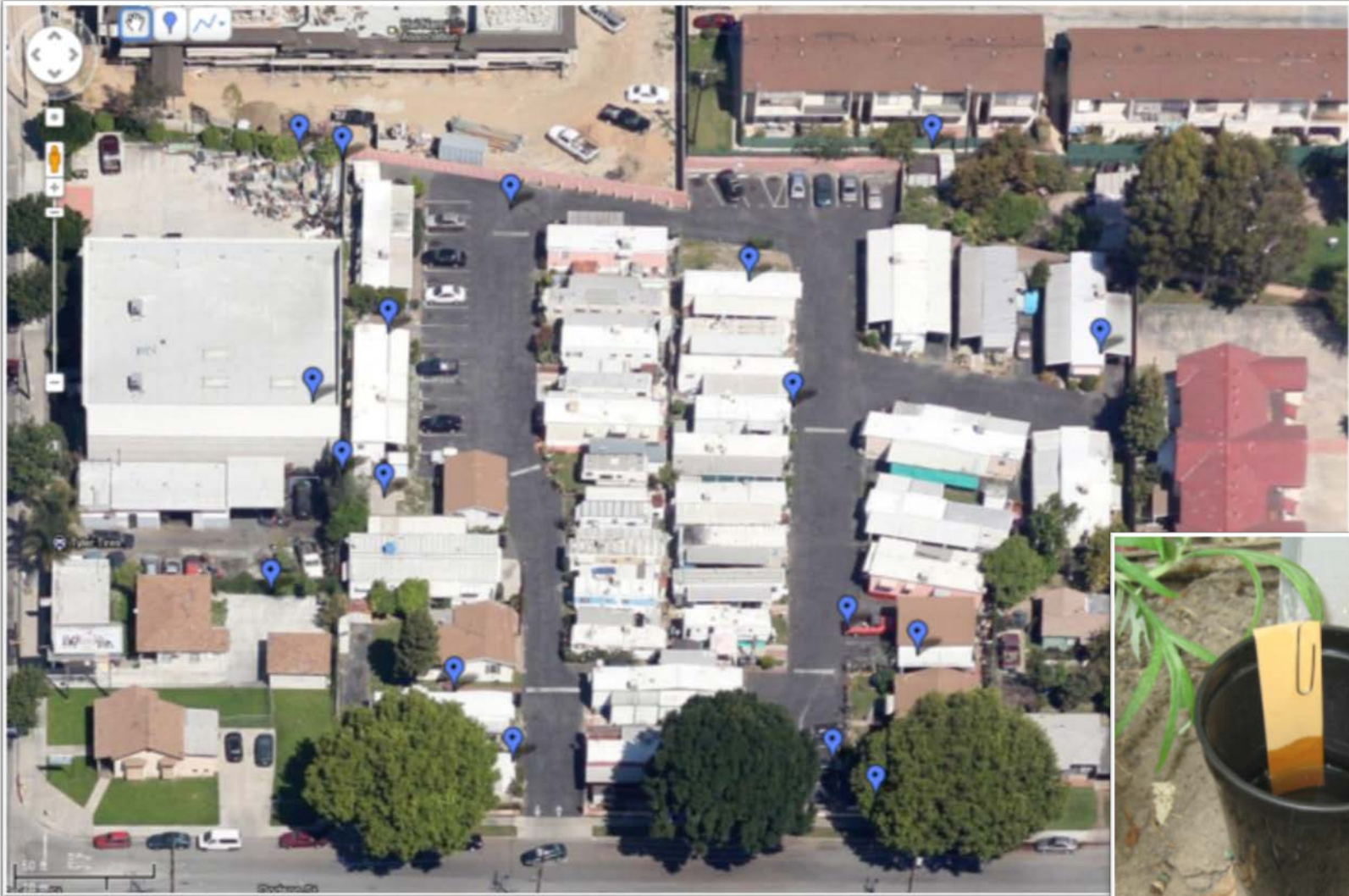


# El Monte, LA County 2011

Trailer Park: Resident Service Request on Sept. 2



# September 5-9, 2011

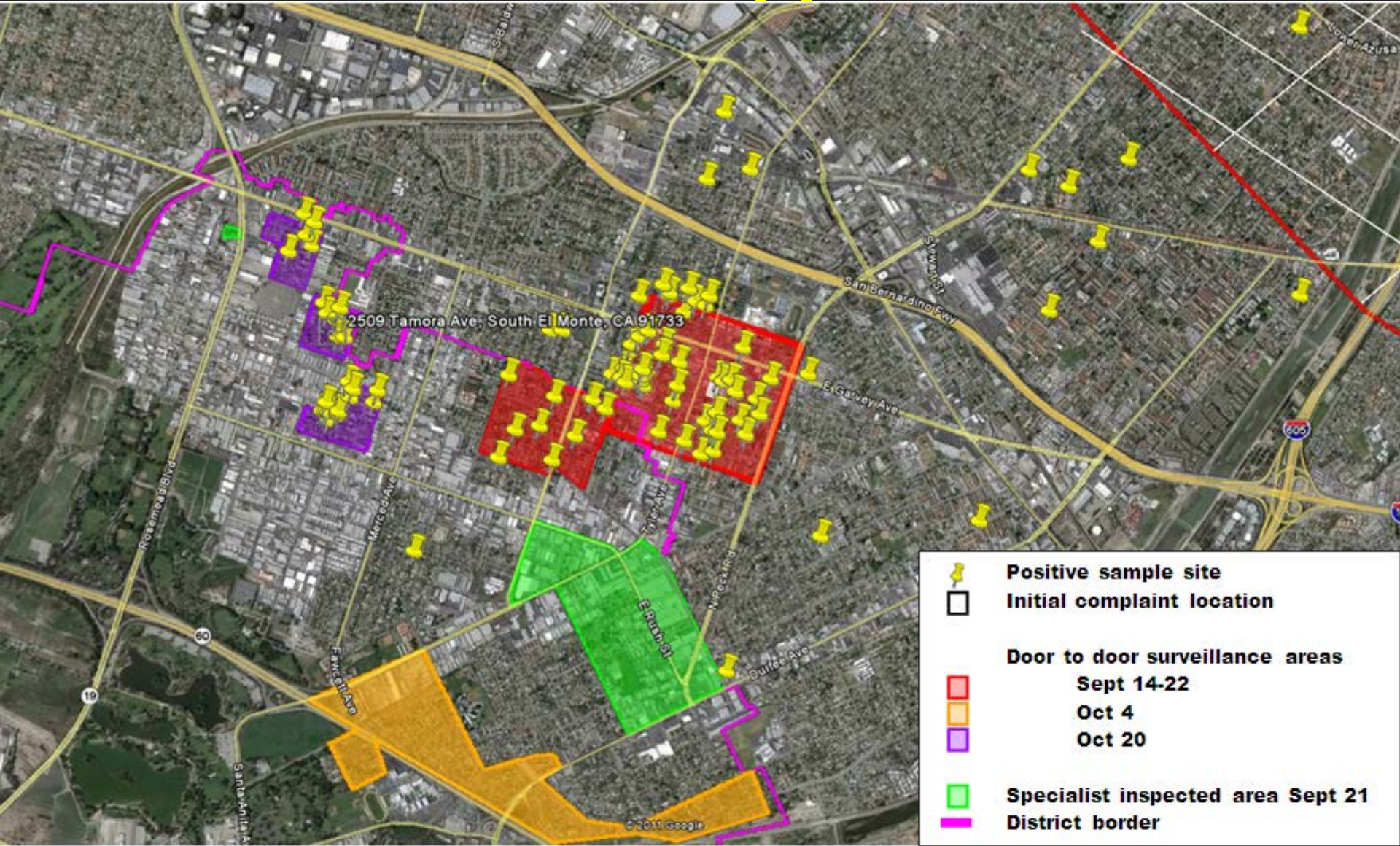


**33 / 63 (52%) ovitraps positive**

# Good micro-habitat breeding sources

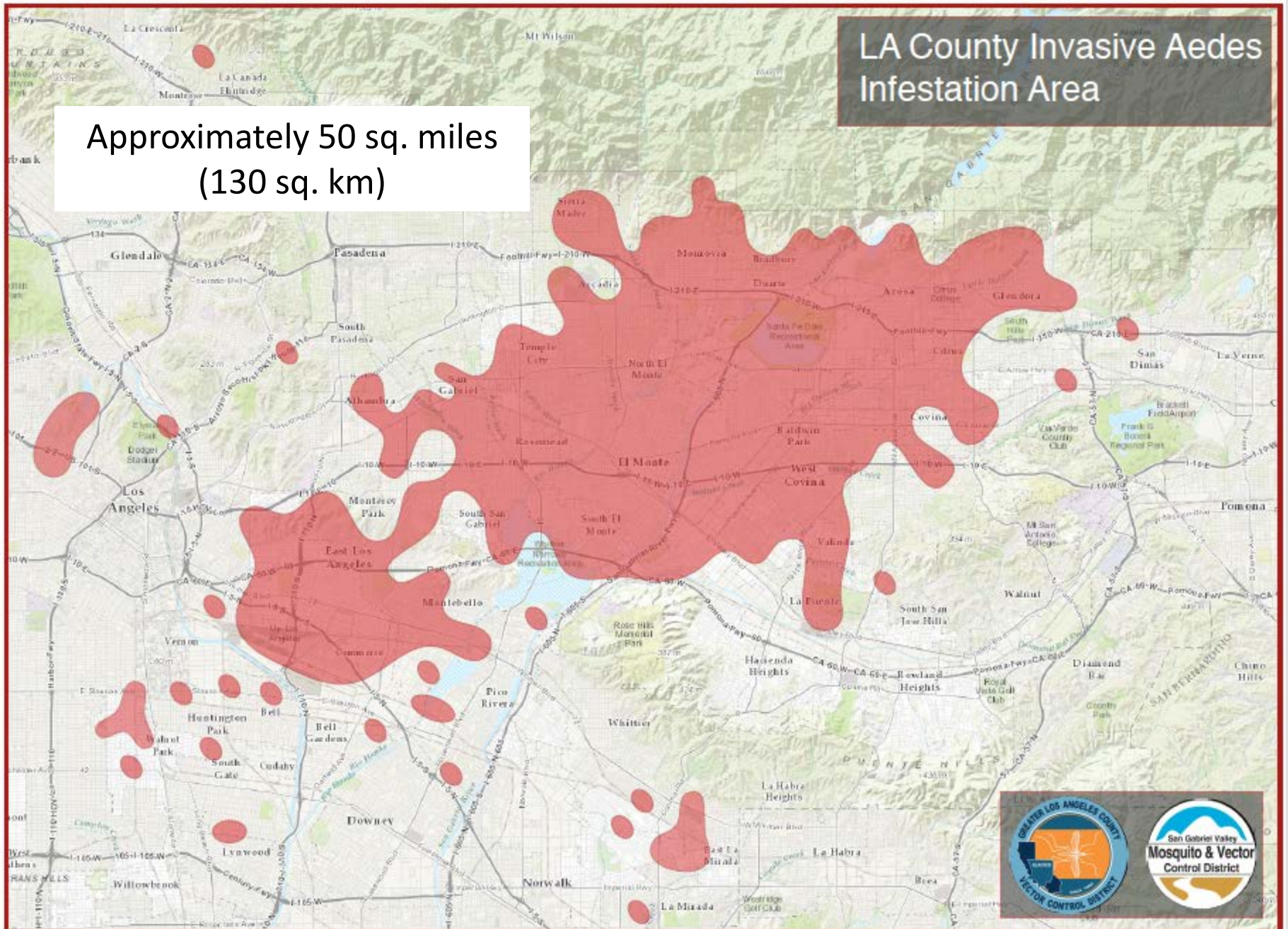


# October 27 - Approx. 8 mi<sup>2</sup>



# LA County Invasive Aedes Infestation Area

Approximately 50 sq. miles  
(130 sq. km)





# Origin of *Aedes albopictus* in LA?

OPEN ACCESS Freely available online

PLOS ONE

## Genetic Analysis of Invasive *Aedes albopictus* Populations in Los Angeles County, California and Its Potential Public Health Impact

Daibin Zhong<sup>1</sup>, Eugenia Lo<sup>1</sup>, Renjie Hu<sup>2</sup>, Marco E. Metzger<sup>2</sup>, Robert Cummings<sup>3</sup>, Mariangela Bonizzoni<sup>1</sup>, Kenn K. Fujioka<sup>4</sup>, Teresa E. Sorvillo<sup>4</sup>, Susanne Klueh<sup>5</sup>, Sean P. Healy<sup>6a</sup>, Chris Fredregill<sup>7</sup>, Vicki L. Kramer<sup>2</sup>, Xiaoguang Chen<sup>8</sup>, Guiyun Yan<sup>1\*</sup>

