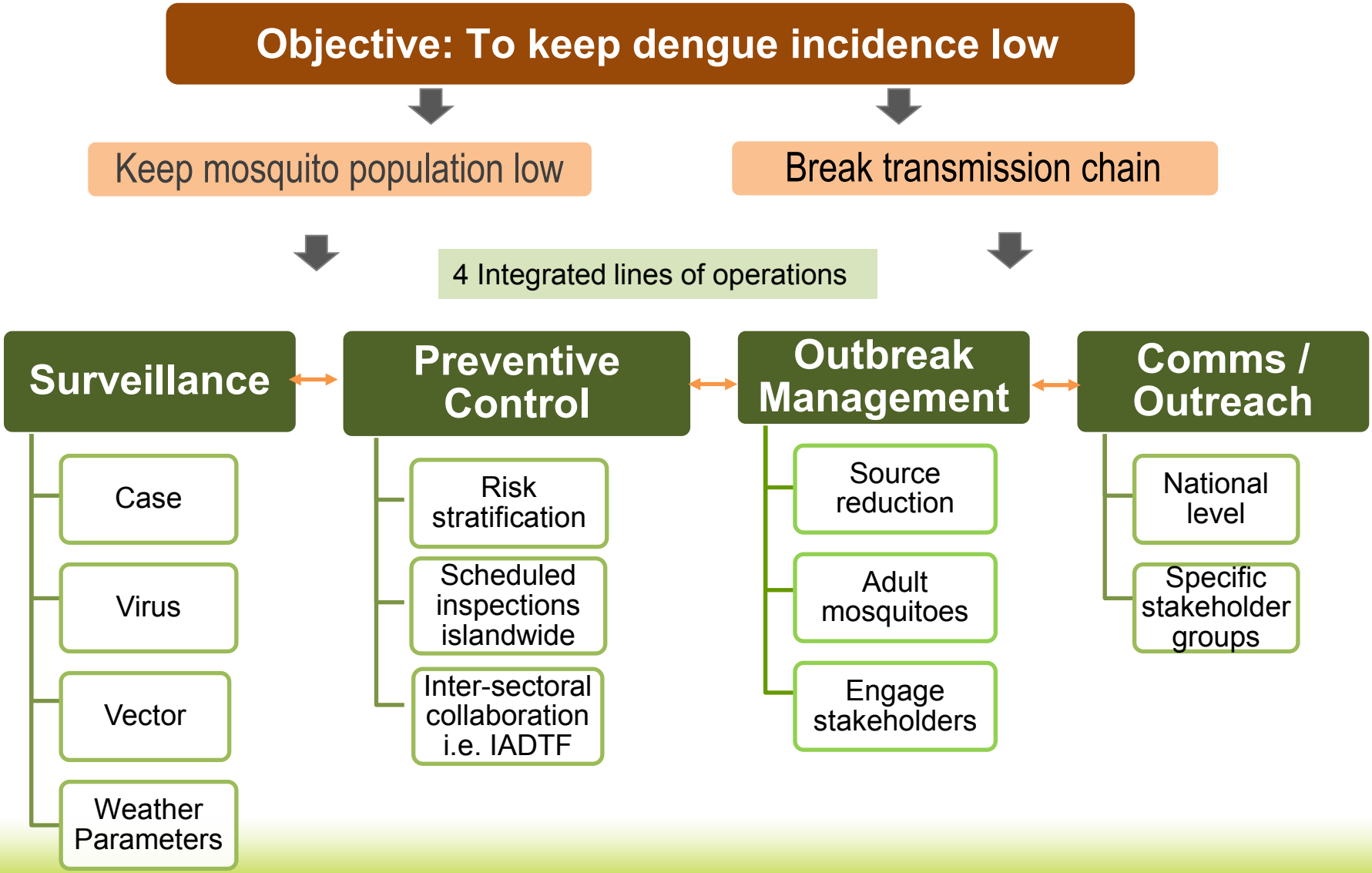
Wolbachia Aedes- An additional Tool to Control *Aedes aegypti* in Singapore

Third FAO/IAEA International Conference on Area-wide Management of Insect Pests

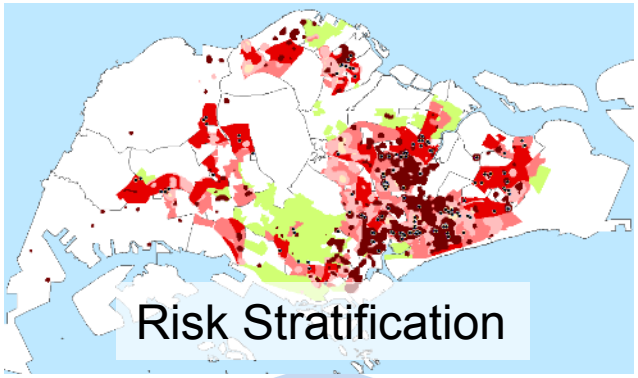
Ng Lee Ching
Environmental Health Institute
Singapore

National Environment Agency
Safeguard · Nurture · Cherish

Dengue Control System in Singapore



Integrated Dengue Surveillance for Decision Support



Rapid Operational Response Time

Early warning of Outbreak

Targeted Response

Risk Assessment

Case

Lab Diagnostics

Disease Notification system

Evaluation and development of new tools

Virus

Temporal and Spatial distribution of serotype

Detect emergence of new genotypes

Vector

Immatures:

Premise check for breedings

Adults:

