



Zika Vector Control and Zika Prevention Practice

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Centers for Disease
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Zika Virus: First Isolation

- In April 1947, 6 sentinel platforms were in use at Zika; temperatures of the rhesus monkeys on the platforms were taken daily
- 18th April 1947, the temperature of one of the monkeys, Rhesus 766 was 39.7°C
- 19th April its temperature was recorded as 40°C.
- On the following day it was brought to the laboratory at Entebbe (UVRI)
- 20th April, a sample of blood was taken from Rhesus 766, the 3rd day of fever
- The monkey was kept under observation for 30 days but showed no abnormality other than the slight pyrexia

Zika Forest



Zika – overgrown
Ziika - bury

Uganda Virus Research Institute, Entebbe, Uganda



Zika Tower: Background

- In 1959 a steel tower was constructed in Mpanga forest. It was constructed using a grant by the WHO
- The aim was to study the activity stratification of sylvatic mosquitoes in an African rain forest
- Mpanga forest was selected because the plant species were well characterized
- After a year, only 59 *Ae. africanus* were captured! One can capture more than that number in a single evening at Zika forest
- In 1961 the steel tower was relocated to Zika



Zika Virus Early Isolations



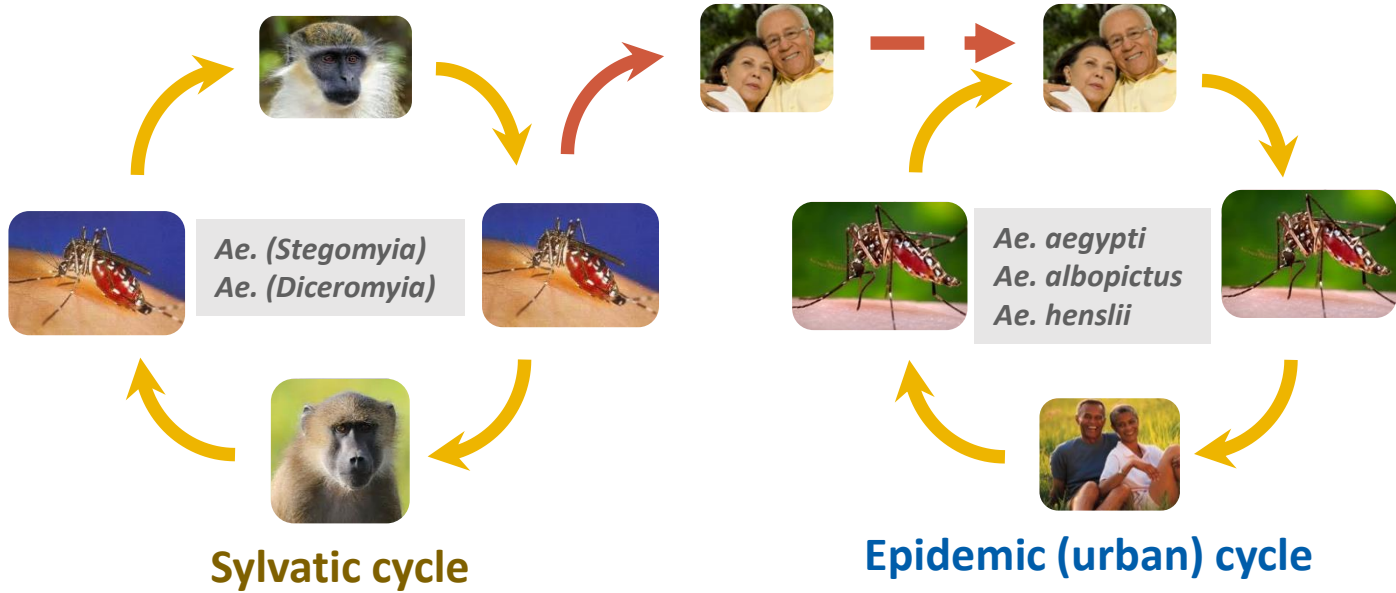
- 1st isolation from (rhesus monkey 766) (GWA Dick) in Zika Forest near Entebbe, April 1947 (Dick et al. 1952)
- 2nd isolation from *Ae. africanus* from Zika Forest (AJ Haddow), January 1948 (Dick et al. 1952)
- 3rd isolation from a 10 year old girl in Afikpo Division, Eastern Nigeria in 1952 (MacNamara 1954)
- 4th isolation from *Ae. africanus*, Lunyo Forest, Entebbe Uganda (Weinbren and Williams 1958)
- By 1961 – 3 isolates from *Ae. africanus* (Haddow et al. 1961)
- 1961 – 1963 12 isolations from *Ae. africanus* captured in Zika Forest (Haddow et al. 1964)

Zika Virus

- Family *Flaviviridae*, genus *flavivirus*
 - Enveloped, single-stranded RNA virus
 - Plus-sense, unsegmented genome of 10,794 nucleotides, 3,419 amino acids
 - A member of the Spondweni serocomplex and closely related to Spondweni virus

5'-C-prM-E-NS1-NS2A-NS2B-NS3-NS4A-NS4B-NS5-3'