- Population genetics study with UC Irvine collaborators, published July 2013
- Mosquitoes collected in 2001 and 2011 shared similar genetics and were similar to specimens from south China
- Population likely represents descendants of the 2001 lucky bamboo introduction that remained undetected for over a decade

# *Aedes aegypti*: Previous Detections in CA

- **1910-1912: San Diego County, San Francisco (Angel Island)**
- **1979: San Mateo County, near SFO airport**
  - Single 4<sup>th</sup> instar larva collected in marsh during routine surveillance
- **1987: San Mateo County**
  - Single dead 2<sup>nd</sup> instar larva in a shipment of tire casings from Miami FL



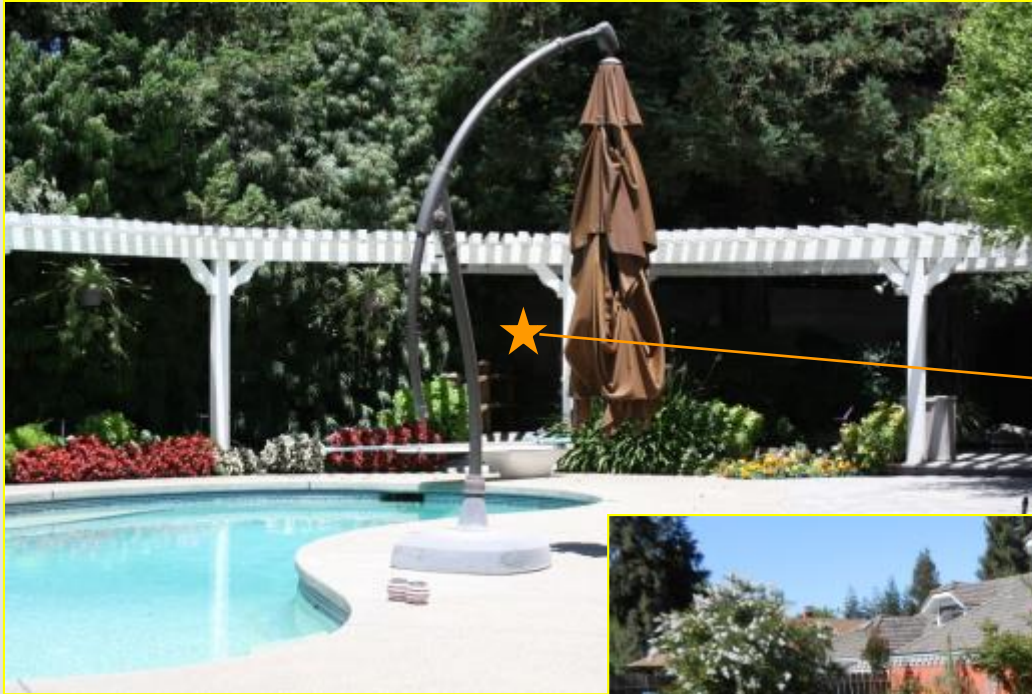
June 7, 2013

# Madera, Madera County



# Madera Index Site

residential neighborhood  
with large backyards,  
pristine landscaping, lots of  
potted plants