Gravitrap surveillance

Insecticide Resistance

Ecology

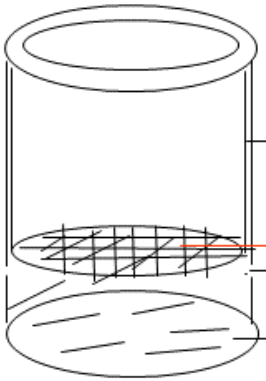
Weather paramters

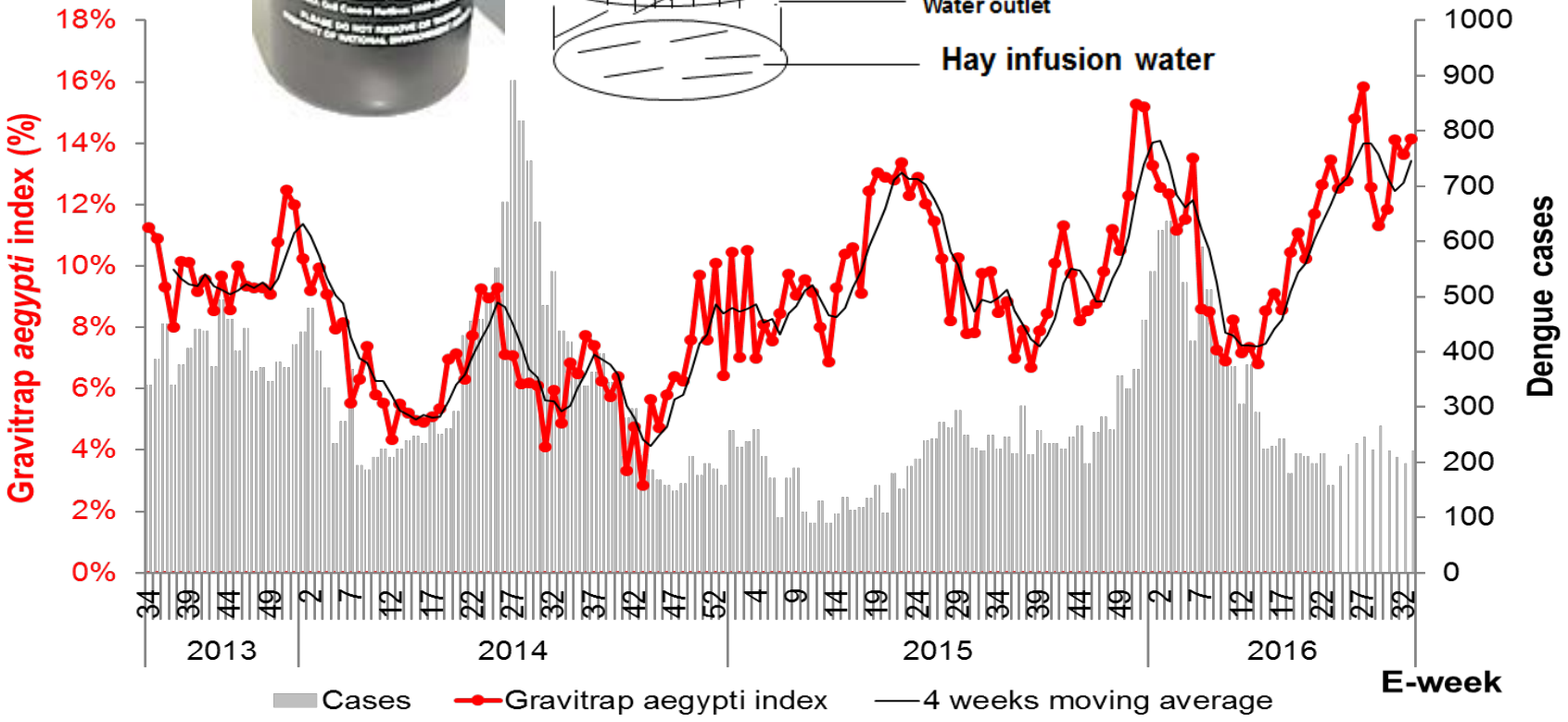
Population density

Age of buildings

Extent of urbanisation

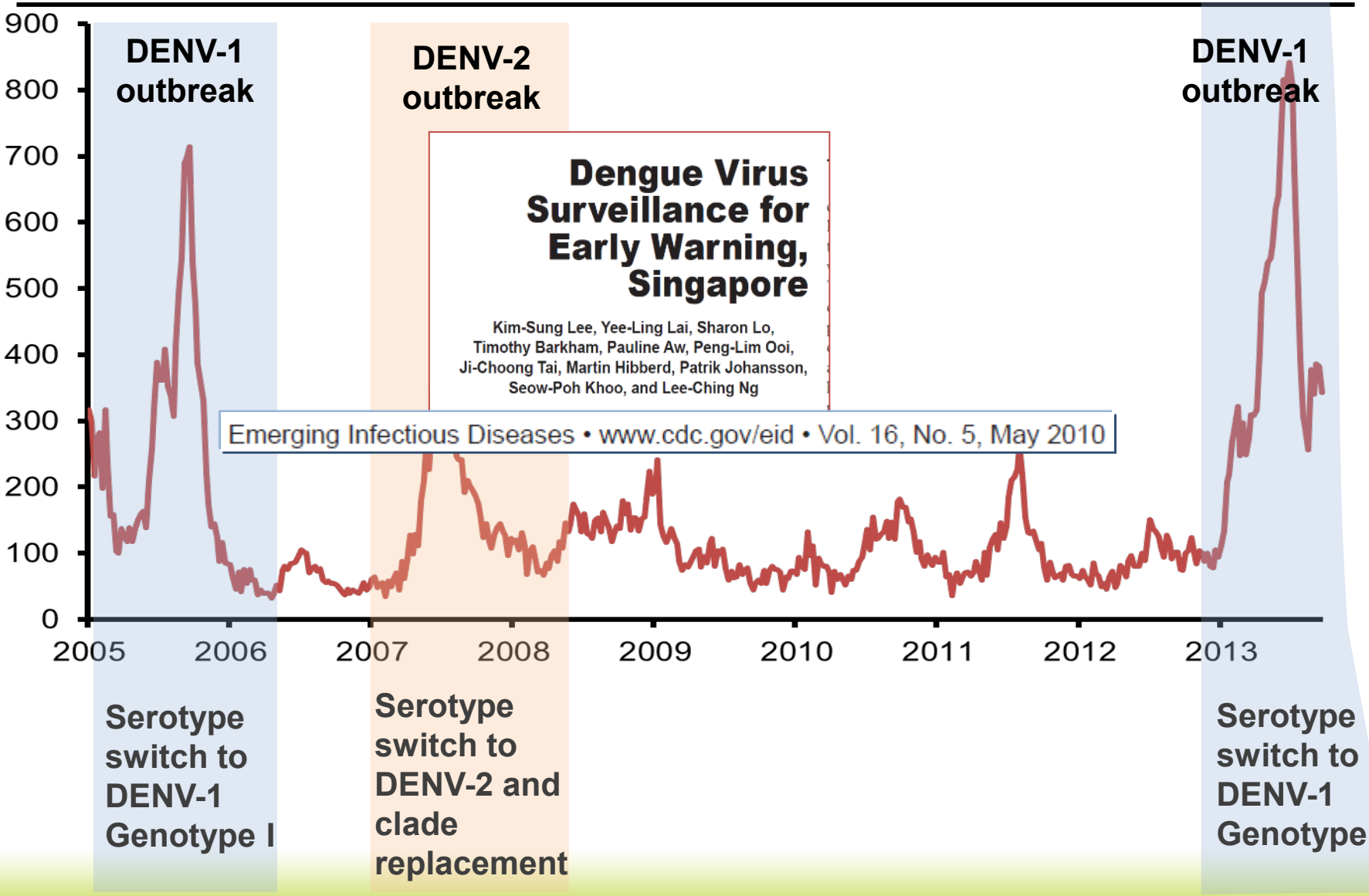
Gravitrap *Aedes* Adult Surveillance



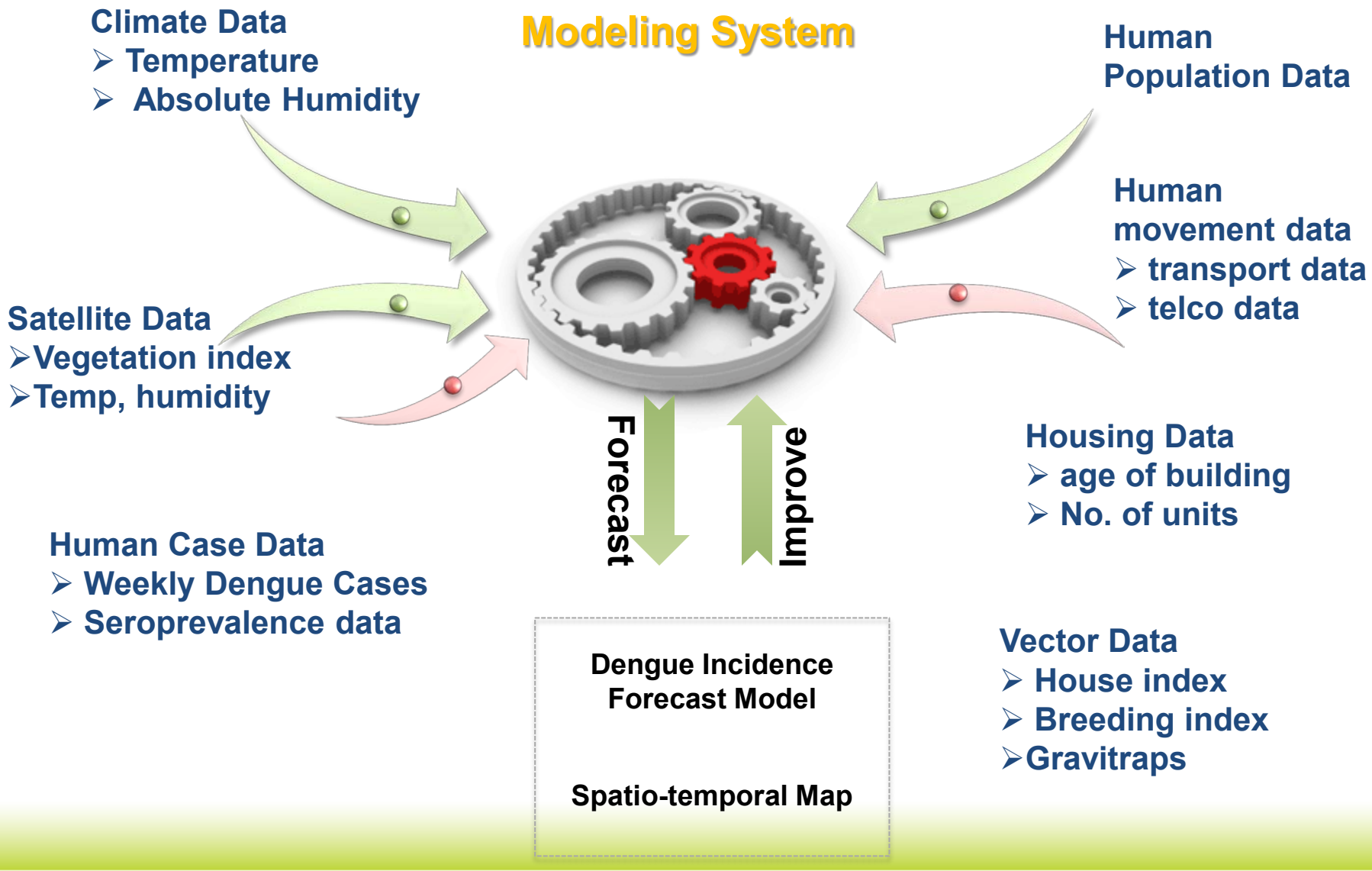


Weekly data from 34 sentinel sites

Outbreaks associated with switch in predominant serotype



Temporal and Spatial Modelling to support operations

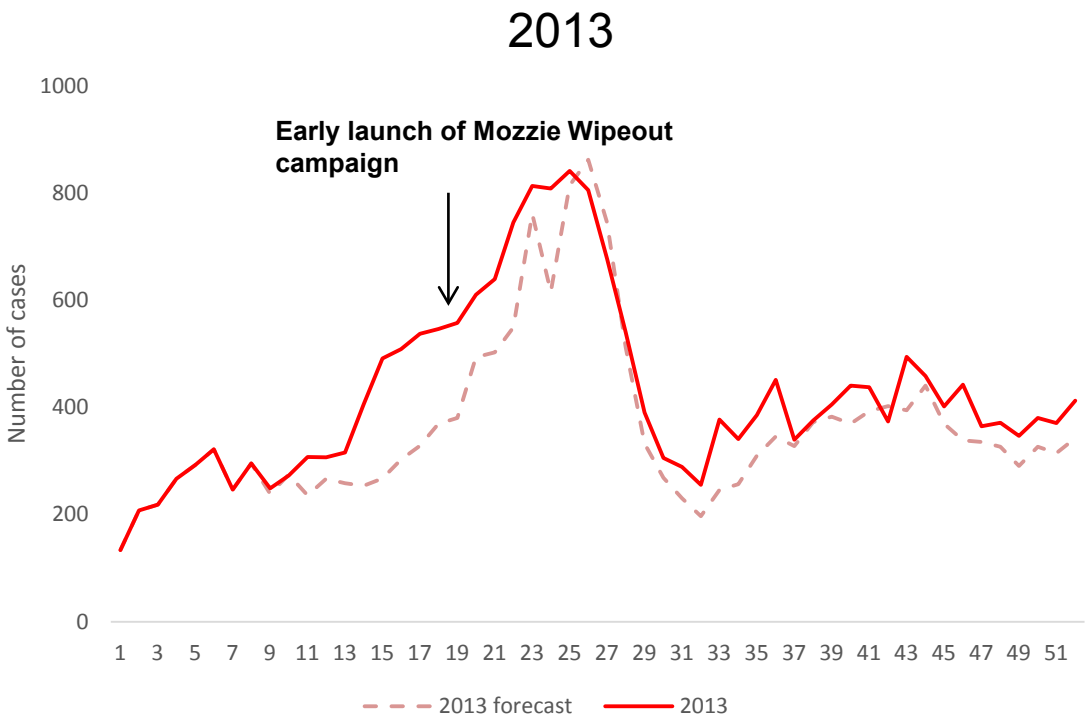


Early warning of outbreaks

Environ Health Perspect; DOI:10.1289/ehp.1509981

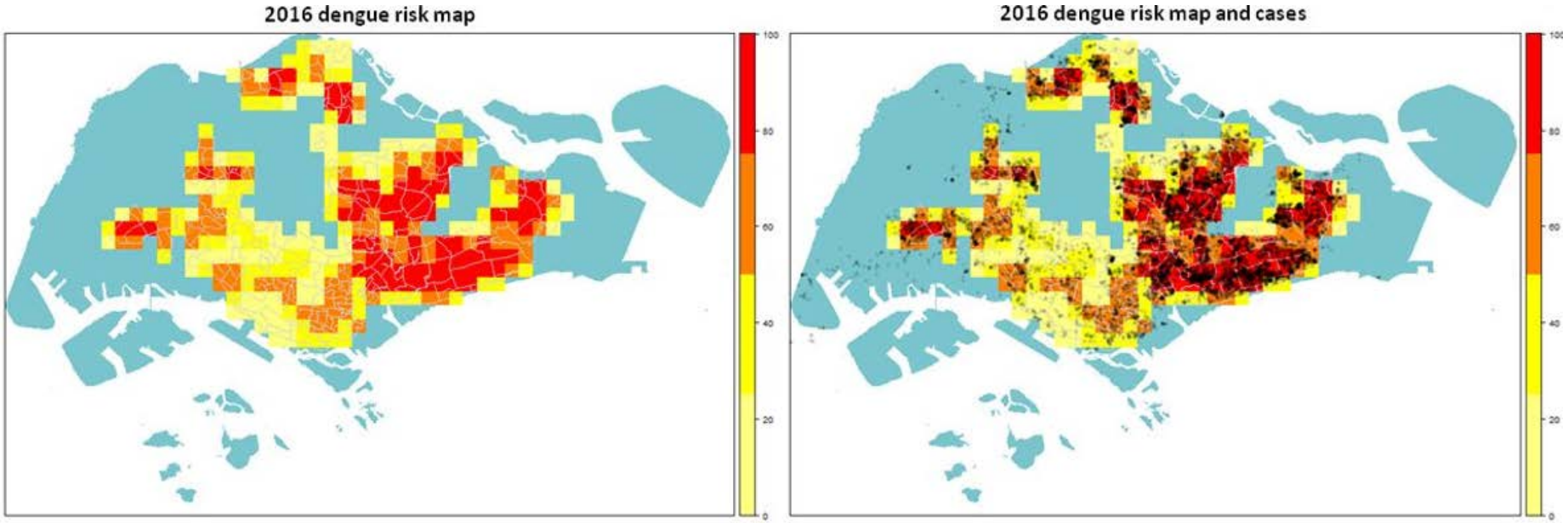
Three-Month Real-Time Dengue Forecast Models: An Early Warning System for Outbreak Alerts and Policy Decision Support in Singapore

Yuan Shi[1], Xu Liu[1], Suet-Yheng Kok[1], Jayanthi Rajarethinam[1], Shaohong Liang[1], Grace Yap[1], Chee-Seng Chong[1], Kim-Sung Lee[1], Sharon S.Y. Tan[2], Christopher Kuan Yew Chin[1], Andrew Lo[3], Waiming Kong[4], Lee Ching Ng[1,5], and Alex R. Cook[6,7]



Facilitate preparedness for public health response

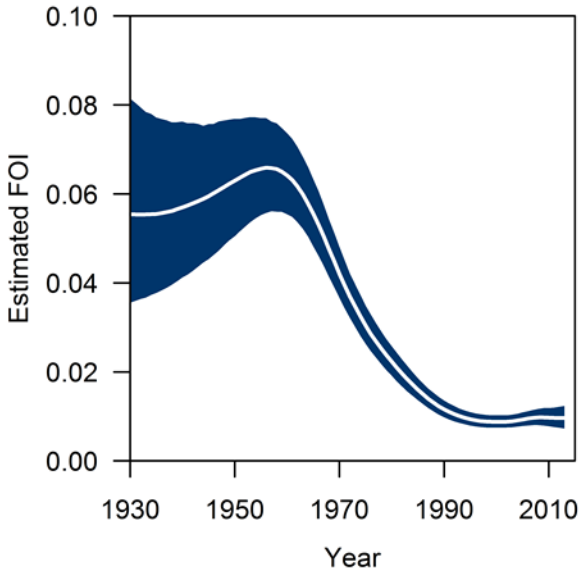
Dengue Risk Map

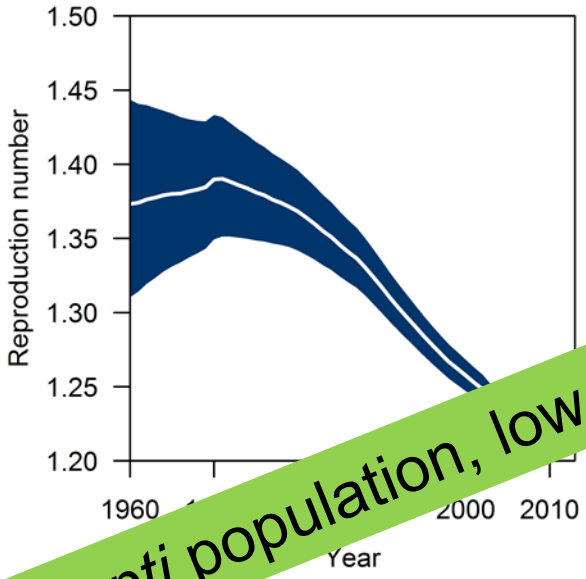


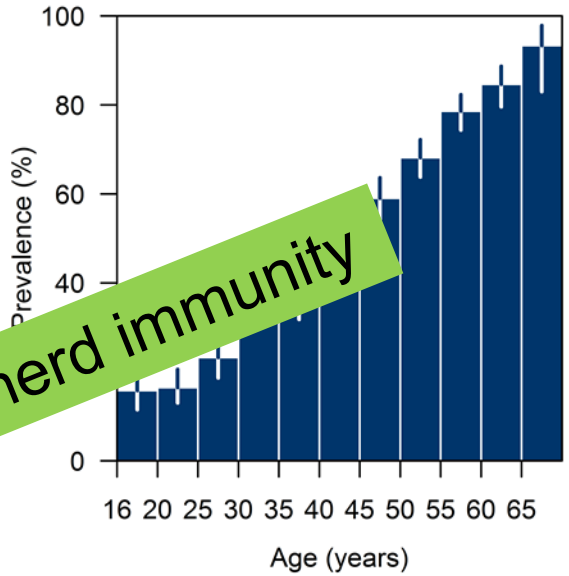
80% of cases fall in risk groups 3 and 4