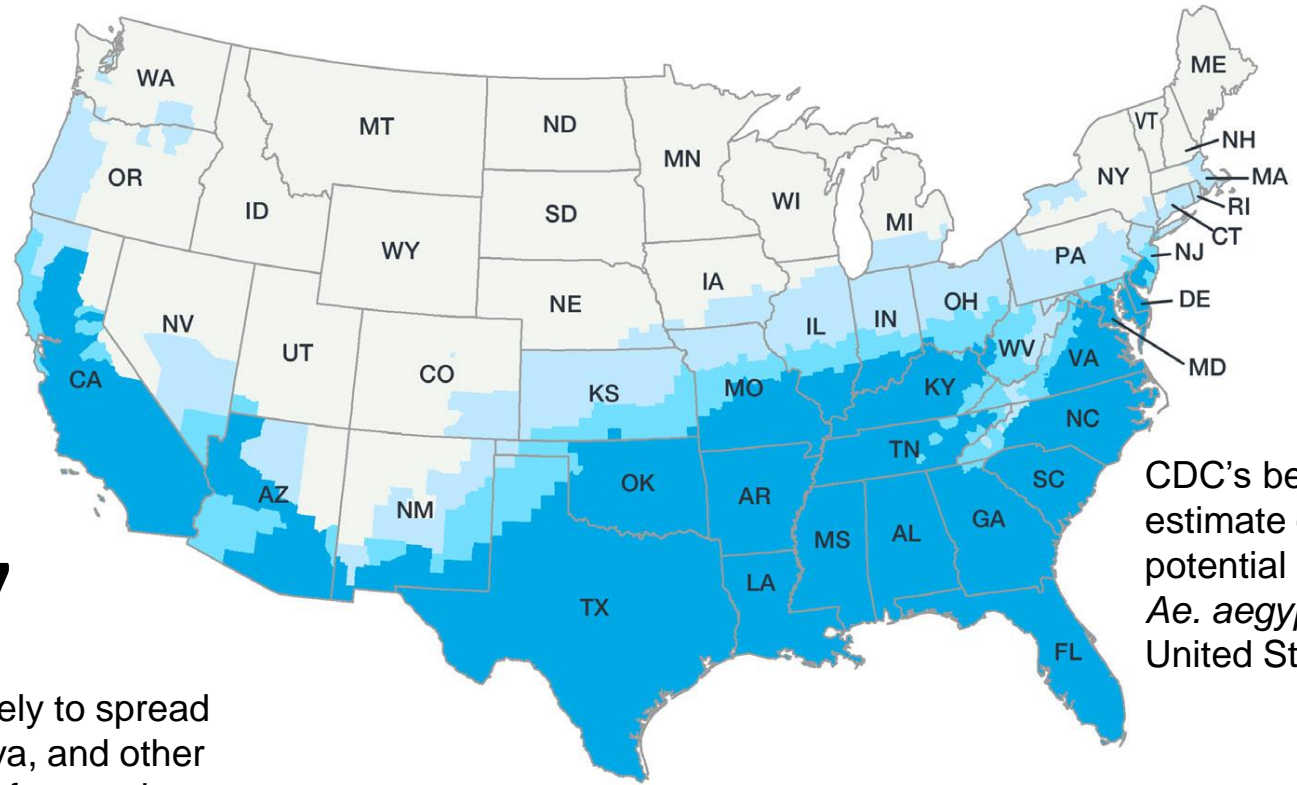
Zika Virus Transmission Cycles



ZIKV Vectors

<i>Ae. africanus</i>	(Dick et al. 1952., Haddow et al. 1964, Wienbren and Williams 1958)
<i>Ae. luteocephalus</i>	(Lee 1969, Fagbami 1979)
<i>Ae. vittatus</i>	(Akoua-Koffi 2001, Diallo et al. 2011)
<i>Ae. furcifer</i>	(Akoua-Koffi 2001, Diallo et al. 2011)
<i>Ae. apicoargenteus</i>	(Haddow et al. 2012)
<i>Ae. hensilli</i>	(Ledermann et al 2014)
<i>Ae. aegypti</i>	(Olson et al. 1981, Akoua-Koffi 2001, Marchette 1969, Li et al. 2012)
<i>Ae. albopictus</i>	(Grard et al. 2012)