June 7 – CO<sub>2</sub> = 3F  
June 11 – BG = 17F, 33M



# Additional surveillance tools used



**BG Sentinel**



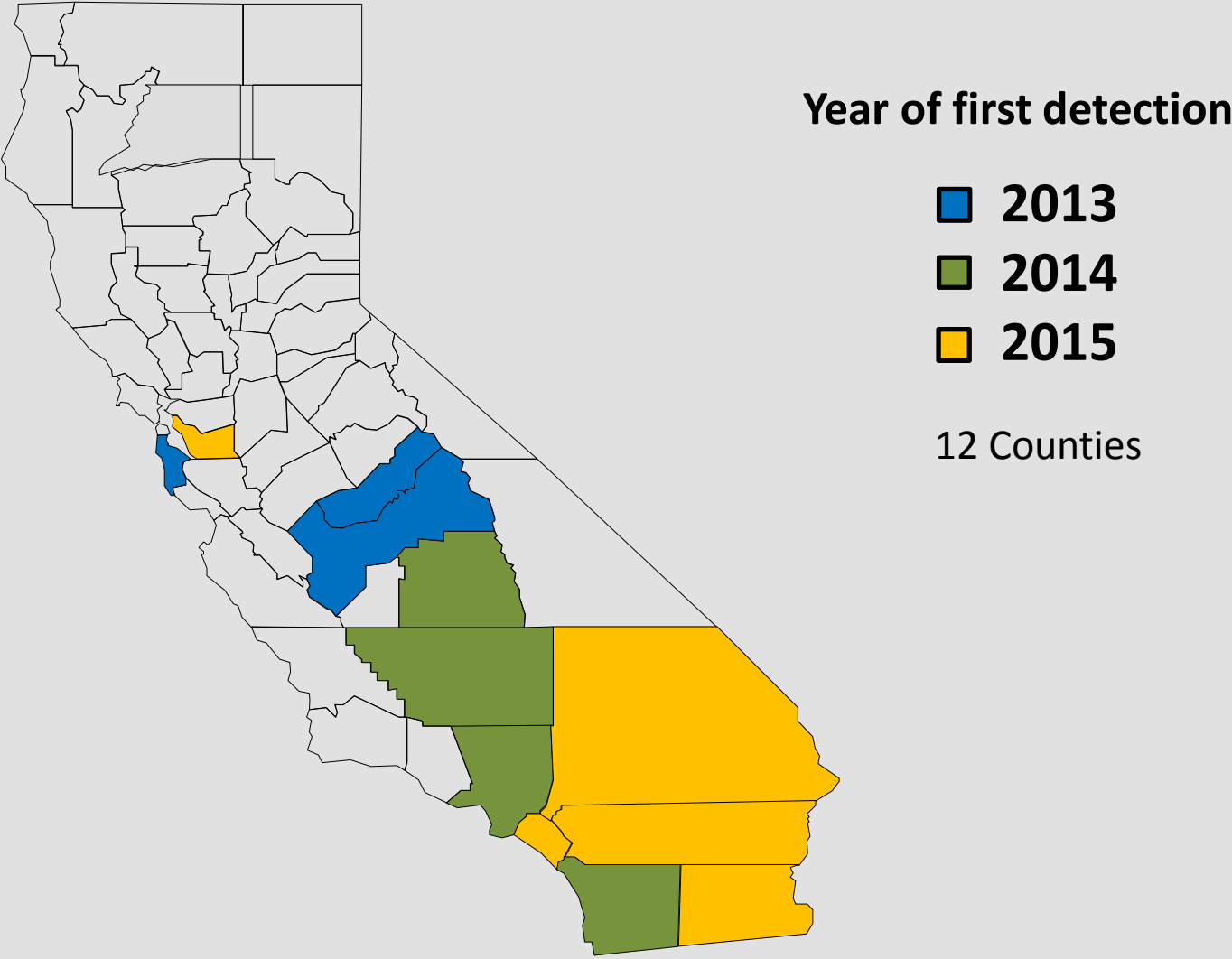
**Ovitrap**



**Autocidal Gravid Ovitrap (AGO)**

Supplied by CDC Dengue Branch

# *Aedes aegypti* Mosquito Detection Sites in California 2013-2015



# Origin of *Aedes aegypti* in California?

## (Madera, Fresno, San Mateo Counties)

OPEN ACCESS Freely available online

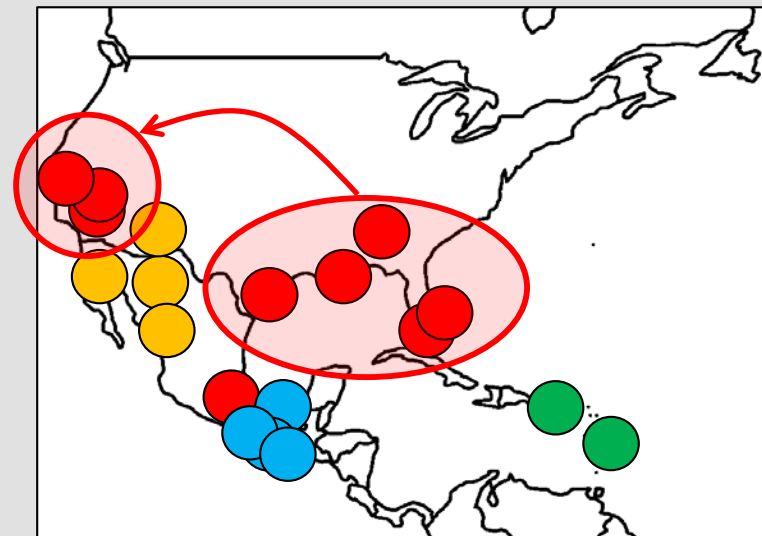
PLOS NEGLECTED TROPICAL DISEASES

### Origin of the Dengue Fever Mosquito, *Aedes aegypti*, in California

Andrea Gloria-Soria<sup>1</sup>, Julia E. Brown<sup>1</sup>, Vicki Kramer<sup>2</sup>, Melissa Hardstone Yoshimizu<sup>2</sup>, Jeffrey R. Powell<sup>1\*</sup>

<sup>1</sup> Department of Ecology and Evolutionary Biology, Yale University, New Haven, Connecticut, United States of America, <sup>2</sup> California Department of Public Health, Vector-Borne Disease Section, Sacramento, California, United States of America

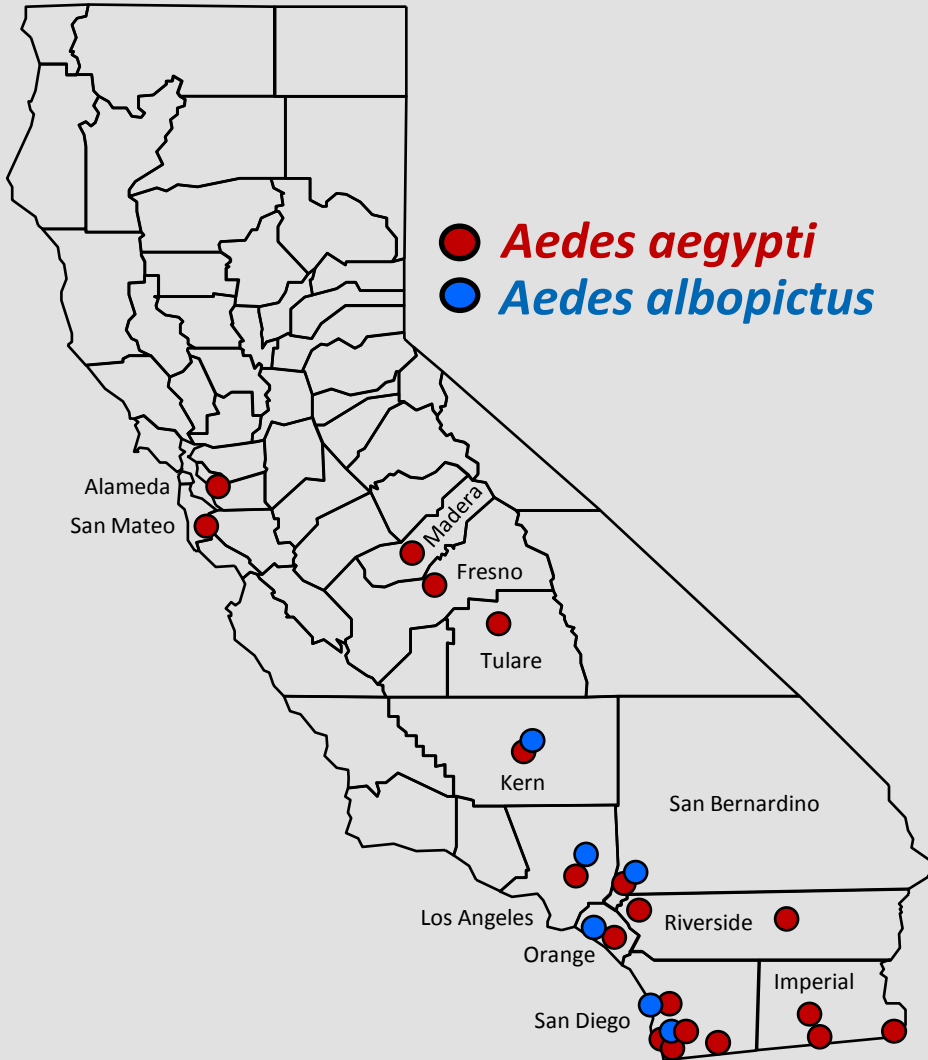
- Population genetics study with Jeffrey Powell (Yale), published July 2014
- High genetic variation in CA specimens suggests multiple founders
- Genetically most similar to specimens collected from New Orleans / Houston
- Mode of introduction remains unknown