Impact on Dengue Transmission

3 years of seroprevalence studies at EHI:







Low *Aedes aegypti* population, low herd immunity

Force of Infecti… ma…ed at low levels since the end of 1980s in Singapore

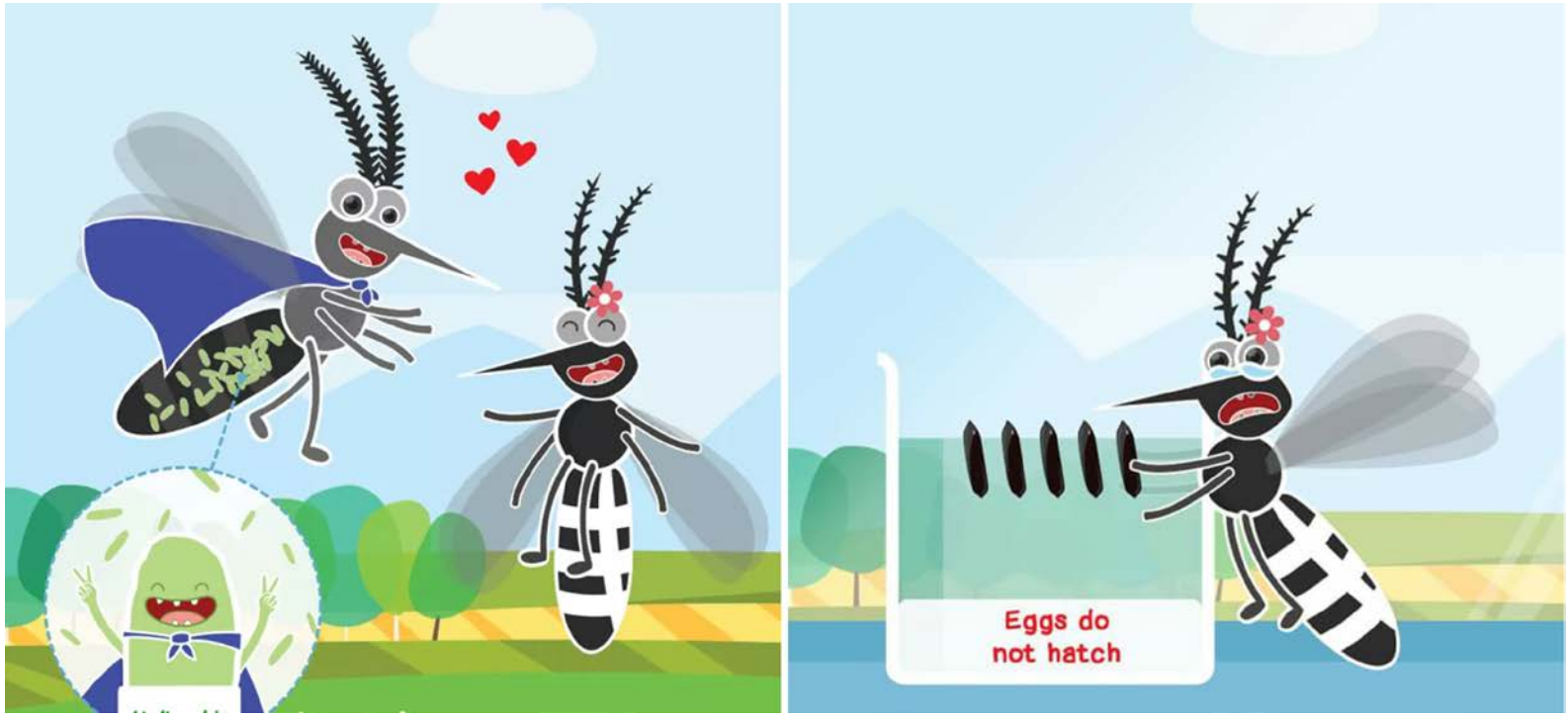
Low R0 (number of cases generated by a single case)

Low sero-prevalence:

shifts dengue to older adults where co-morbidity is common.

PROJECT WOLBACHIA SINGAPORE

Future complementary vector control tool, part of adaptation to climate change



Studies on the feasibility of *Wolbachia* for the suppression of *Ae. aegypti* population in Singapore

3 Tracks:

Effectiveness

Scientific studies for the implementation of a *Wolbachia*-based suppression strategy to control *Ae. aegypti* population in Singapore

Risk Assessment

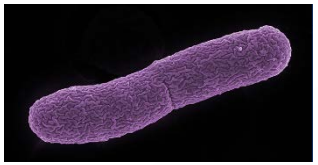
Assessment to ensure the technology is safe and to identify unintended secondary impact of *Wolbachia-Aedes* and recommend mitigation measures

Community engagement

Engagement and consultation of oversea and local experts and local stakeholders to identify knowledge gaps that could result in potential risk of failure

Development of *Wolbachia Aedes aegypti* strain - *w*AlbB

Aedes albopictus
(carries 2 *Wolbachia* strains, *w*AlbA and *w*AlbB)



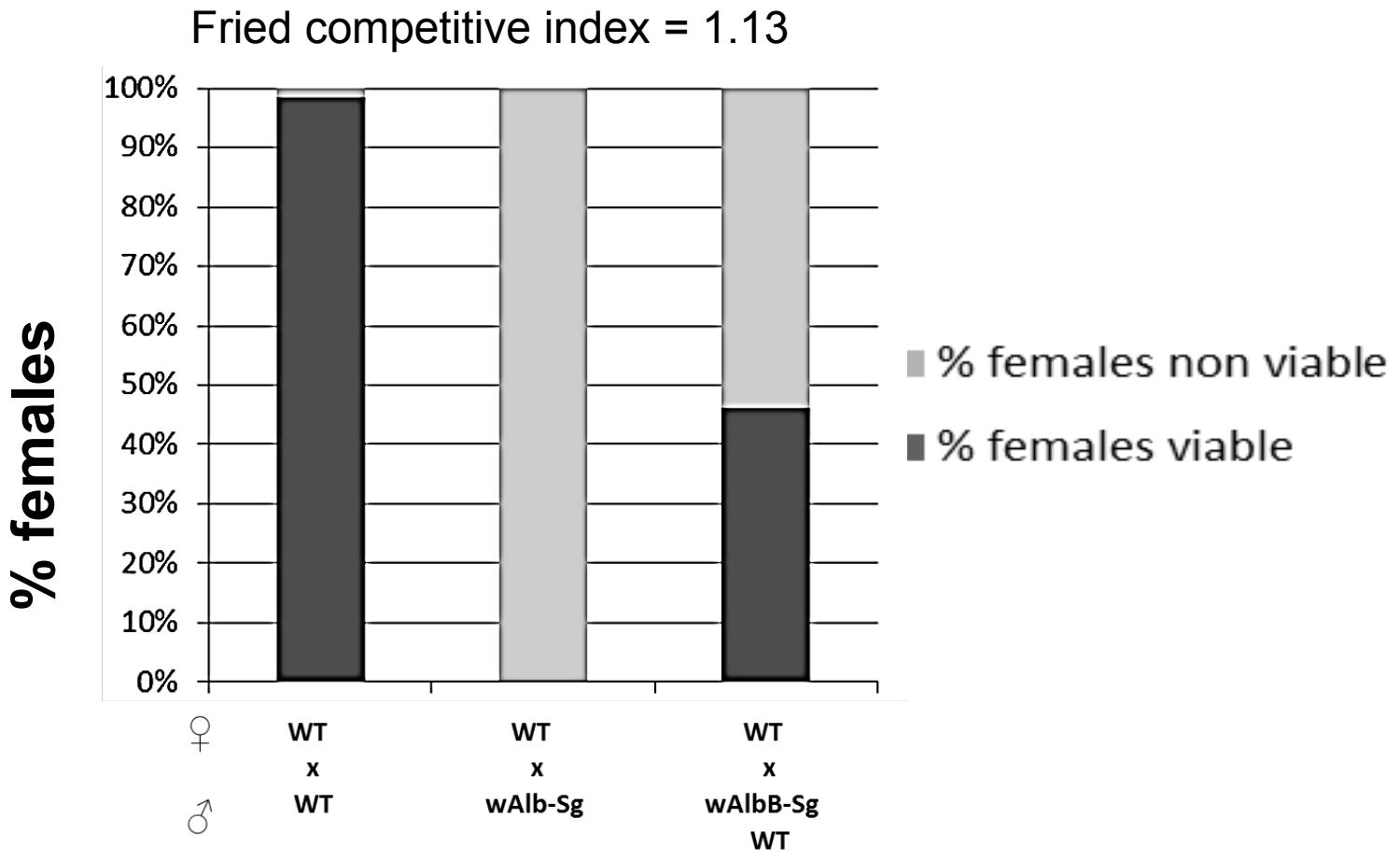
wAlbB-Sg

Aedes aegypti
(does not carry *Wolbachia* naturally)

- Outcrossed for 6 generations
- 100% maternal transmission (35 females every generation)

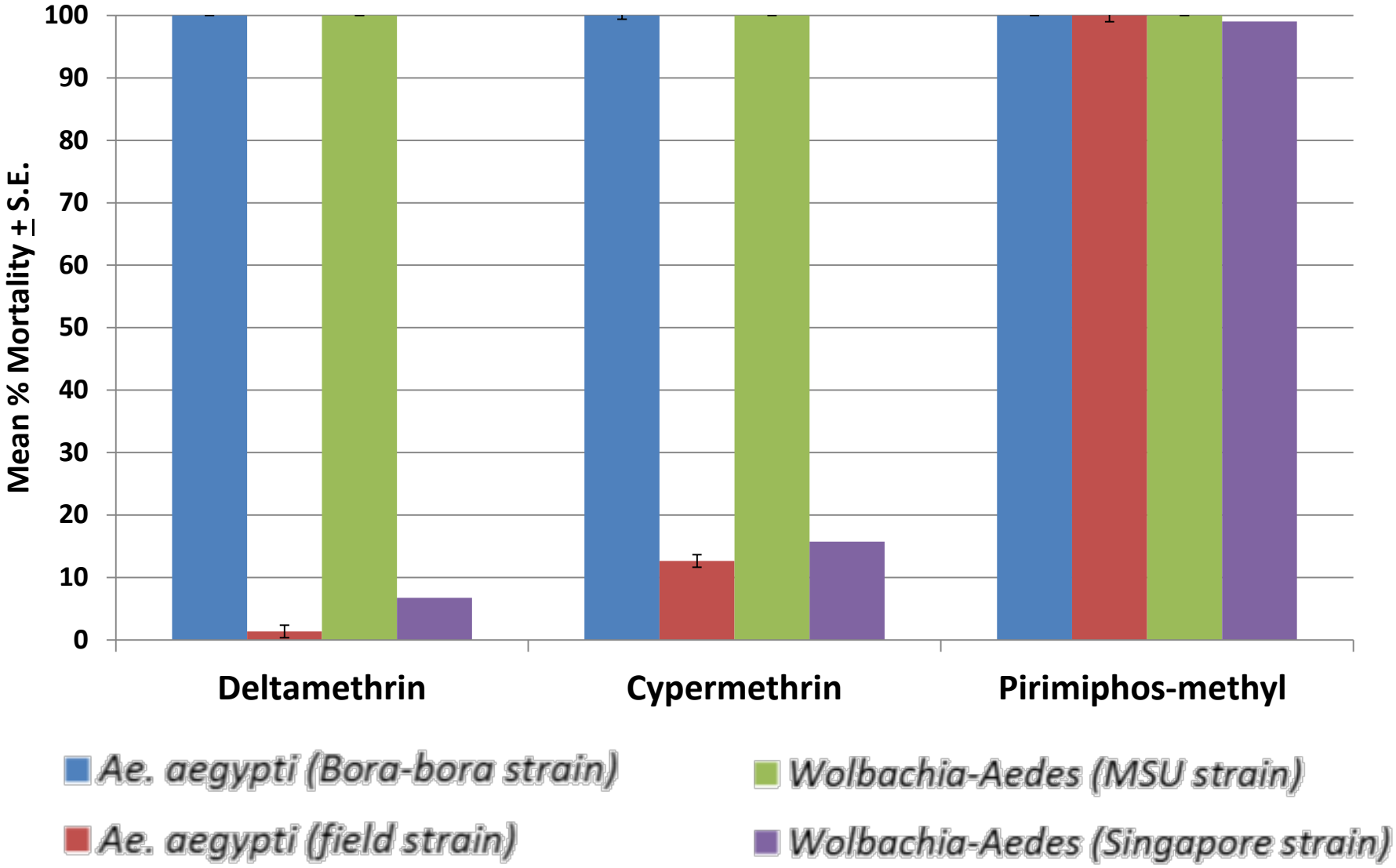
Prof Zhiyong Xi
Michigan State University

Critical Properties of *w*AlbB-Sg's Validated in Lab



- **100% cytoplasmic incompatibility (>30,000 eggs from 306 females)**
- **Mating competitiveness and mating vigor equivalent to WT**

Insecticide resistance of *w*AlbB-Sg equivalent to WT



Calibration study sites – release of male *Wolbachia-Aedes*

- 10 apartment blocks (~1000 homes)