Estimated range of *Aedes aegypti* in the United States, 2017



CDC's best estimate of the potential range of *Ae. aegypti* in the United States

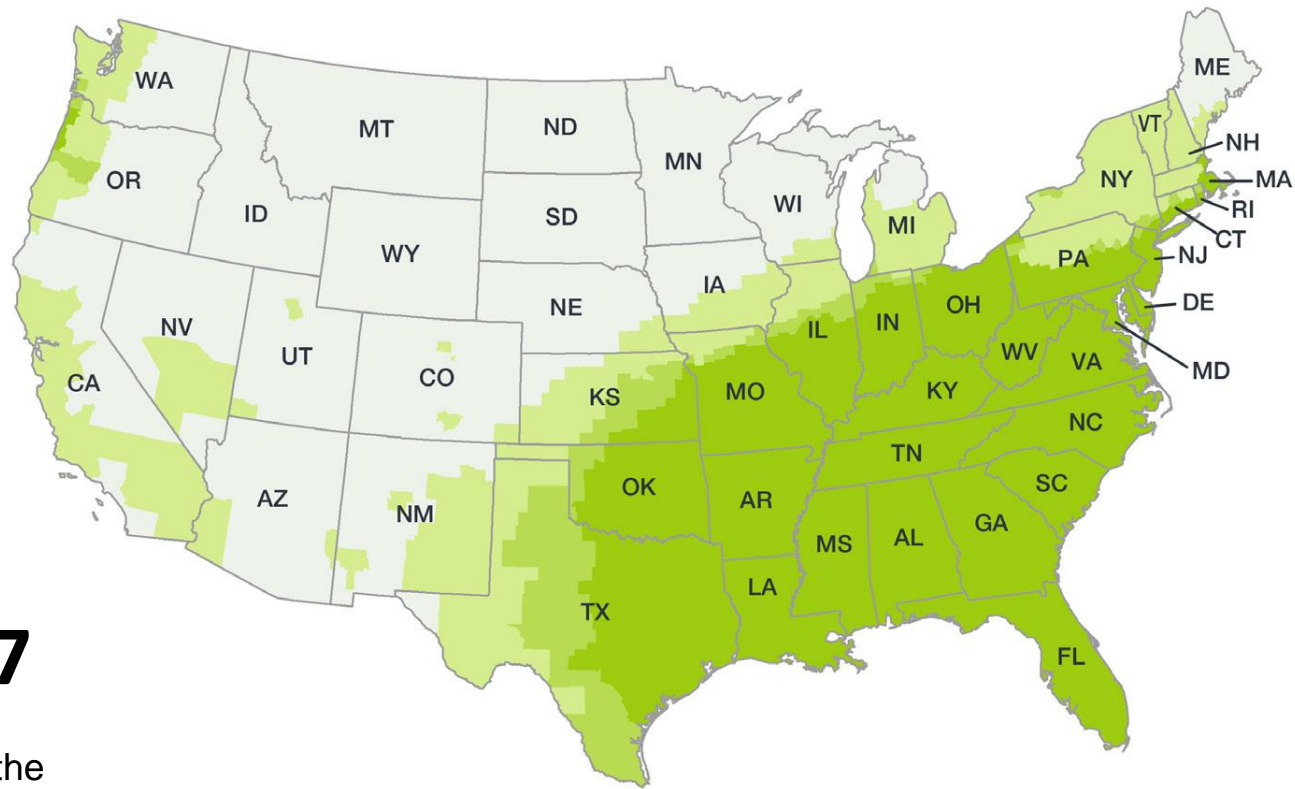
Aedes aegypti is more likely to spread Zika, dengue, chikungunya, and other viruses than other types of mosquitoes such as *Ae. albopictus*

Mosquitoes' ability to live and reproduce



Estimated range of *Aedes albopictus* in the United States, 2017

CDC's best estimate of the potential range of *Ae. albopictus* in the United States