# Aedes aegypti and Aedes albopictus Mosquitoes in California

113 cities (74 Aedes aegypti and 38 Aedes albopictus)

**Aedes aegypti** and **Aedes albopictus** Detection Sites by County/City<sup>§</sup>



## Alameda

Hayward

## Fresno

Clovis  
Firebaugh  
Fowler  
Fresno  
Kerman  
Mendota  
Sanger  
Tranquillity\*<sup>§</sup>

## Imperial

Andrade\*  
Brawley  
Calexico  
El Centro  
Heber\*  
Holtville  
Imperial  
Seeley\*

## Kern

Arvin  
Arvin

## Los Angeles

Alhambra  
Avocado Heights\*<sup>§</sup>  
Bell<sup>§</sup>  
Bellflower  
Bell Gardens  
Commerce  
Downey<sup>§</sup>  
East Los Angeles\*  
Florence-Graham\*  
Huntington Park  
La Mirada  
Los Angeles  
Maywood  
Montebello  
Monterey Park  
Paramount<sup>§</sup>  
Pico Rivera  
Rosemead  
South Gate  
South Whittier\*<sup>§</sup>

## Los Angeles (continued)

Alhambra  
Altadena\*  
Arcadia  
Avocado Heights\*  
Azusa  
Baldwin Park  
Bradbury  
Covina  
Duarte  
El Monte  
Glendora  
Irwindale  
La Cañada Flintridge  
La Mirada  
La Puente  
La Verne<sup>§</sup>  
Los Angeles  
Monrovia  
Monterey Park  
Pico Rivera  
Rosemead  
San Dimas<sup>§</sup>  
San Gabriel  
Sierra Madre  
South El Monte  
South Whittier\*  
Temple City  
West Covina  
Whittier\*

## Madera

Madera  
Madera Ranchos\*  
Parkwood\*

## Orange

Anaheim  
Costa Mesa  
Garden Grove  
Orange  
Lake Forest  
Mission Viejo  
Santa Ana  
Huntington Beach  
Los Alamitos

## Orange (continued)

Mission Viejo  
Newport Beach<sup>§</sup>  
Santa Ana

## Riverside

Cathedral City<sup>§</sup>  
Coachella  
Corona  
East Hemet\*<sup>§</sup>  
Riverside  
San Jacinto

## San Bernardino

Colton  
Montclair  
Upland

## San Diego

Bonita\*  
Chula Vista  
Coronado<sup>§</sup>  
El Cajon  
Escondido  
Imperial Beach  
Lakeside\*  
La Mesa  
La Presa\*  
Lemon Grove  
National City  
Oceanside  
San Diego  
Spring Valley\*  
Tecate\*  
Vista  
Carlsbad  
San Diego