- 29 apartment blocks (~3300 homes)

Release sites' advisers giving their support to the project

- 216 Landed homes

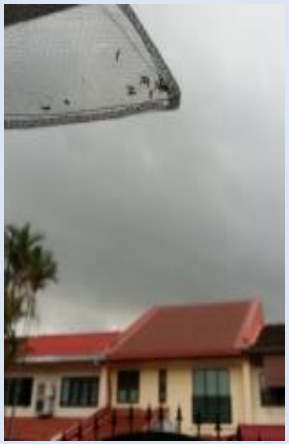
Monitoring traps set up at release sites

Gravitrap collects female adults for **population monitoring**

- Attractant: hay infusion
- Trap: sticky lining

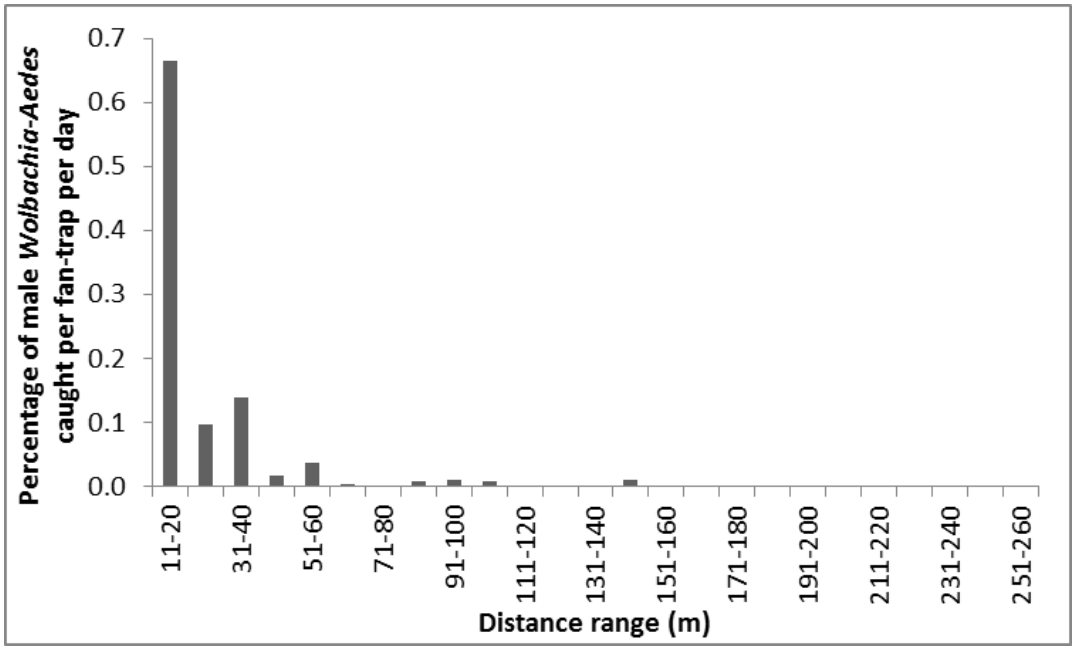
Ovitrap collects *Aedes* eggs from the field monitoring for estimating **hatch rates**

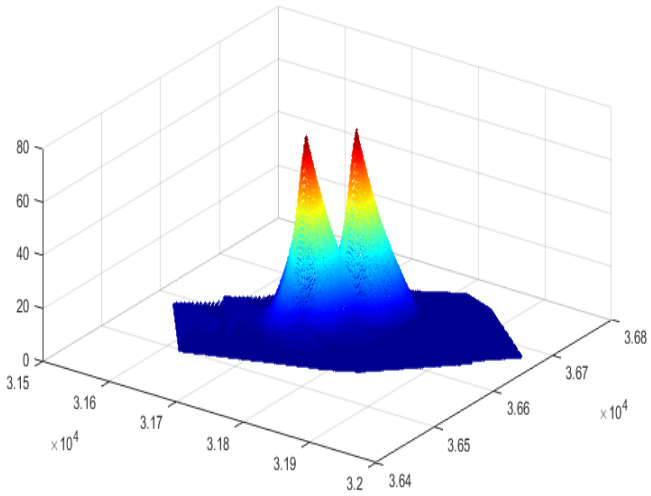
- Attractant: hay infusion
- Trap: Paper



Fan trap: passive trap for catching released males and field mosquitoes (estimate **dispersal and field population density**)

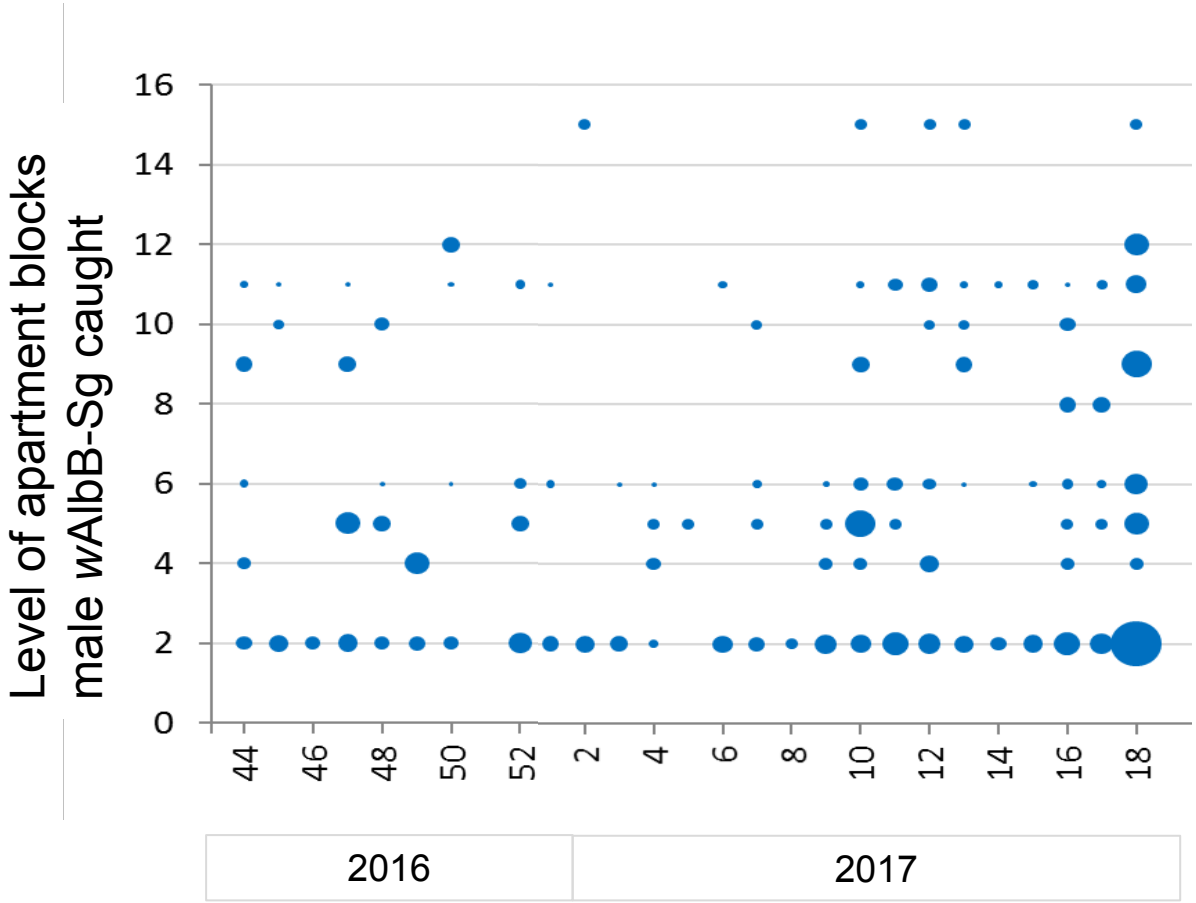
Horizontal dispersal of *w*AlbB-Sg





- Most male *Wolbachia-Aedes* (90%) caught within 40m from release point
- Some were captured by the furthest traps set at 140m
- Mean distance travelled by male *Wolbachia-Aedes* (60m)

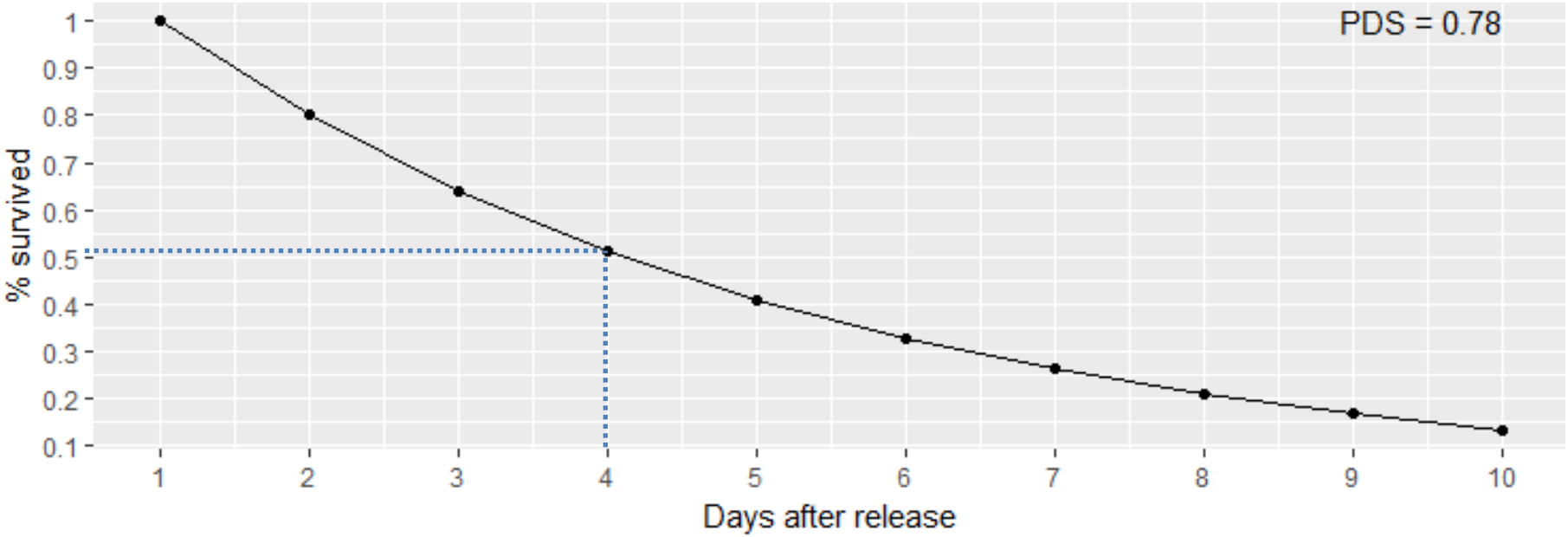
Vertical dispersal of *w*AlbB-Sg



Male *w*AlbB-Sg well distributed following regular multi-point releases from ground level

Longevity of *w*AlbB-Sg

➢50% survived to 4 days after release



Probability of daily survival of male *Wolbachia-Aedes* (mean = 0.78)