Mosquitoes' ability to live and reproduce



Aedes aegypti



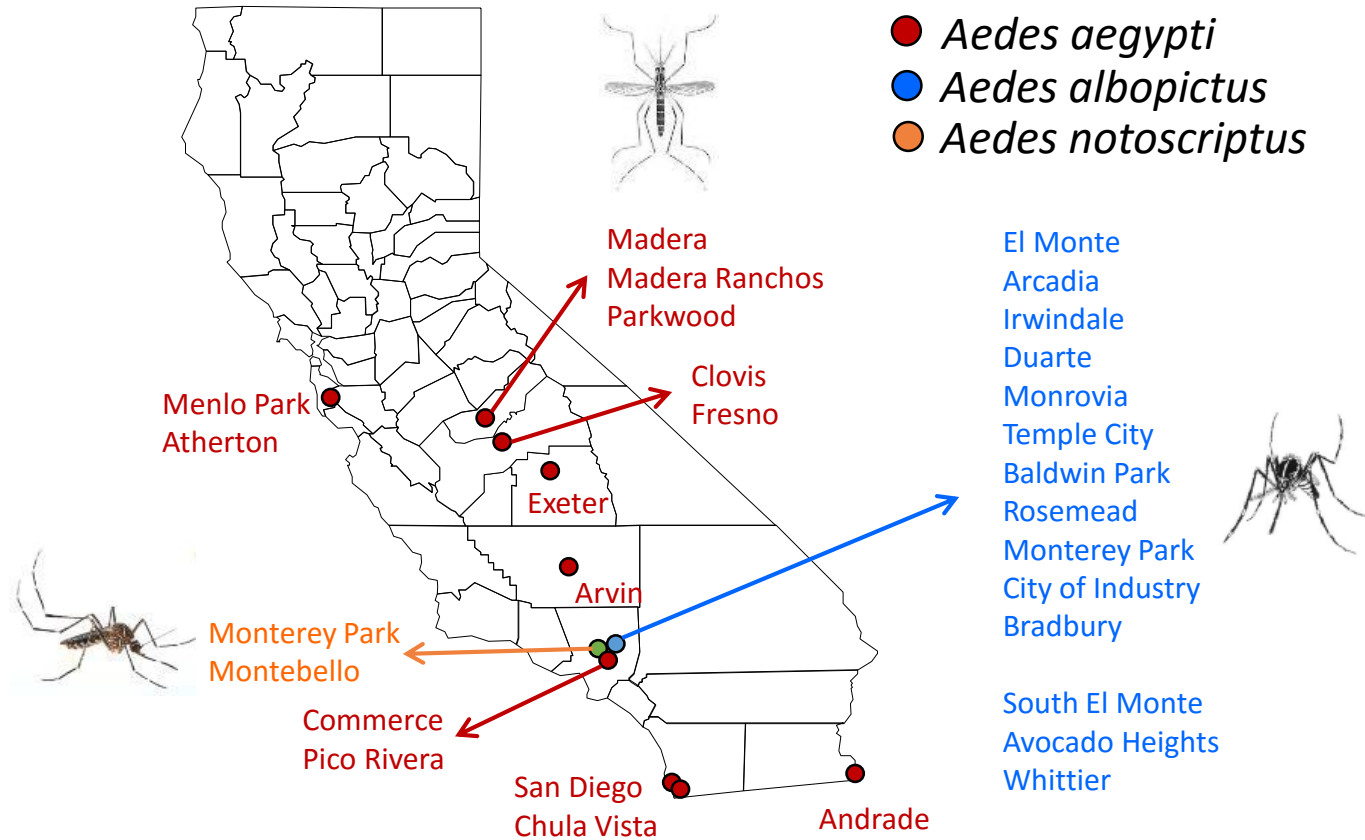
* Darsie and Ward 2005

Aedes albopictus



* Darsie and Ward 2005

Invasive *Aedes* in California



SCIENTIFIC NOTE

NEW DISTRIBUTION RECORDS OF MOSQUITOES IN WASHINGTON STATE¹

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AND ELIZABETH A. DYKSTRA^{2,5}

ABSTRACT. Routine West Nile virus (WNV) surveillance in 2016 by the Washington State Department of Health resulted in 1 new state distribution record for *Aedes hendersoni*, bringing the total number of mosquito species reported from Washington to 52. We also report new county records for *Aedes japonicus japonicus*, *Aedes togoi*, and *Culex salinarius*.

KEY WORDS Culicidae, distribution, mosquito, new county record, Washington

ZIKA Response: Overview

- ✦ Prevention or reduction of ZIKV transmission is **primarily** dependent on the control of mosquito vectors and limiting human-vector contact
- ✦ Entomological response to ZIKV outbreaks hinges on detection of human case(s)
- ✦ The overall response is a group effort involving:
 - ✦ Epidemiologists
 - ✦ Entomologists
 - ✦ Healthcare providers
 - ✦ Local public health officials
 - ✦ The media, educators etc.
- ✦ ZIKV entomological surveillance and control activities are conducted throughout the mosquito season

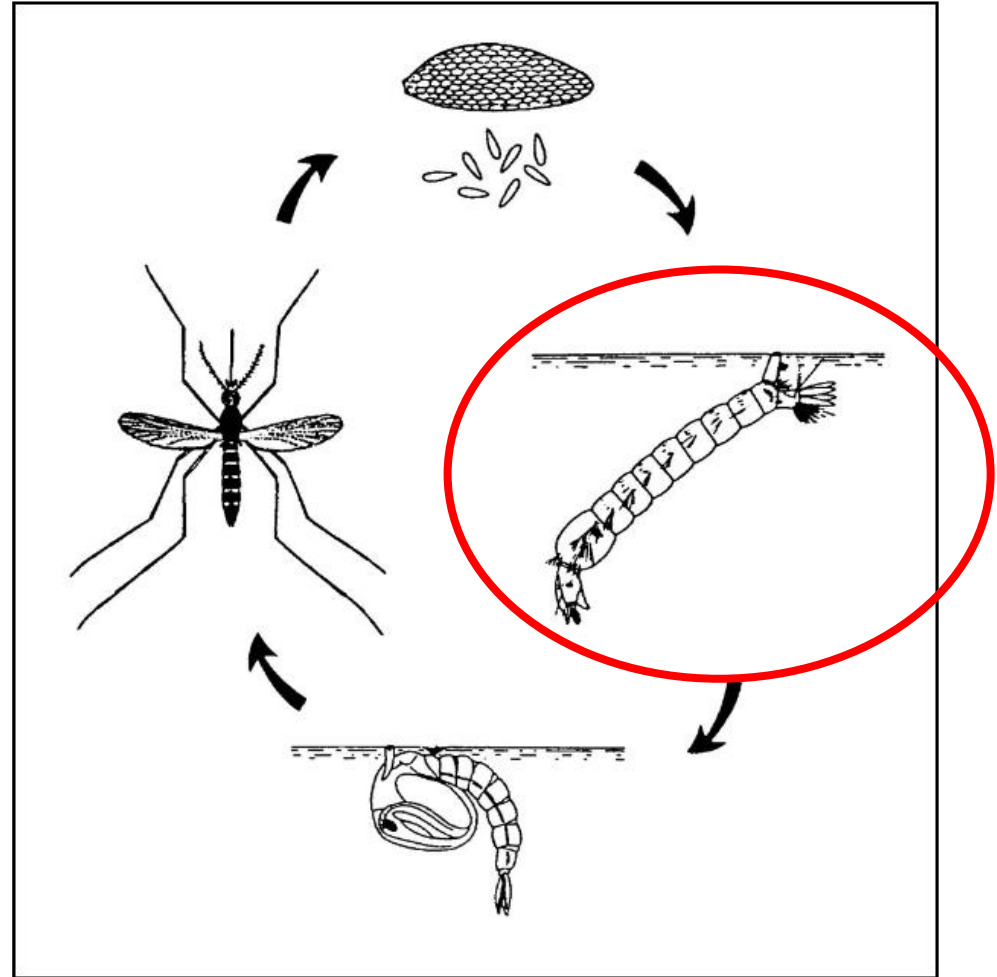
Before the Mosquito Season

- ✦ Conduct area-wide surveys to determine abundance, distribution and type of containers:
 - ✦ large numbers of containers may translate into high mosquito abundance
- ✦ Initiate source reduction:
 - ✦ Remove discarded containers
 - ✦ Cover or modify immovable and LARGE containers to prevent water retention
- ✦ Implement education programs
 - ✦ Screen windows
 - ✦ Home owner (residence) larval source reduction program