## San Mateo

Atherton  
Menlo Park

## Tulare

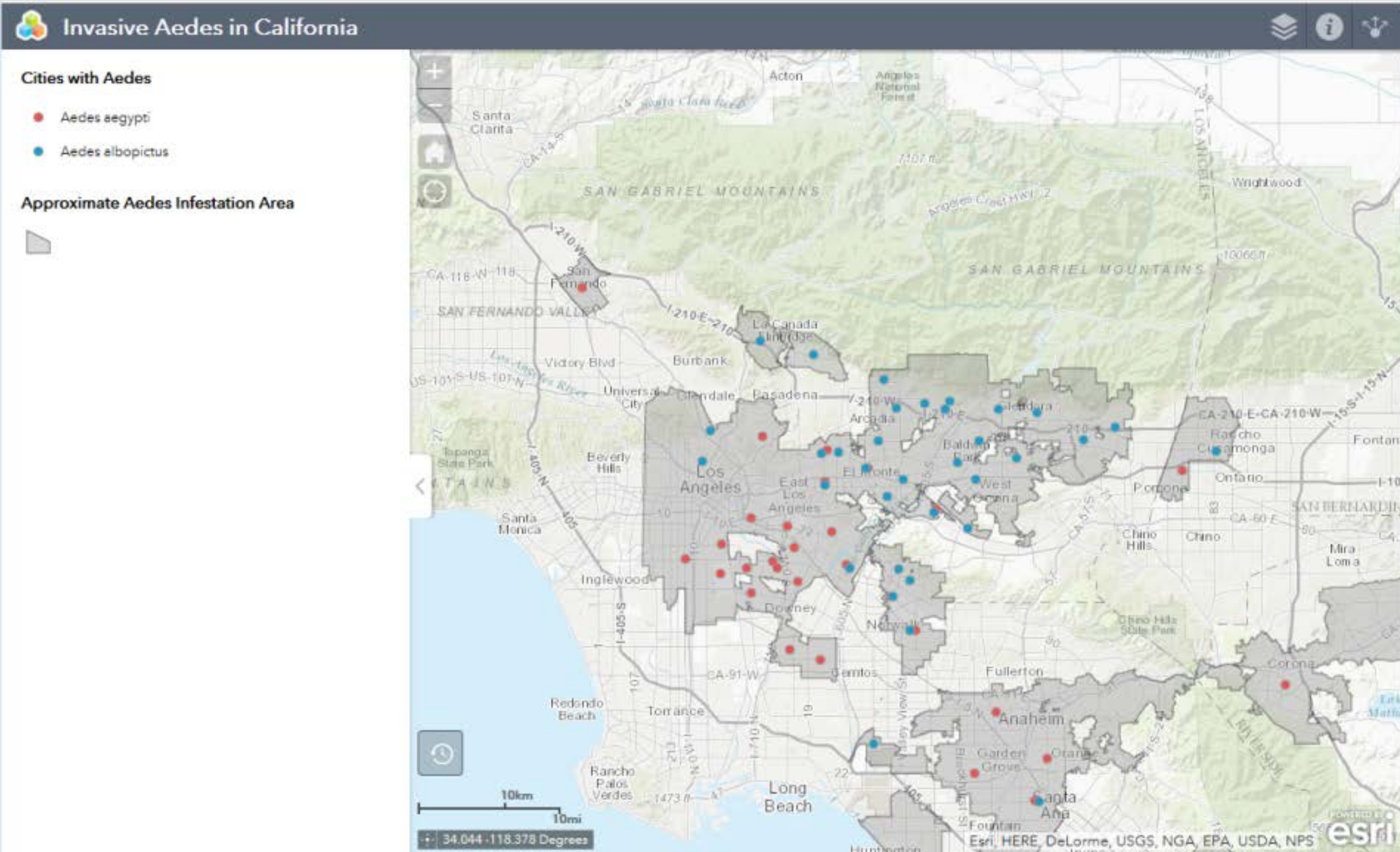
Exeter

<sup>§</sup> New detection location within the previous four weeks

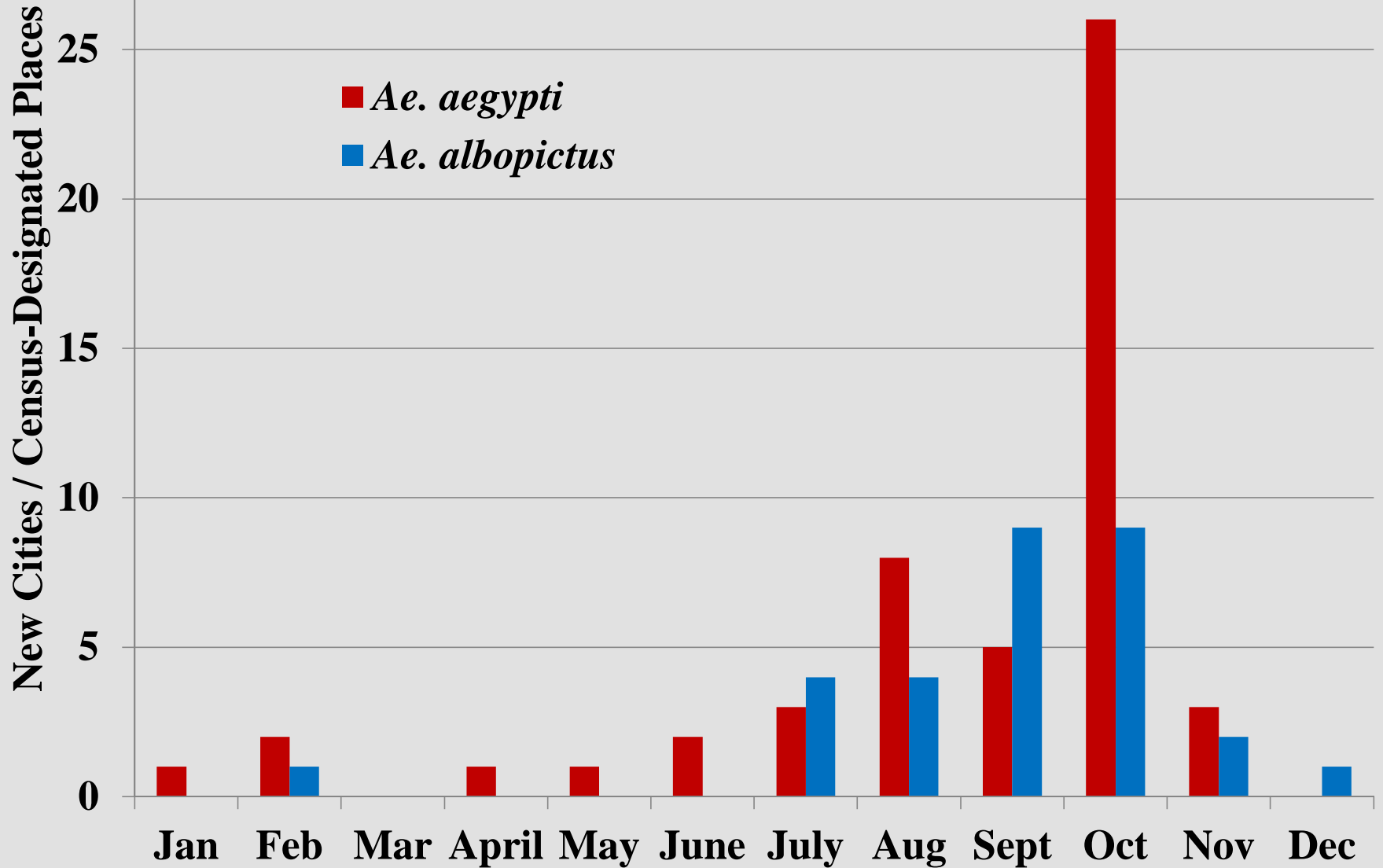
\*Unincorporated Census-Designated Places



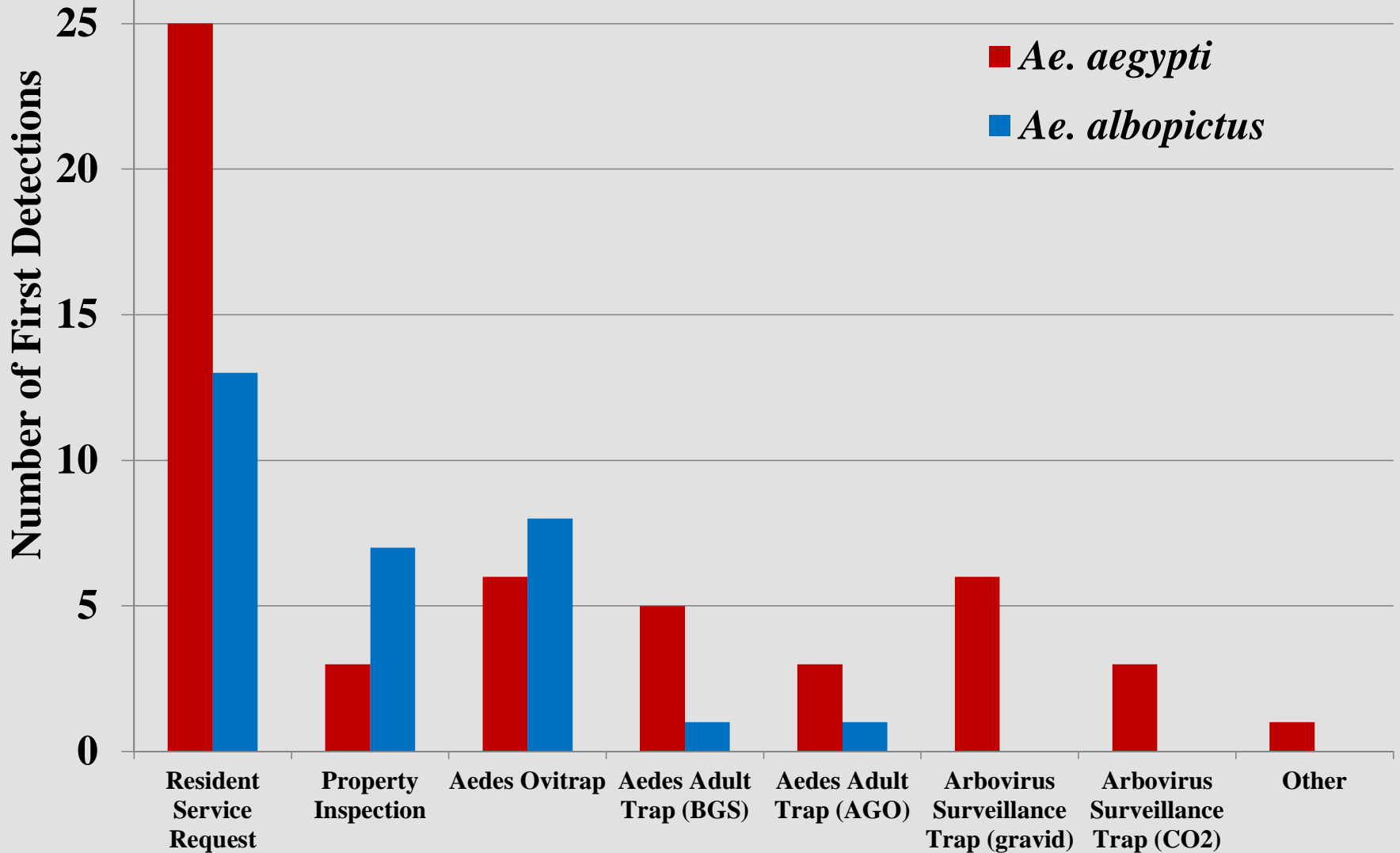
# Aedes mosquitoes, Los Angeles County



# Month of first detection of *Aedes* mosquitoes 2011 - 2015



# Method of first detection of *Aedes* mosquitoes 2011 - 2015



# Control Challenges

- Biology of *Aedes aegypti* and *albopictus*
  - Eggs resistant to drying
  - Breed in artificial containers; cryptic sites
  - Day biters; readily enter dwellings
- Insufficient resources to find, eliminate and/or treat all sources
- Difficult to educate community and elicit on-going source reduction
- Rapid and ongoing reintroduction of *Aedes* eggs and adults into an area post-treatment

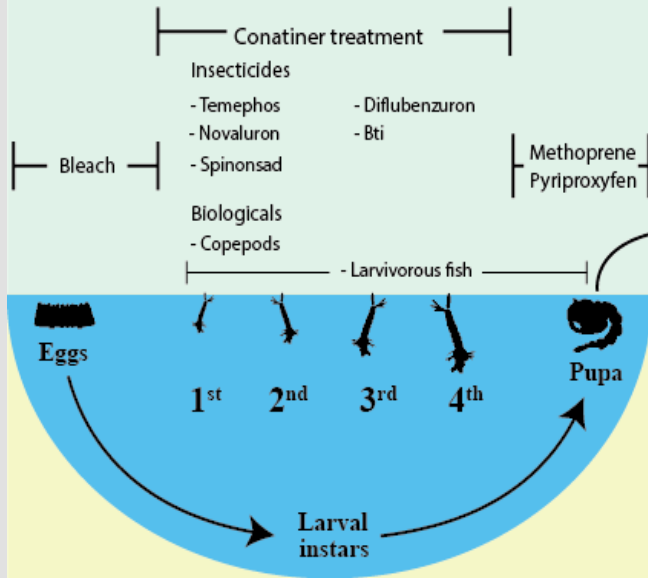
# Overview of *Aedes* Control

## Existing Methods

### Immature control

#### Major categories

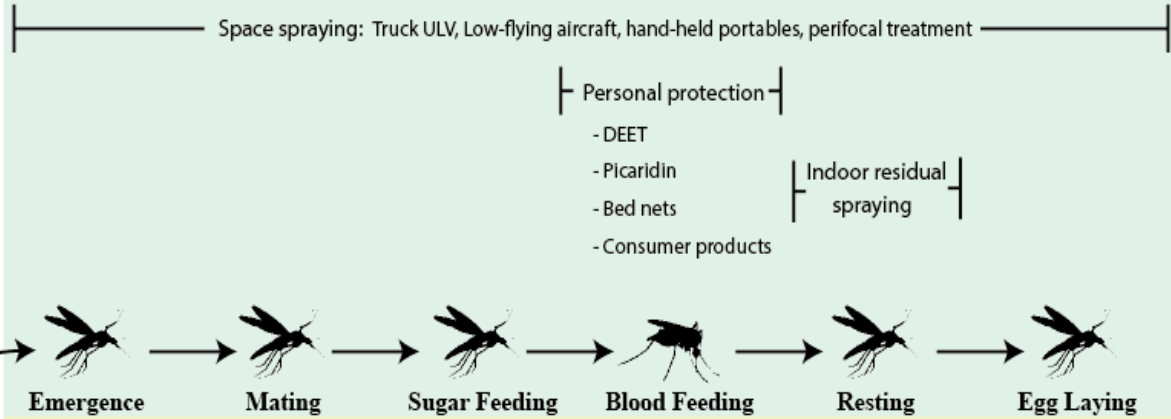
- Container cleaning (bleach/wash/dump)
- Container manipulation (polystyrene beads)
- Container treatment
- Social campaigns (education, source reduction)
- Environmental Management
- Legislation