Release strategy to assess effectiveness

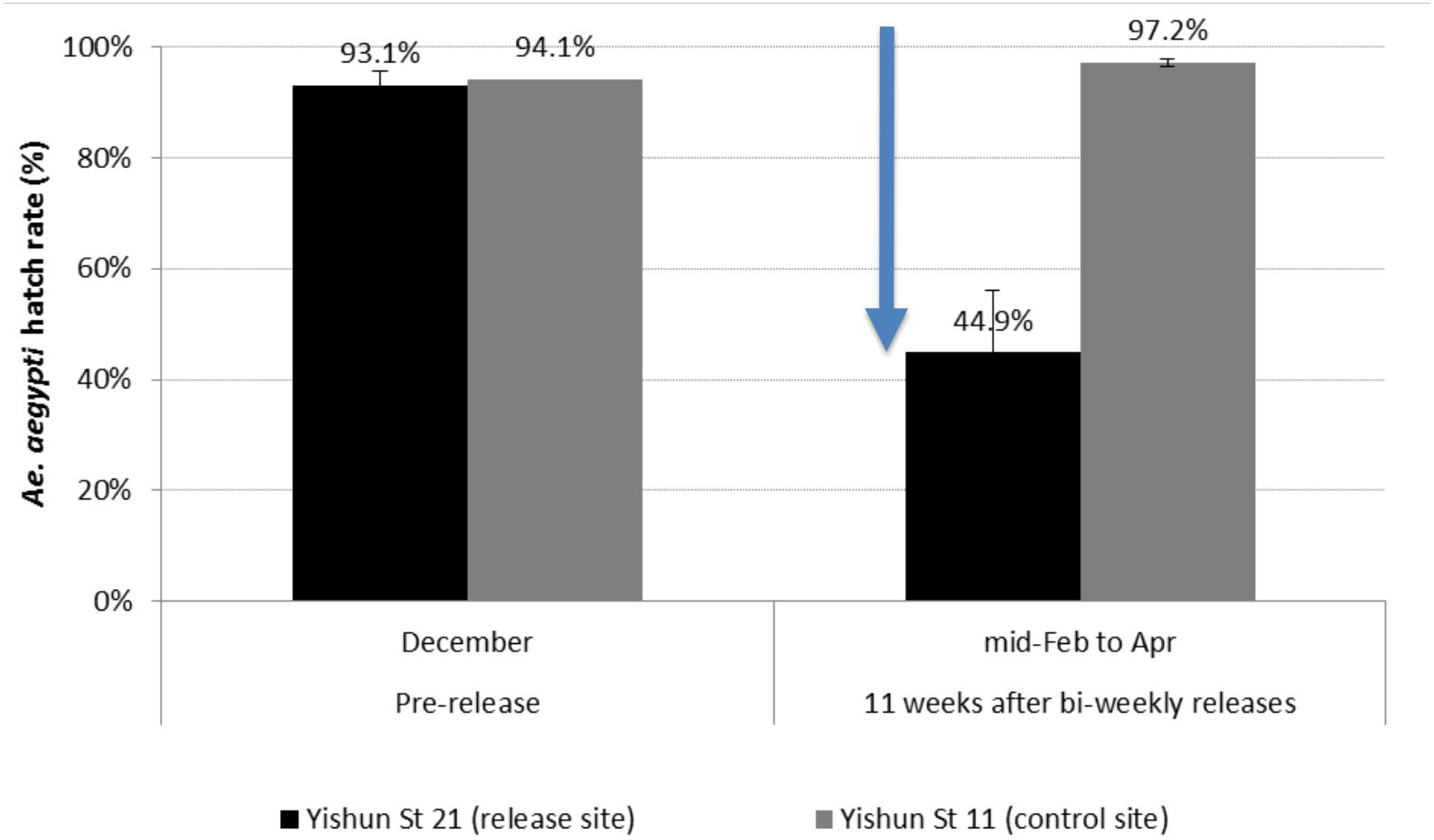
Zig Zag releases

Tampines West: weekly

Nee Soon East twice a week

Nee Soon East

Reduction of hatch rates of eggs collected from Nee Soon site

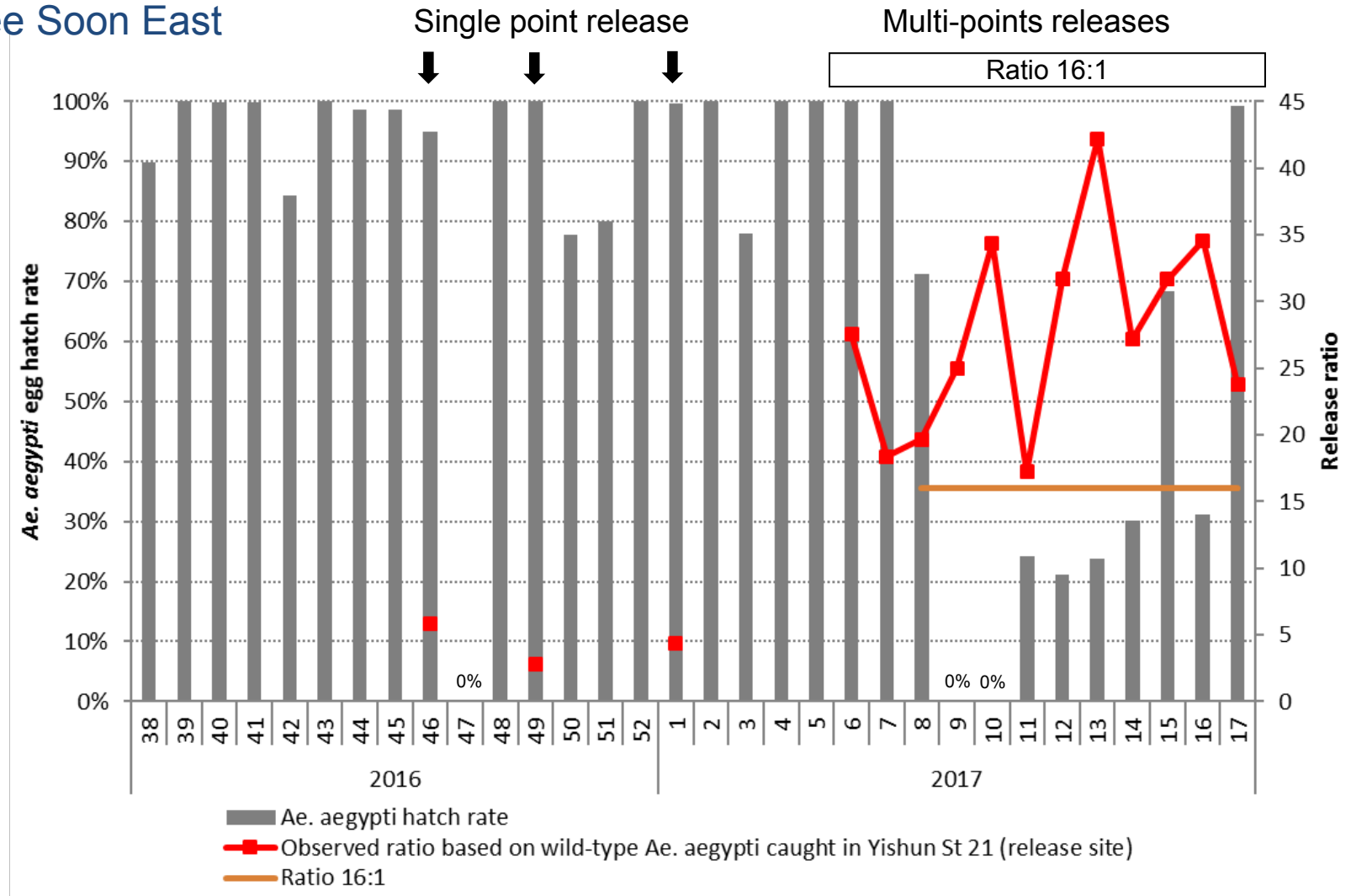


As of 2017 Eweek 17

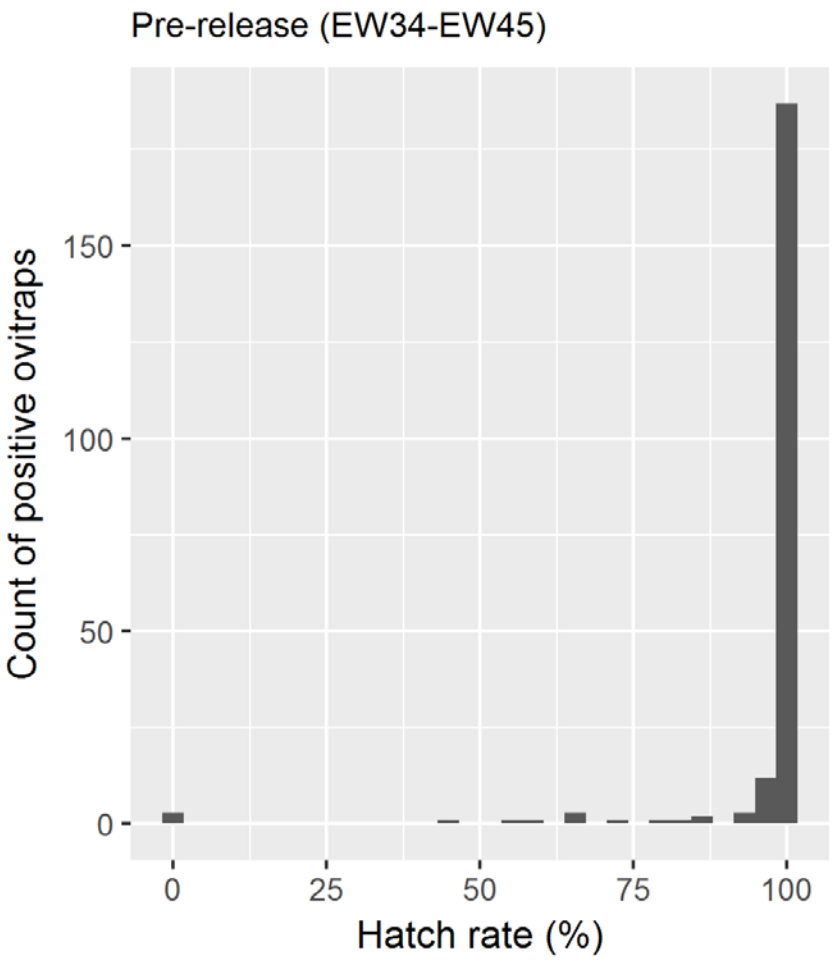
Clear reduction in spatial hatch rates in each site

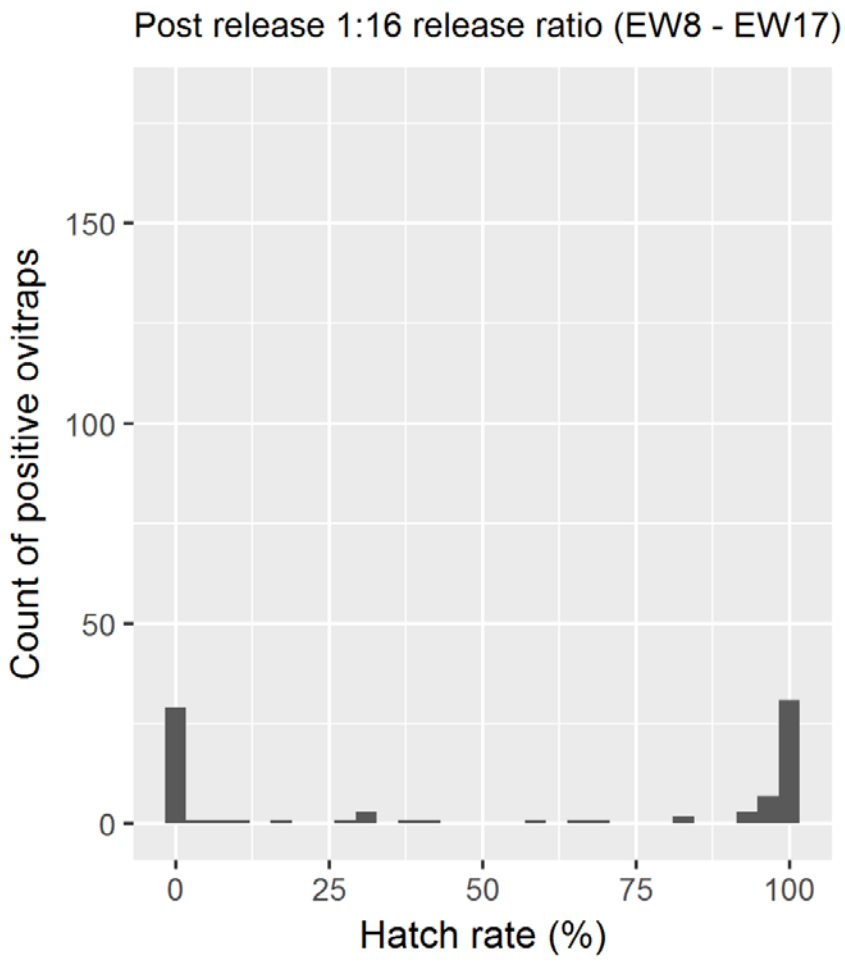
Decline in hatch rates correspond with high release ratio

Nee Soon East



Lower number of positive ovitraps, increase proportions with 0% hatch rates





Nee Soon: “High” hatch rates in EW17 likely due to “infiltration”