Beginning of the Mosquito Season

- ✦ Initiate vector surveys to:
 - ✦ Determine presence or absence
 - ✦ Estimate relative abundance
 - ✦ Determine distribution; develop detailed distribution maps
 - ✦ Vectors surveys are continuous to detect new populations, seasonal variations in abundance and seasonal ranges
- ✦ Continue source reduction efforts; containers are continually discarded
- ✦ Maintain education programs:
 - ✦ Screen windows
 - ✦ Personnel protection
 - ✦ Repellents
 - ✦ Avoid exposure
 - ✦ Home owner (residence) larval source reduction program

Aedes aegypti Life Cycle



Container Aquatic Habitats For ZIKV Vectors

Water-storage containers (barrels, jars, tanks, cisterns)

Utensils (pails, tarps)

Discarded containers (trash)

Recreation objects (plastic pools, toys, boats)

Ornamental (fountains, plant pots)

Animal drinking pans

Septic tanks

Water meters

Treeholes



Zika Virus Vector Surveillance Tools

- Ovitrap (presence/absence; eggs/trap)



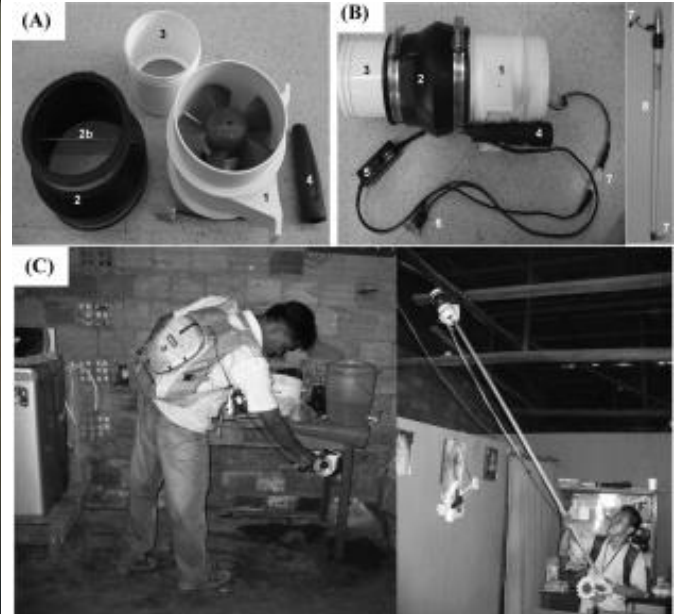
Zika Virus Vector Surveillance Tools

-Larval Surveillance



Zika Virus Vector Surveillance Tools

- Electromechanical aspirators (Resting population)



Zika Virus Vector Surveillance Tools

- Sticky traps for gravid mosquitoes
- AGO = Autocidal Gravid Ovitrap
- Passive!

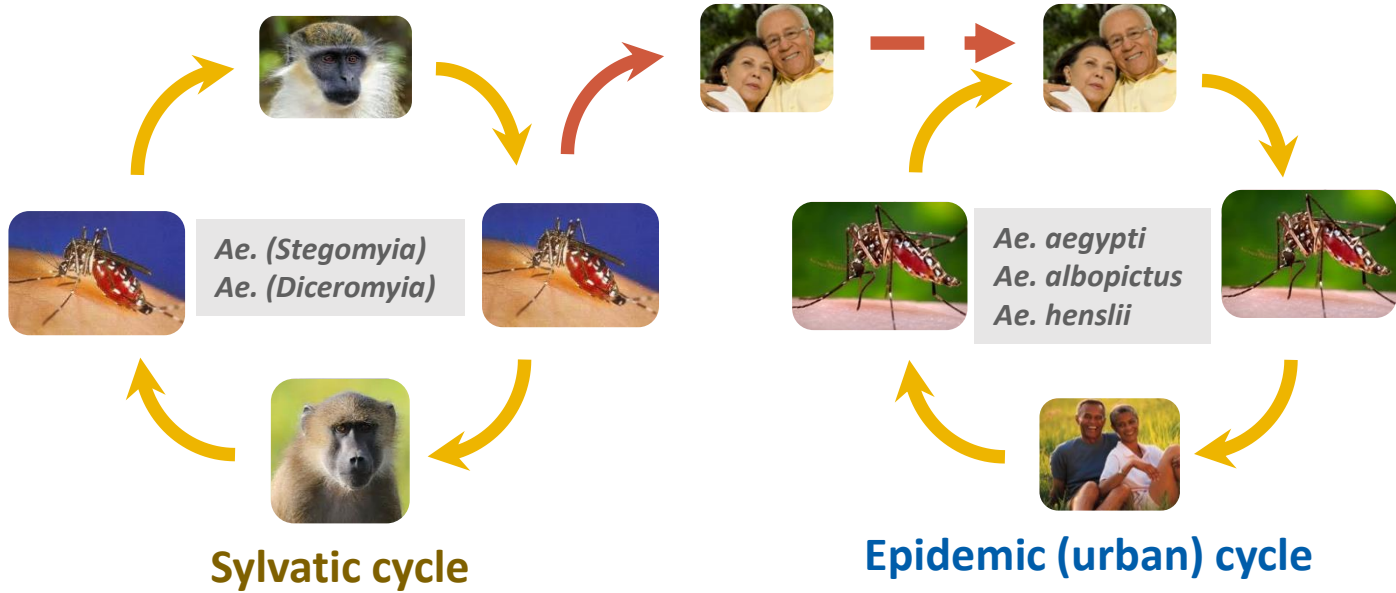


Zika Virus Vector Surveillance Tools

- Electromechanical traps such as the BG-Sentinel Trap = attracts blood meal seeking mosquitoes