### Adult control

#### Major categories

- Space spraying
- Indoor residual spraying
- Personal protection



REVIEW

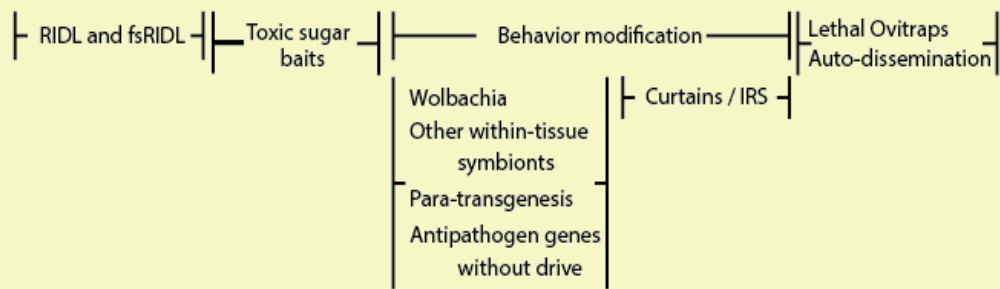
### A Critical Assessment of Vector Control for Dengue Prevention

Nicole L. Achee<sup>1\*</sup>, Fred Gould<sup>2</sup>, T. Alex Perkins<sup>3,2</sup>, Robert C. Reiner Jr.<sup>3,4</sup>, Amy C. Morrison<sup>5</sup>, Scott A. Ritchie<sup>6</sup>, Duane J. Gubler<sup>6,9</sup>, Remy Teyssou<sup>7</sup>, Thomas W. Scott<sup>8,9</sup>

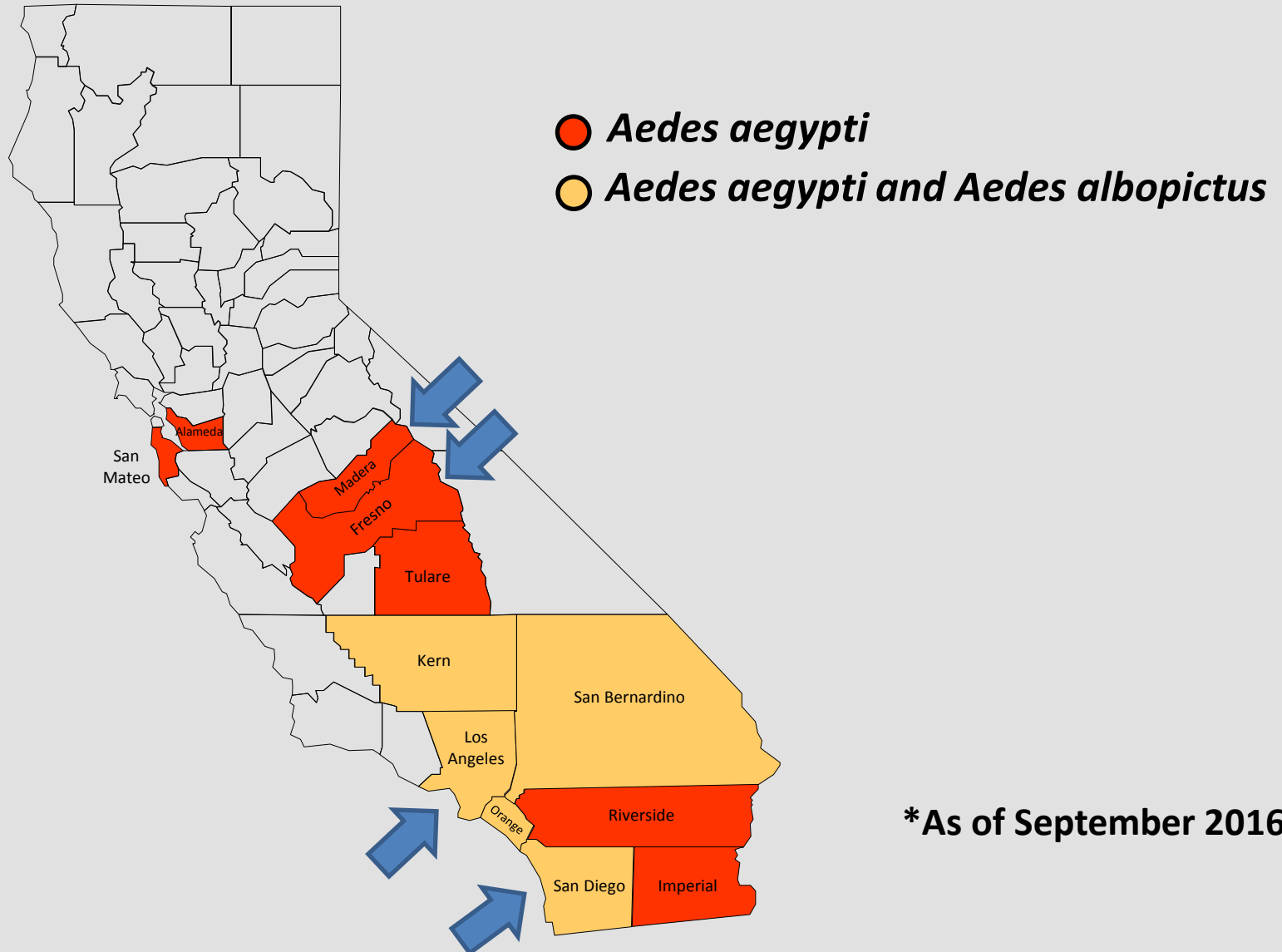
New entomopathogenic fungi

Molecular insecticides, medea/HEGs, new insecticides

## Methods under Development



# *Aedes aegypti* and *Aedes albopictus* Mosquito Detections, by County, California, 2011-2016\*



# Examples of Strategies Used in CA

- ✓ All agencies focus on community education and source reduction (scrub, cover, dump, discard)

## Madera County

- Larvicides (Bti)
- Absorbent gel in vases (cemetery)
- Residual barrier sprays (deltamethrin)

## Fresno County

- Lethal ovitraps (CDC AGO trap)
- Residual barrier sprays (quick rebound)
- Spinosad (Natular) for yard drains
- Note: documented pyrethroid resistance

## Los Angeles County

- Backyard space spraying (Duet – pyrethroids)
  - Done in response to service requests; includes surrounding homes
  - Cannot sustain; getting up to 90 service requests/day
- Larviciding with Bti (LV – Vectobac WDG)
  - Early morning only; spray in backyards
  - Problem: Underground storm drains

## San Diego County

- Larviciding; adulticiding in response to travel-associated cases



## Response: Travel-Associated Case

- Conduct door-to-door inspections within 150 meters around a case-patient's home and eliminate larval habitats
- Treat with long-lasting larvicide any water-holding containers that cannot be dumped, covered, or discarded
- Educate the public to continually eliminate larval habitats
- Encourage the public to use insect repellents, window and door screens, and air conditioning to reduce risk of getting mosquito bites