- 4 ovitraps had 100% hatch rate

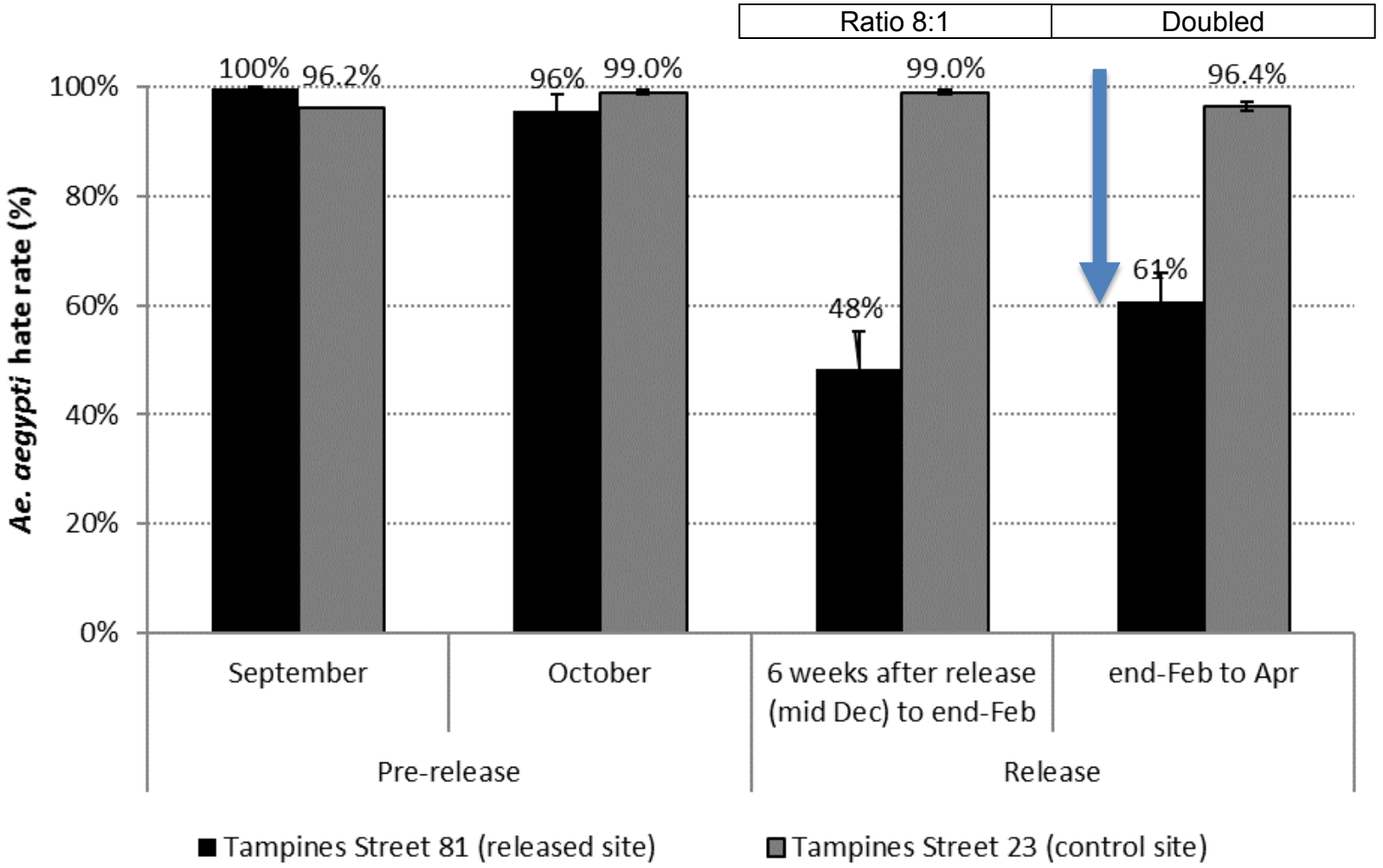
Blk	Floor	No. of eggs
217	6th	55
221	3rd	120
224	9th	8
226	1st	62

- Ovitraps with high hatch rates are in the periphery of the area.
- Could be due to female mosquitoes that have flown in from surrounding areas and have not mated with *Wolbachia-Aedes* males.

Blocks with positive ovitraps

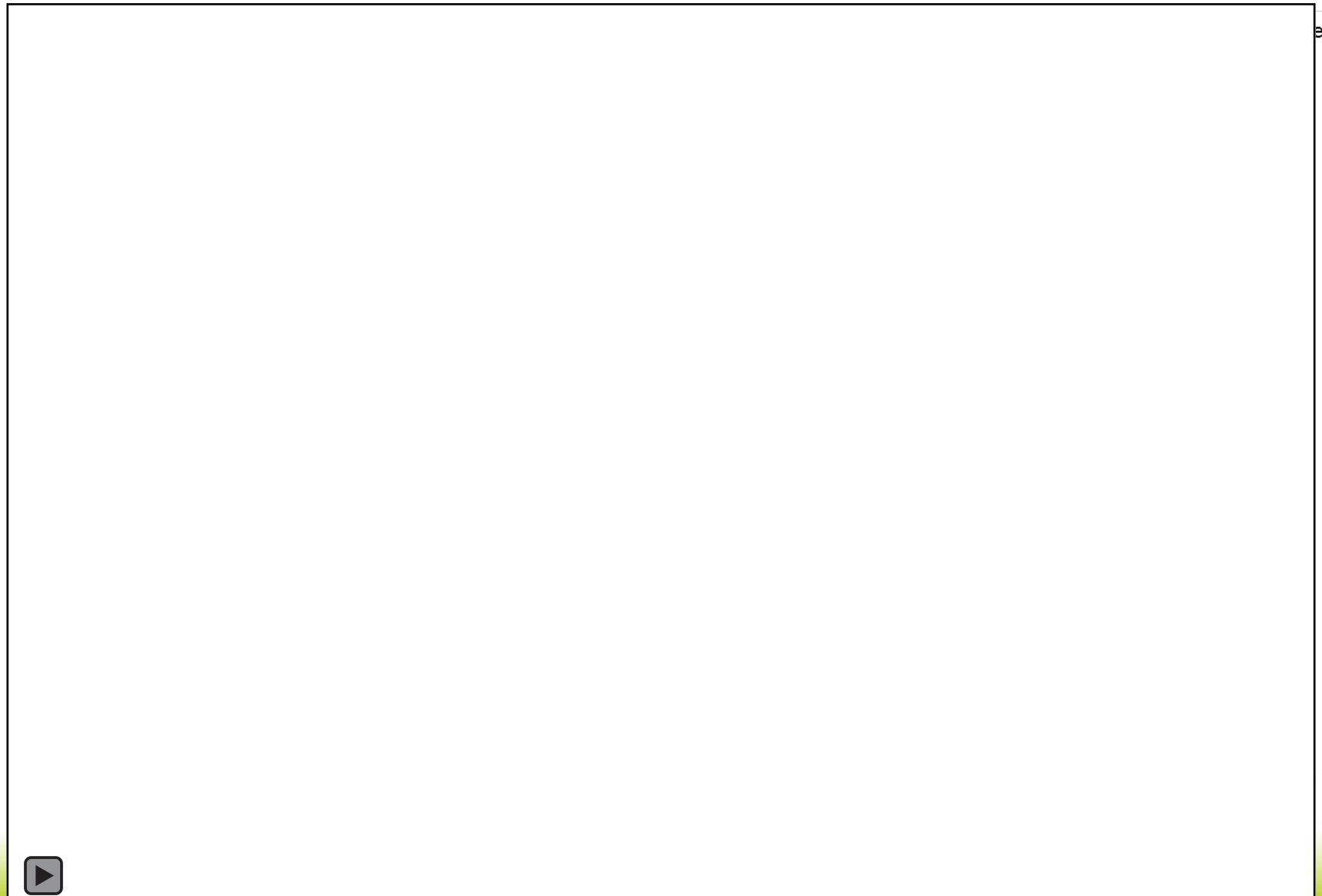
Tampines West

Reduction of hatch rates of eggs collected from Tampines sites

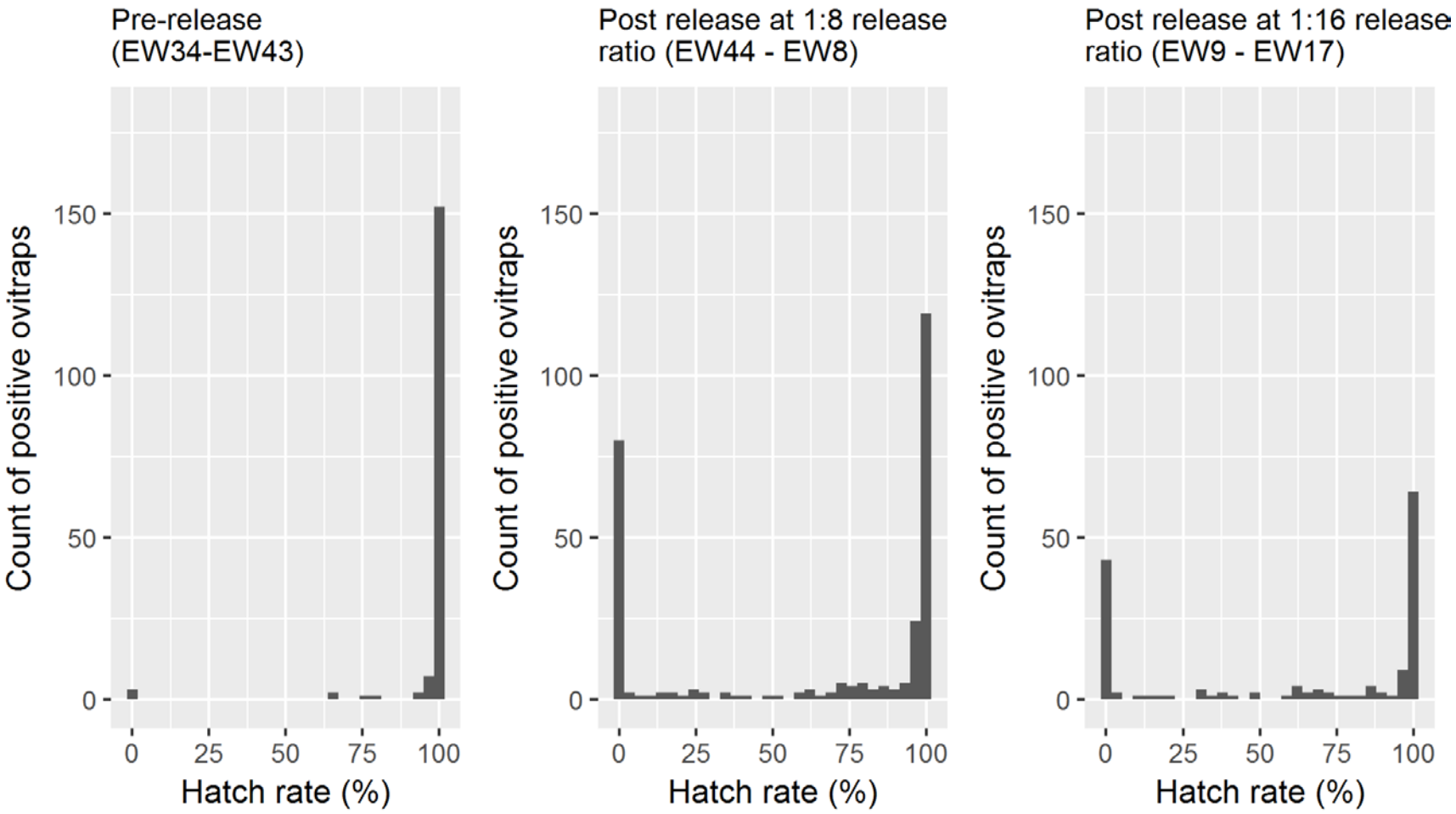


As of 2017 Eweek 17

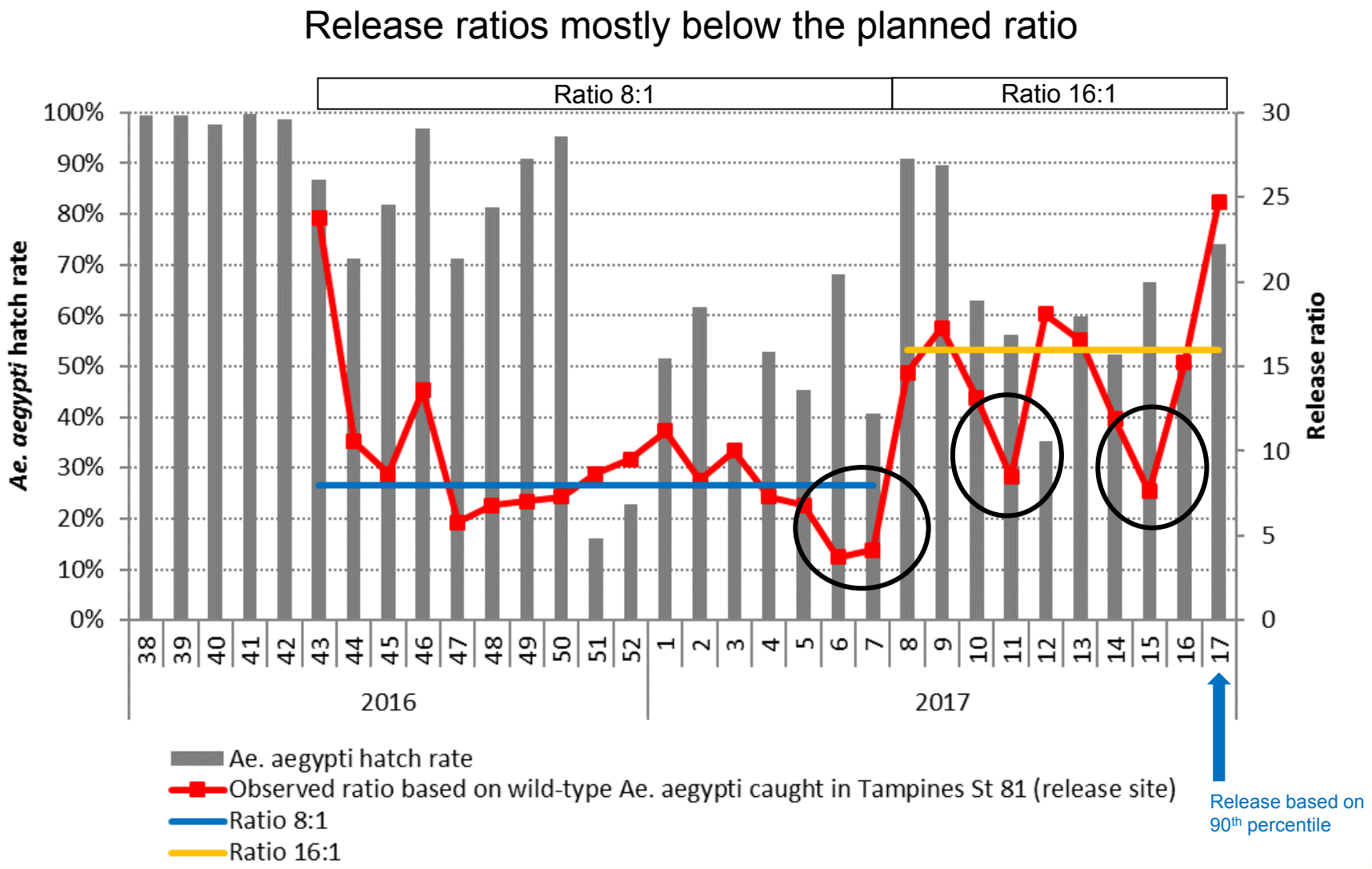
Overall reduction in *Ae. aegypti* hatch rate in each block