Zika Virus Transmission Cycles



Zika Vector Control Strategies

- Targeting the immature stages:
 - Oviposition traps (Ovitrap)
 - Larvicide
 - Source reduction



Zika Vector Control Strategies

-Source Reduction



Zika Vector Control Strategies

- **Targeting adult mosquitoes:**
 - Hand-held or truck-mounted spraying



Zika Vector Control Strategies

- Targeting adult resting mosquitoes:
 - Indoor/outdoor residual spraying



Zika Vector Control Strategies

- Targeting gravid mosquitoes:
 - Autocidal Traps

AGO



In2Care



GAT

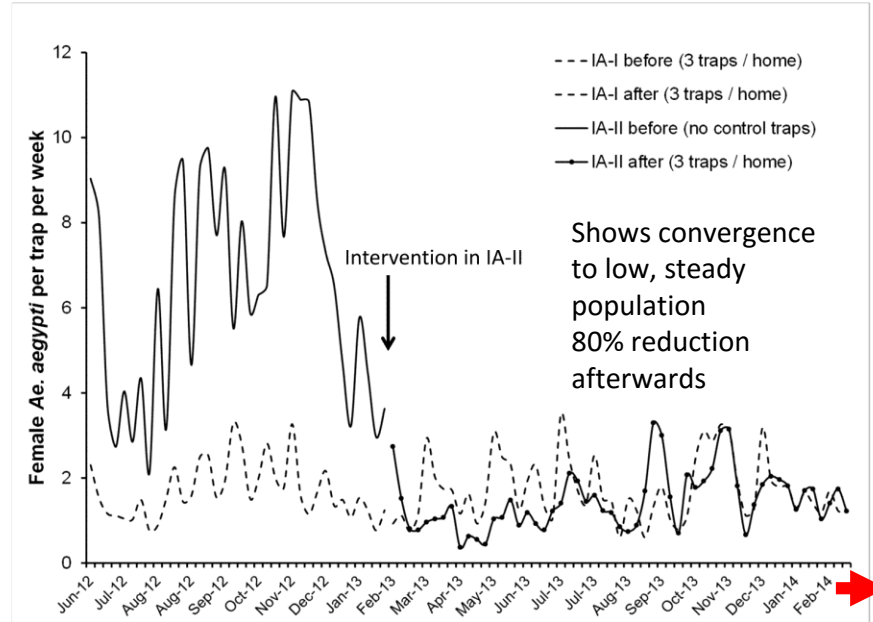


Zika Vector Control Strategies

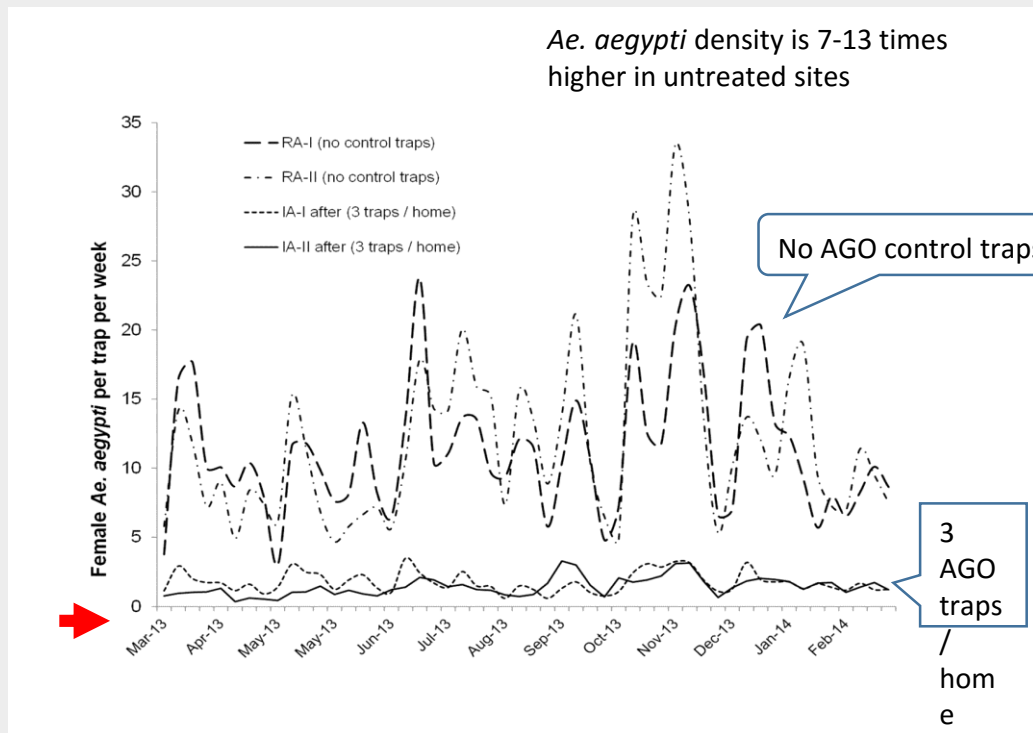
- Targeting actively flying mosquitoes:
 - Aerial spraying