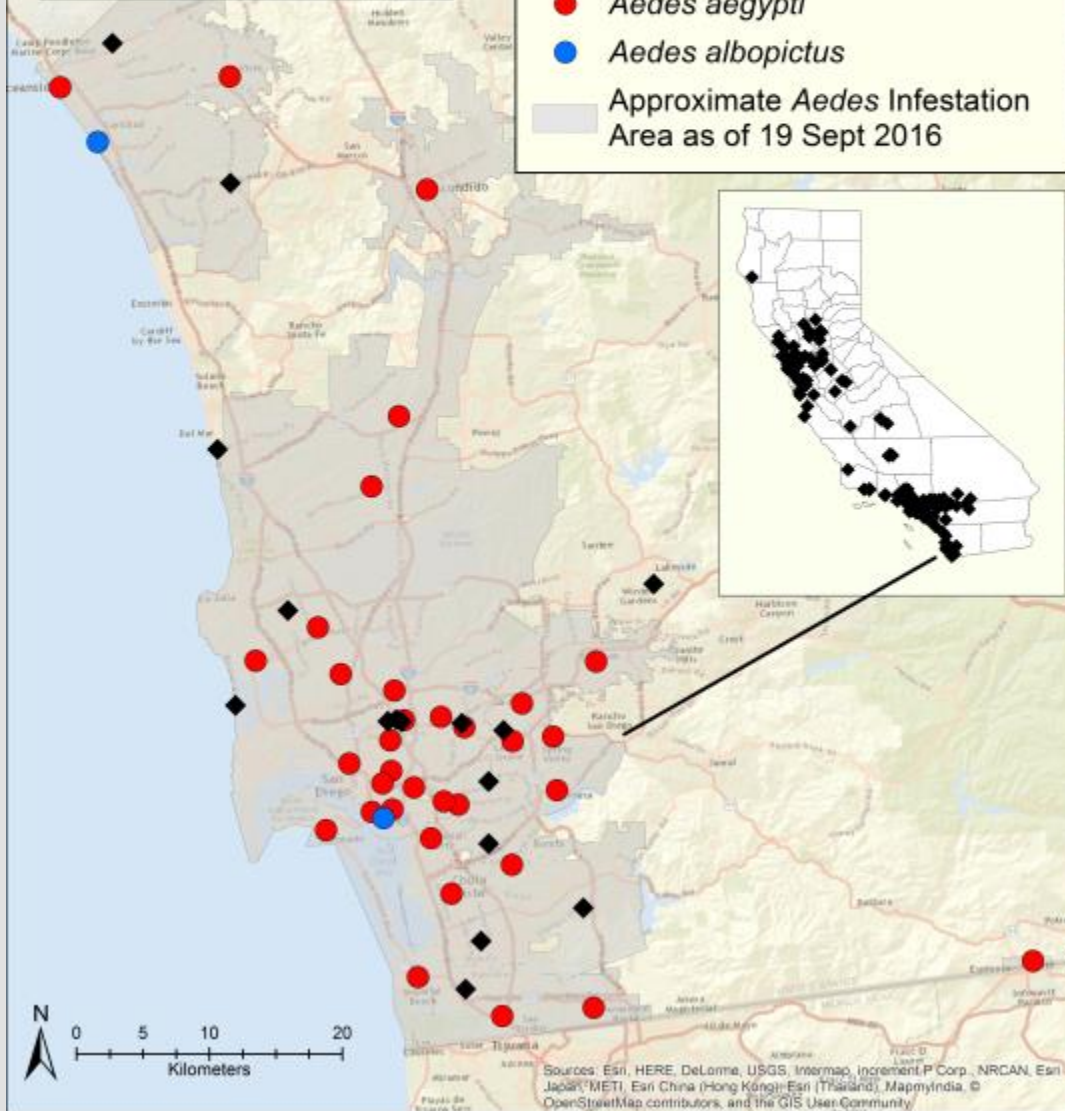
# Initiate adult mosquito control

- Treat the outdoors within 150 meters around a case-patient's home with adulticide
    - Include residual and spatial insecticide treatments
    - Repeat as necessary to reduce vector abundance
  - Initiate/maintain adult sampling to estimate adult mosquito abundance and evaluate effectiveness of insecticide treatments
  - Test mosquitoes for viruses (UC Davis)
- Intensify efforts if case is locally transmitted and escalate further if a cluster of cases

# Travel-Associated Zika Cases and *Aedes* Detections in San Diego County\*

\* *Aedes* may not be found throughout the contiguous area indicated in gray.

- ◆ Zika Cases as of 19 September 2016
- *Aedes aegypti*
- *Aedes albopictus*
- Approximate *Aedes* Infestation Area as of 19 Sept 2016



# Innovative Control Approaches

## Two concepts were evaluated in California in 2015

- A *Wolbachia* - based strategy: Los Angeles County
- Auto-dissemination of insect growth regulators strategy: Fresno County

Mosquitoes are good at:

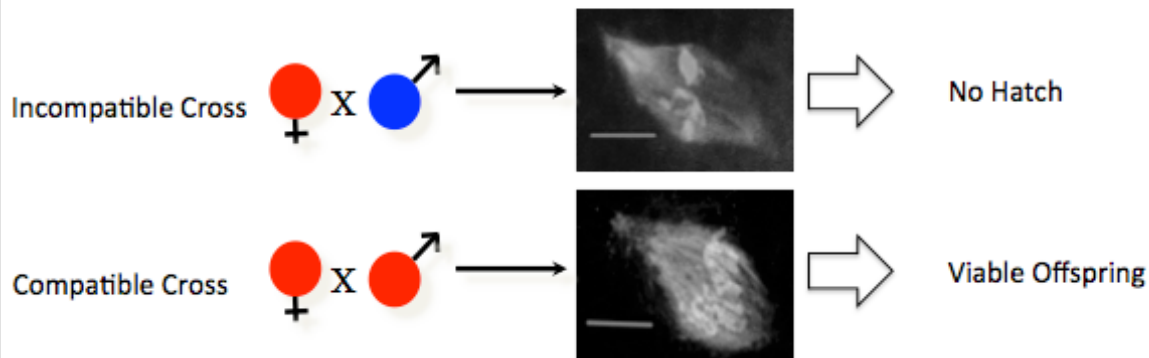
- ✓ finding each other for mating
- ✓ finding cryptic sources of water for breeding



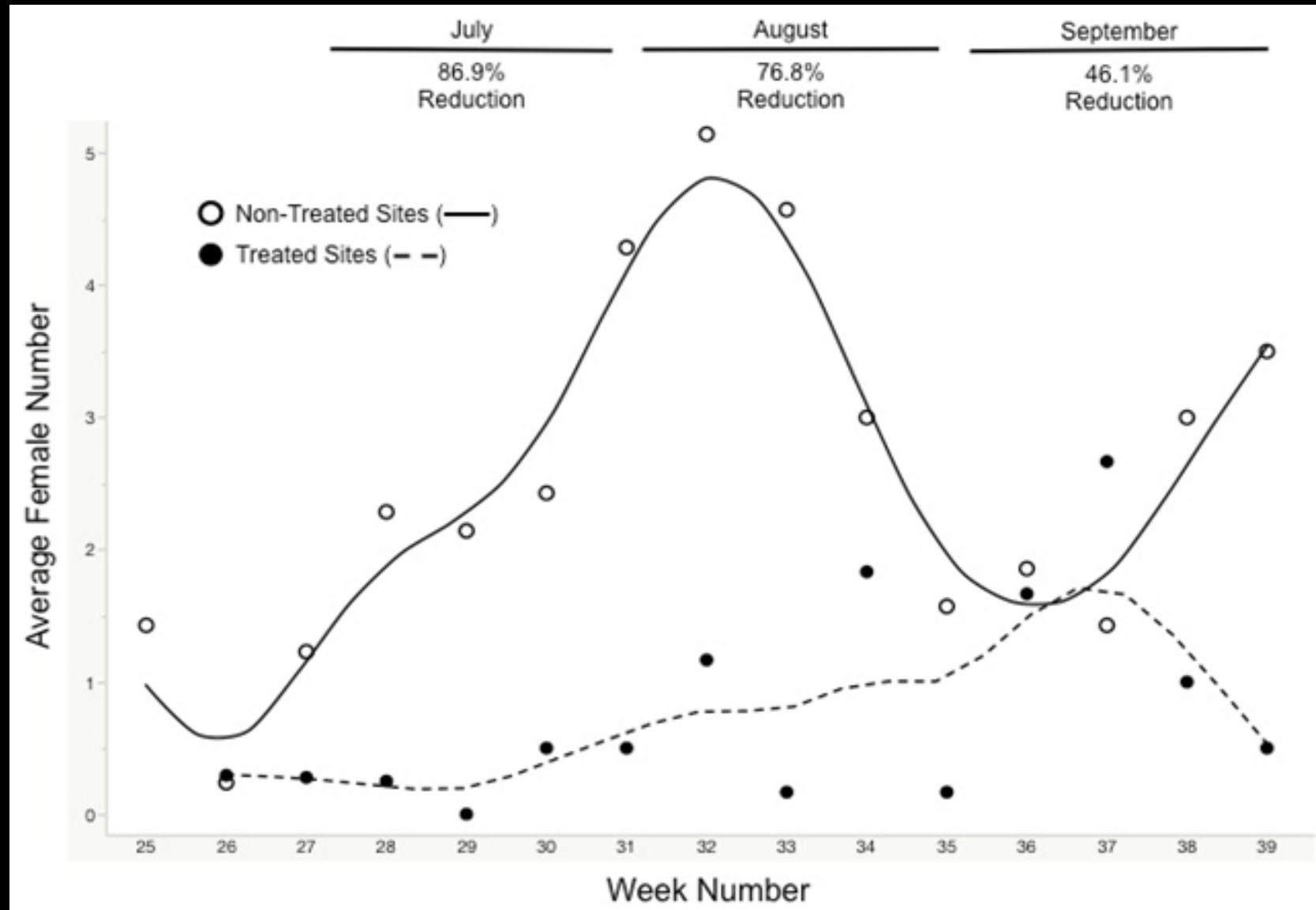
# *Wolbachia*-Infected Male *Aedes albopictus*