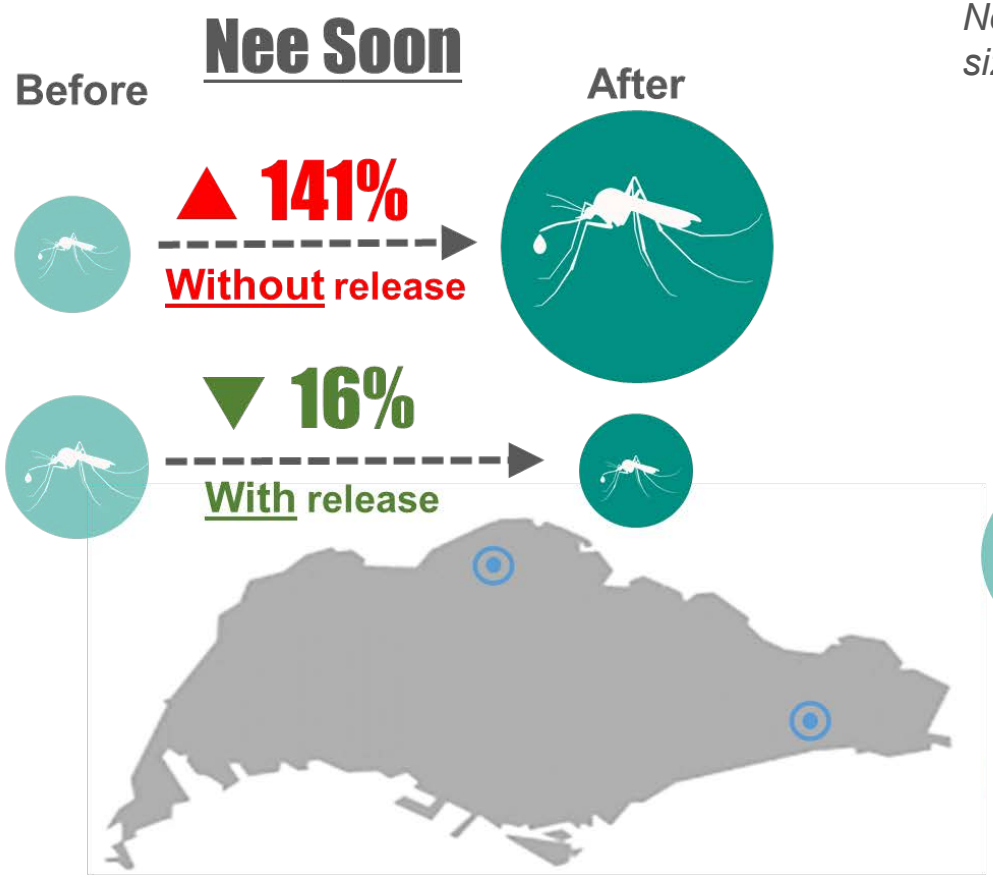
Lower number of positive ovitraps, increase proportions with 0% hatch rates



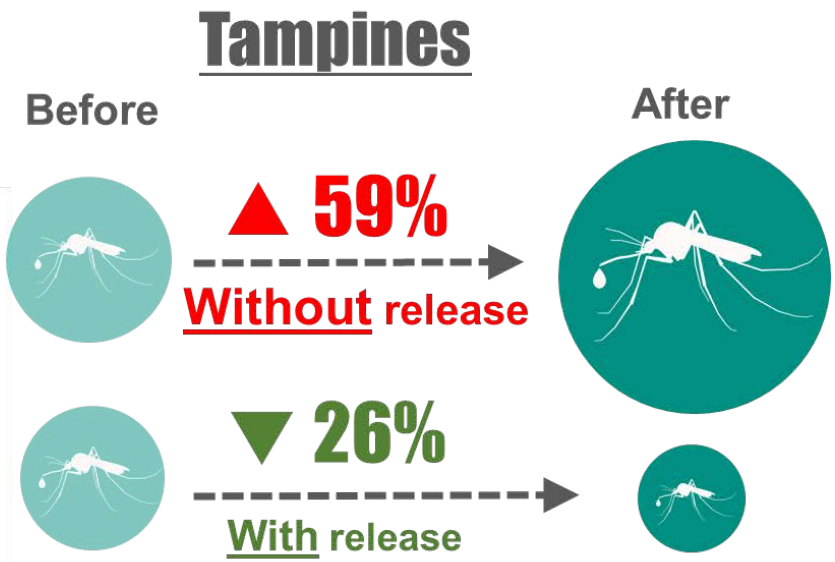
Variable Release Ratio due to Fluctuation of Field Population



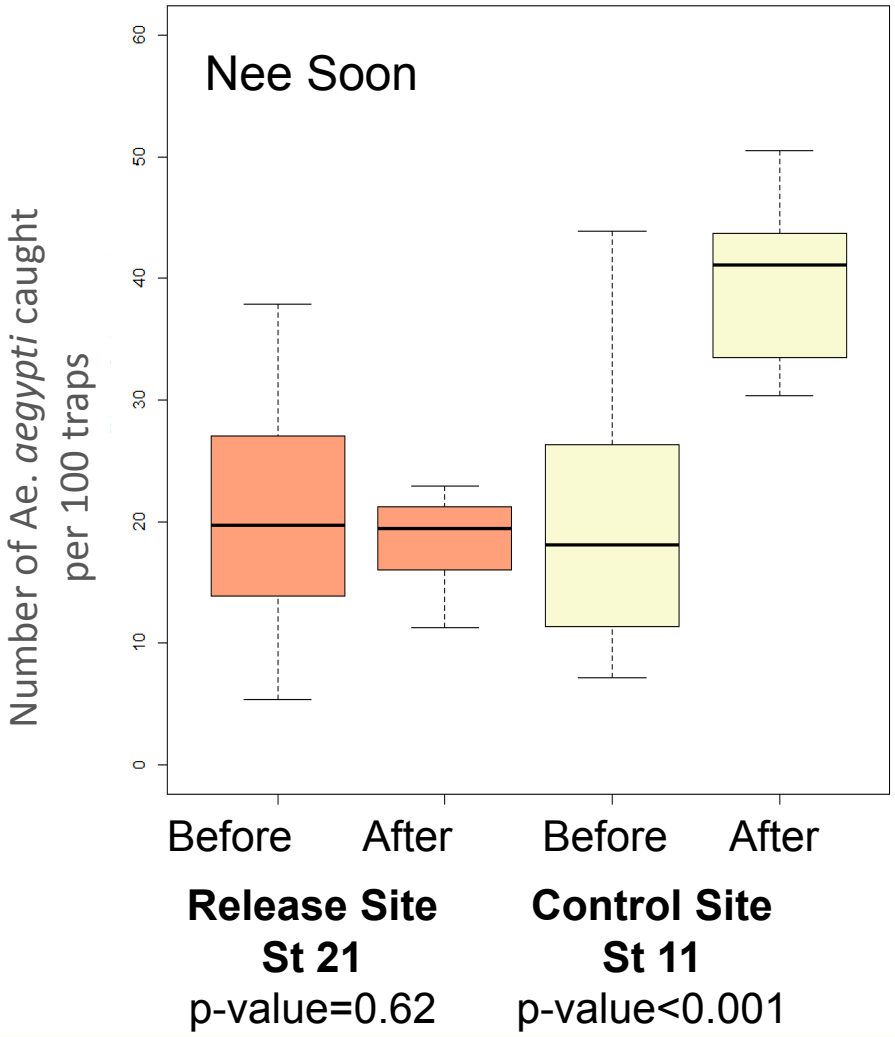
Decreased number of urban female *Aedes aegypti* mosquitoes caught in sites with *Wolbachia-Aedes* releases

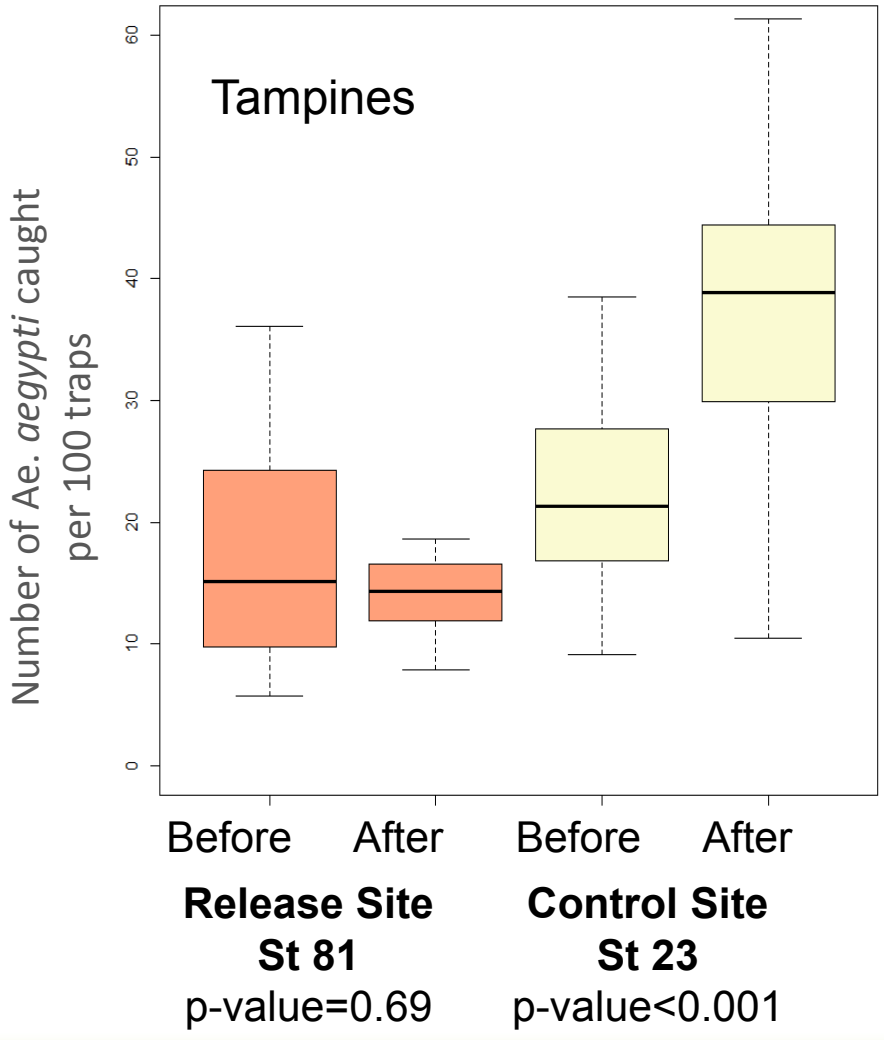


Note: Size of bubble is proportional to the size of Aedes aegypti *mosquito population*



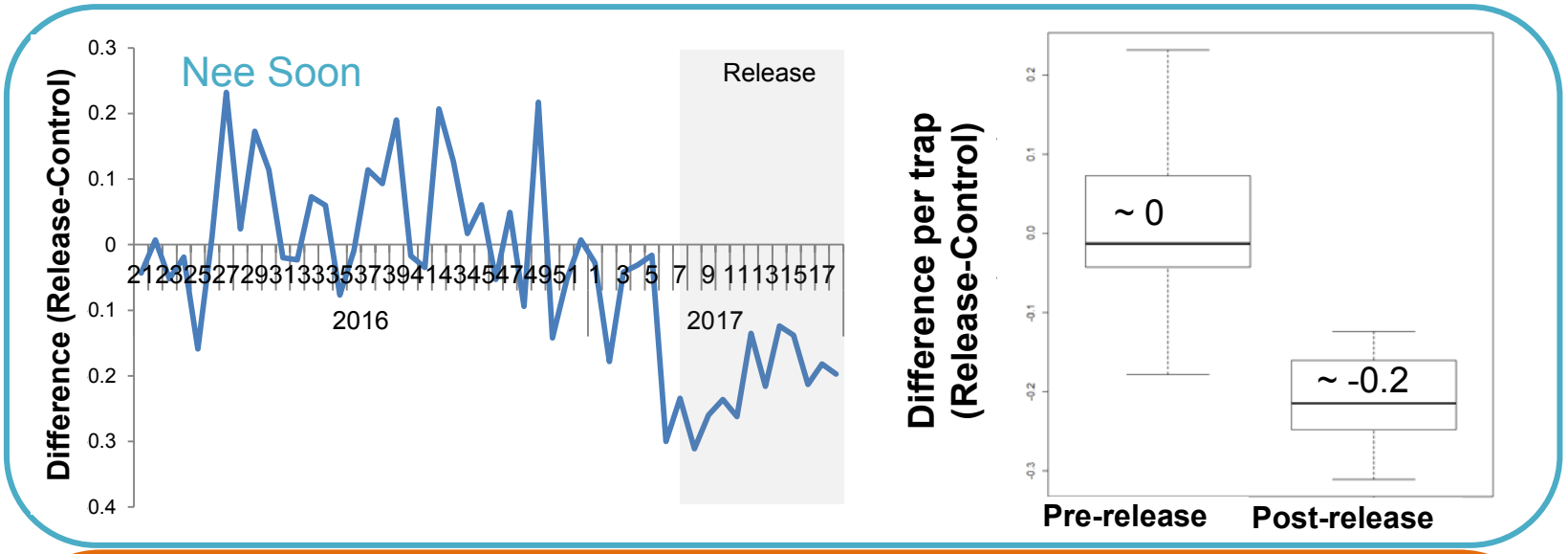
No significant difference in *Ae. aegypti* population in release sites, in contrast to significant increase in control sites