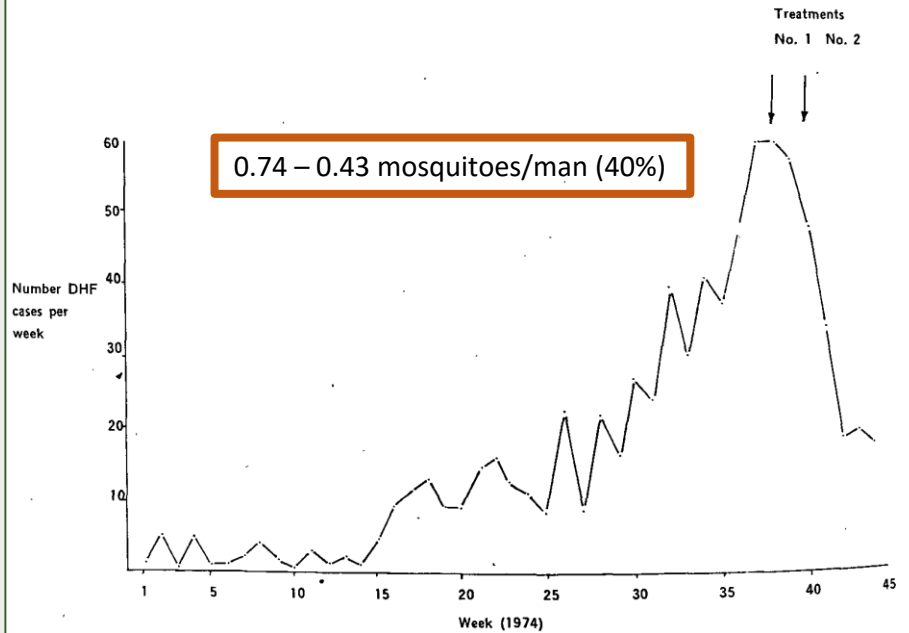
Results — control traps added to former non-intervention area



Results – *Ae. aegypti* density in urban sites without and with AGO control traps



NUMBER OF REPORTED CASES OF DHF AT MENADO (POPULATION 150 000) BEFORE AND AFTER
AERIAL SPRAYING WITH ULV MALATHION AT 0.5 L/Ha

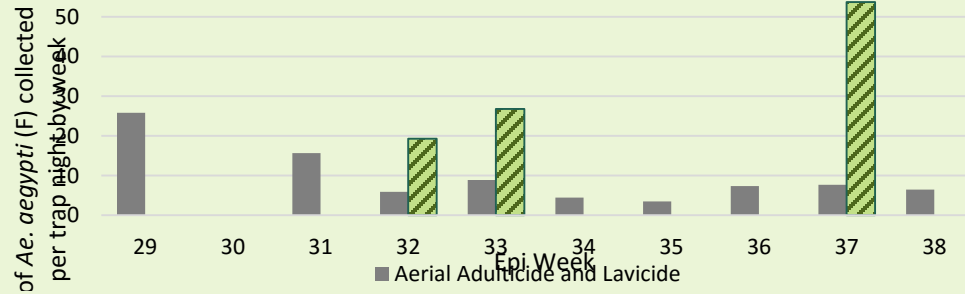
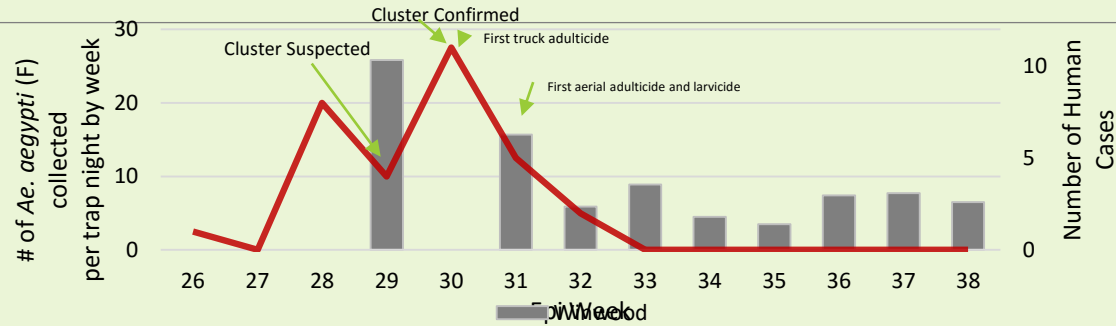