- Previous research
  - When naturally-occurring *Wolbachia* bacteria in *Aedes albopictus* is replaced with one that occurs naturally in other mosquitoes (*Wolbachia pipientis*), and infected males mate with wild females, eggs fail to hatch
- Approach similar to the “sterile male technique”
- *Wolbachia*-infected *Aedes* reared in KY and shipped to LA; male mosquitoes released twice weekly

## Cytoplasmic Incompatibility (CI) in Mosquitoes

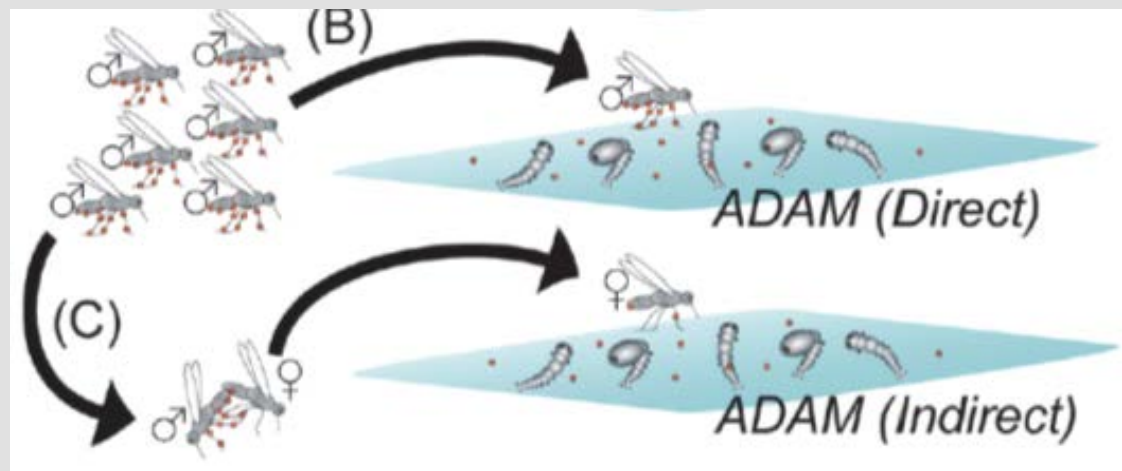


# *Aedes albopictus* abundance in treated and control sites, Los Angeles County, 2015



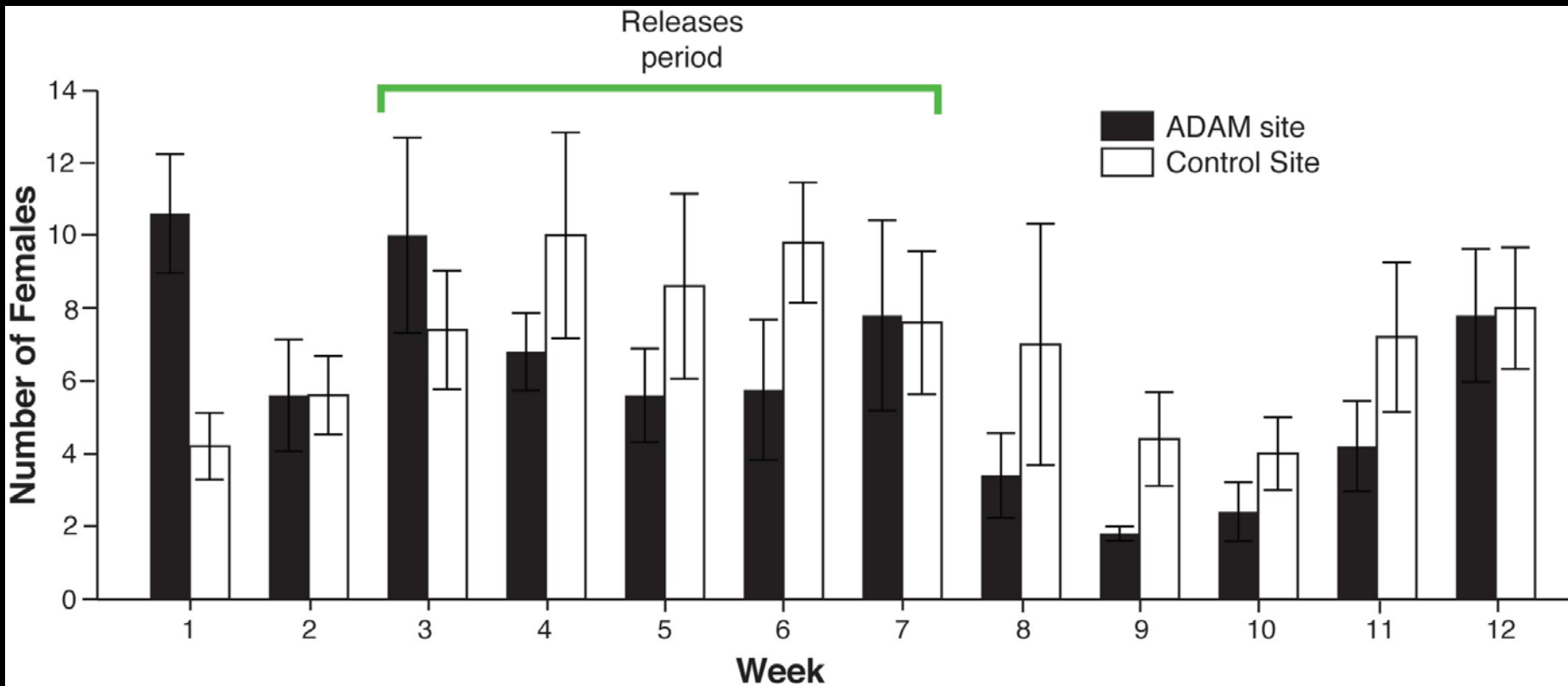
# Auto-Dissemination Augmented by Males (ADAM) Control Concept

- Mass-produced male mosquitoes are treated with the larvicide pyriproxyfen, an insect growth regulator (IGR)
- Released males indirectly spread the IGR to larval development sites by contaminating female mosquitoes during mating
- Males also directly disseminate pesticide to target areas - even when populations of female mosquitoes are low



*Mains et al.  
PLoS-NTD 2015*

# *Aedes aegypti* abundance: Treated and controls sites, Fresno County, 2015





# Future Potential?

- Both *Wolbachia* and ADAM strategies have potential to reduce populations of *Aedes* mosquitoes
- Neither is considered a stand-alone system at this time, but both may be useful components of an integrated vector management program
- More work is needed to determine maximum efficacy, long-term sustainability, and costs
- Additional research is ongoing in 2016

# 2016 ...and Beyond

- **Keep pressure on existing infestations to slow spread**
  - Aerial and ground-based applications of larvicides and adulticides, coupled with public education
  - Container breeding habits and desiccant resistant eggs pose challenges
- **Explore innovative methods to enhance control of *Aedes aegypti* and *Aedes albopictus* in California**
- **Risk of local disease transmission is low, but possible**
- ***Aedes* surveillance and control are critical to minimize risk of local transmission**

# Acknowledgements



**CDC Dengue Branch**

**University of Kentucky**

**UC Davis**

**UC Irvine**

**Yale University**

**Consolidated MAD**

**Delta VCD**

**Fresno MVCD**

**Greater LA County VCD**

**Imperial County EHD**

**Kern MVCD**

**Madera County MVCD**

**San Diego County VCP**

**San Gabriel Valley MVCD**

**San Mateo County MVCD**