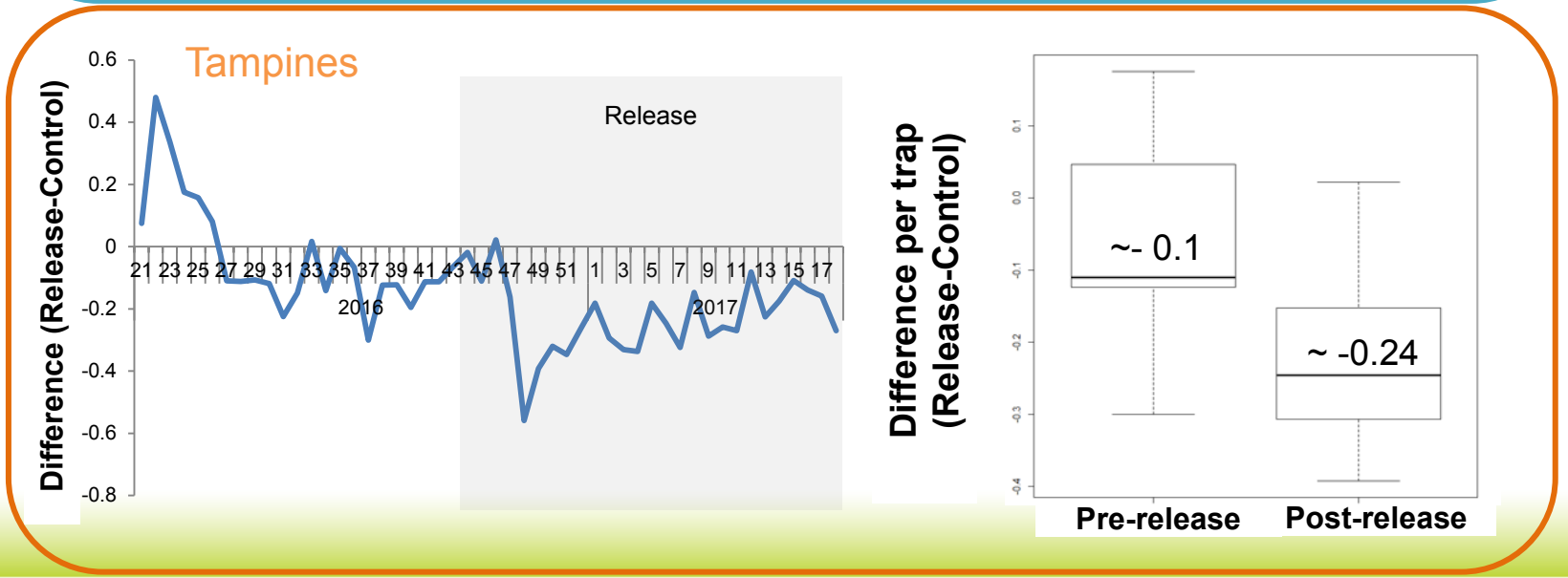




Before-After-Control-Impact Analysis (BACI)

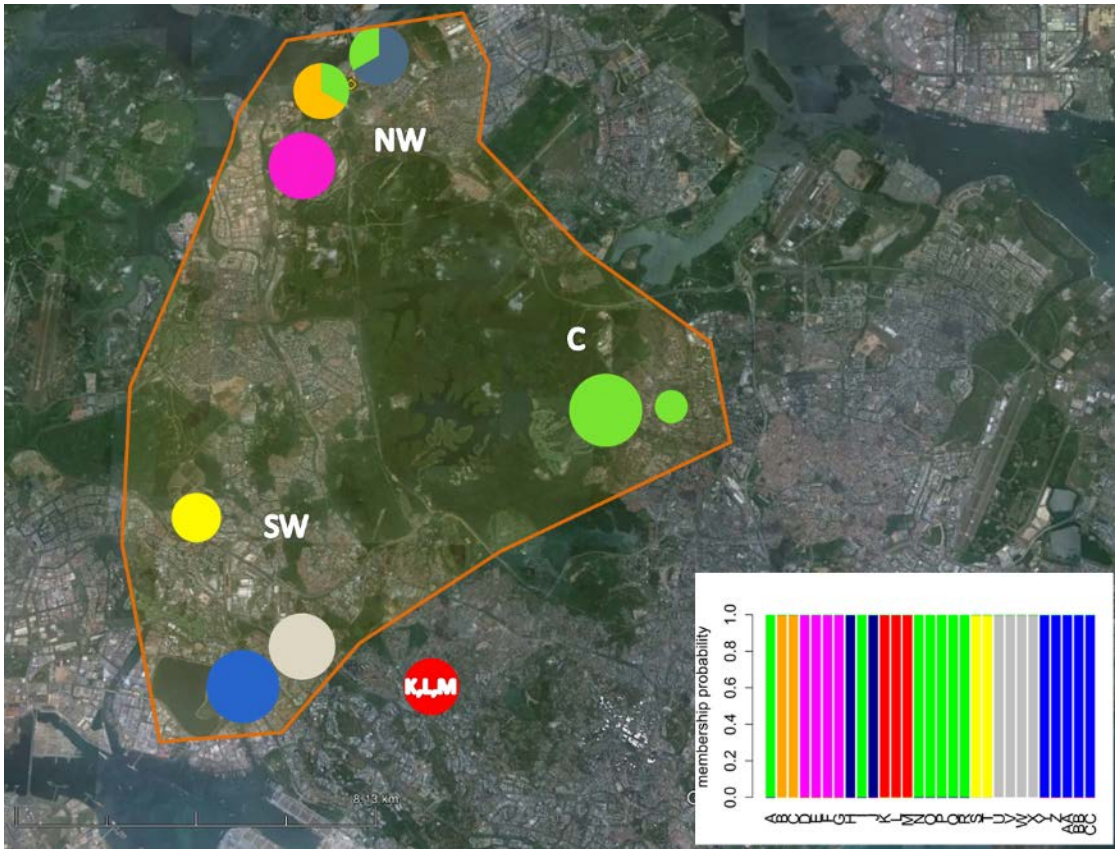
Significant change in differences (0.2 *Ae. aegypti* per trap) between control and release site post-release (p-value<0.001)





RADSEQ for understanding mosquito movement

Estimate the rate of reinvasion of wild type *Aedes* population after suppression/elimination by *Wolbachia*-Aedes



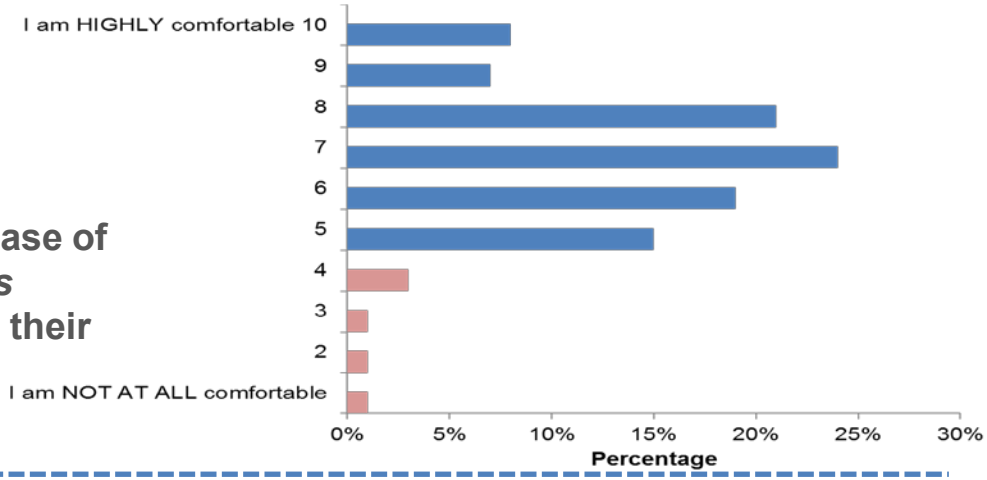
RADSEQ: Restriction site associated DNA sequencing showing distribution of different genetic cluster of *Aedes aegypti*, at ultra fine levels

Nationwide Online Survey and Face-to-face Street Survey (Pre-release Survey Results)

Nationwide Online Survey
(respondents skewed towards adults <age 40)

94%

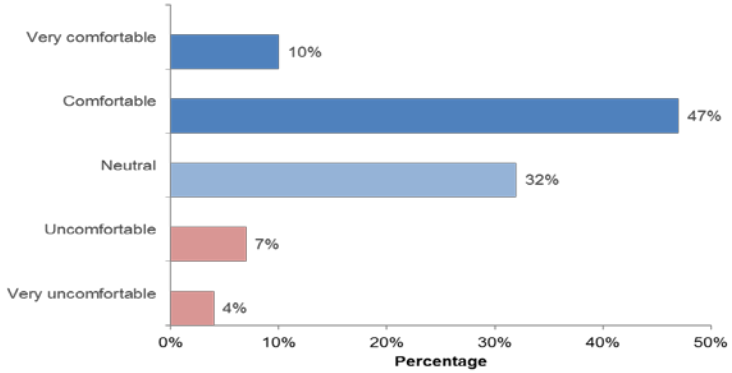
of population had no concerns with the release of male *Wolbachia-Aedes aegypti* mosquitoes in their neighbourhoods



Face-to-face Street Survey
(targeting respondents >age 40)

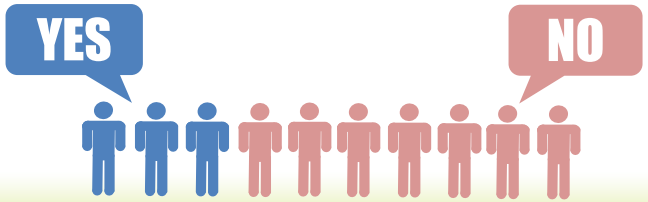
89%

of population had no concerns with the release of male *Wolbachia-Aedes aegypti* mosquitoes in their neighbourhoods



31%

of population have heard of Project *Wolbachia* – Singapore



Household Perception Survey at Nee Soon East (Post-release Survey Results)

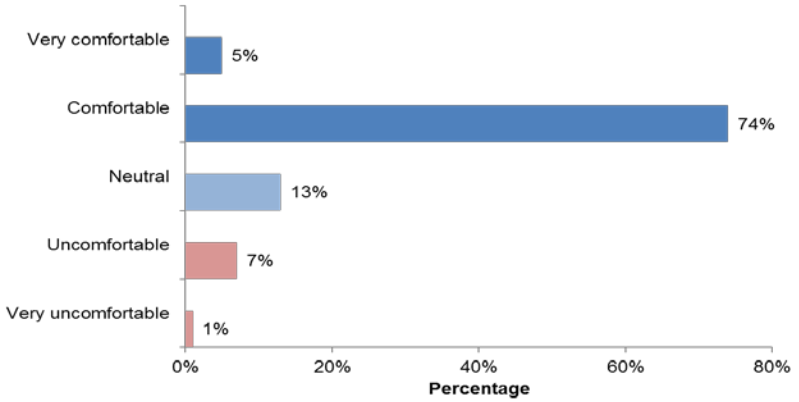
72%

of households have heard of Project *Wolbachia* – Singapore

First heard of Project *Wolbachia* – Singapore through:
-**News (35%)**
-**Publicity materials (33%)**
-Door-to-door house visits by NEA (16%)
-Word of mouth (8%)
-*Wolbachia* outreach events (4%)
-Internet and social media (4%)

92%

of households had no objections with the release of male *Wolbachia-Aedes aegypti* mosquitoes in their neighbourhood



84%

of the households did not notice more mosquitoes around Tampines West

Risk Assessment and stakeholders engagements since 2012

Sharing and promoting the understanding of *Wolbachia* technology through lectures, talks, and community activities

Target groups include the academic, medical and government communities


SCIENTIFIC CONTRIBUTIONS

How Safe is *Wolbachia* for *Aedes* Control?

A risk assessment for the use of male *Wolbachia*-carrying *Aedes aegypti* for suppression of the *Aedes aegypti* mosquito population

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NUS National University of Singapore