L.S. Self, M.D.*
M.J. Nelson, M.D.*
B. Theos, M.D.**
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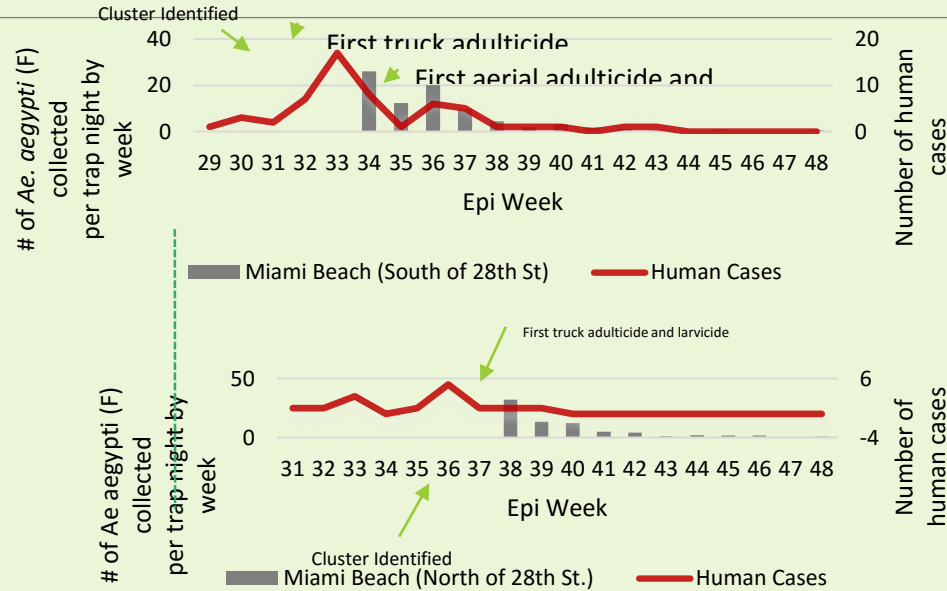
J. Med. Ass. Thailand

Vol. 60 No. 10
October 1977

A Reduction in Hospitalized Cases
Of Dengue Haemorrhagic Fever
In Manado (Sulawesi), Indonesia After Aerial Spraying
With ULV Malathion to Control *Aedes aegypti*



Miami Beach cases and mosquito abundance



Examples of transmission thresholds associated with *Ae. aegypti*



Threshold	Disease	Location	Reference rate
Container Index (CI) < 10%	YF	South America	Connor and Monroe 1923
House Index (HI) < 5%	YF	South America	Soper 1967
Breteau Index (BI) < 5	YF	Senegal	Brown 1974
3 eggs/trap/day	DHF	Thailand	Mogi et al. 1990
0.5 – 1.5 pupae/person	DEN		Focks et al. 2000
0.5 females/trap/week (sticky traps)	DEN	Australia	Ritchie et al. 2004
3 mosquitoes/trap/week (AGO)	CHIKV	PR	Barrera et al. 2017
2 – 3 mosquitoes/trap/day (BG-Sentinel)	DEN	PR	Barrera et al. 2017

Source Materials for the Control of ZIKV Vectors

- Surveillance and Control <http://www.cdc.gov/zika/vector/index.html>
- Surveillance and Control of *Aedes aegypti* and *Aedes albopictus* in the United States
<http://www.cdc.gov/zika/vector/vector-control.html>
- Interim CDC Recommendations for Zika Vector Control in the Continental United States
<http://www.cdc.gov/zika/public-health-partners/vector-control-us.html>

Important Considerations

- **Insecticide resistance in *Ae. aegypti* populations**
 - May be widespread and highly variable
 - Limited products approved by EPA

- **Socio-cultural factors**
 - Objections to aerial spraying
 - Concerns about organophosphate insecticides

Virus Surveillance in Mosquitoes

- Surveillance is conducted to:
 - Obtain evidence of local transmission
 - Estimate infection rates
 - Estimate local transmission thresholds
 - Evaluate the effectiveness of control measures
- Currently not emphasized by CDC:
 - Extremely difficult to detect virus in wild mosquitoes
 - Usually low mosquito abundance
 - Human/disease case surveillance is more efficient
 - Methods and equipment (traps) are improving

History and Purpose of MosquitoNET

- ELC M1 funded mosquito surveillance, and insecticide resistance testing in the US, primary focus on *Stegomyia* species (*Aedes aegypti* and *Aedes albopictus*) :
 - Aug 2016: FY16 funding (\$18M) awarded to 63 entities, including CONUS states as well as some CONUS cities, AK, HI, PR and Territories
 - Dec 2016: FY17 funding (\$27M) awarded to 23 entities, mostly southern CONUS states, HI and Territories
- To facilitate data reporting, CDC developed the MosquitoNET website for ELC recipients.
 - ELC recipients will use MosquitoNET to report data about mosquito collection and insecticide resistance testing.
 - Data about virus infection in mosquito pools will continue to be reported using ArboNET.

Focus of MosquitoNET

- Initial focus is on *Ae. aegypti* and *Ae. albopictus*
- Why only those species?
 - Vectors of several arboviruses of public health importance including CHIKV and ZIKV
 - Accurate distribution and abundance data lacking for these 2 species
- What about other mosquito species identified during surveillance?
 - Data on all other species collected during the course of the surveillance will be reported to MosquitoNET

Negative Data Reporting

□ What is Negative Data Reporting?

- Reporting data that the mosquito of interest was not detected in a particular location

□ Why is Negative Data Reporting Useful?

- May establish whether the species of interest is rare or completely absent in a location (or area)
- May help establish the season(s) or period(s) of time a particular species is detectable in a particular location
- May help determine if the species is:
 - Established
 - Part of the summer expansion range
 - Introduced periodically

Questions?

