A Cluster Randomized Trial to Measure the Impact of 3GIRS in Mozambique: Summary of Entomological Surveillance Results

Kenyssony Varela

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CDC Centers for Disease Control and Prevention

U.S. President's Malaria Initiative

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Protocol

BMJ Global Health

Combination of indoor residual spraying with long-lasting insecticide-treated nets for malaria control in Zambezia, Mozambique: a cluster randomised trial and cost-effectiveness study protocol

Carlos J Chaccour,[1,2] Sergi Alonso,[1,2] Rose Zulliger,[3] Joe Wagman,[4] Abuchahama Saifodine,[5] Baltazar Candrinho,[6] Eusébio Macete,[2] Joe Brew,[1] Christen Fornadel,[7] Hidayat Kassim,[8] Lourdes Loch,[9] Charfudin Sacoor,[2] Kenyssony Varela,[9] Cara L Carty,[4] Molly Robertson,[2,4] Francisco Saute[2]

BMJ Glob Health 2018;**3**:e000610. doi:10.1136/bmjgh-2017-000610

3GIRS Trial in Mozambique – Year 1 Entomology Summary

The PMI AIRS/VectorLink/Abt Mozambique team is leading both the IRS implementation and the enhanced entomological surveillance components of the CRT in Mopeia, with support from IVCC and PATH.

Maputo

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Abuchahama Saifodine (USAID)

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Joe Wagman

Molly Robertson

Jason Richardson

Christen Fornadel

Overview

- Background
  - Study setup and methods
  - Vector bionomics and residual efficacy of Actellic® 300CS
- Impact of IRS on
  - Total *An. funestus* densities (CDC LT)
  - Average number of *An. funestus* collected per trap-night (CDC LT)
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  - Similar trends in *An. gambiae*
- Summary and future directions
- Questions and discussion

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Entomological Surveillance Setup

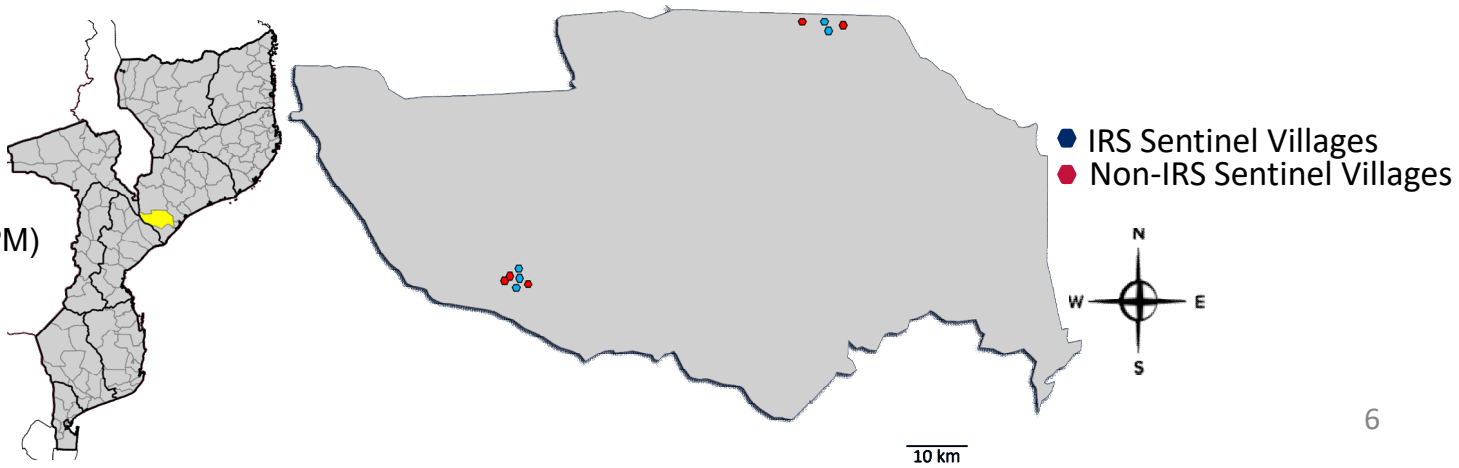
Ten sites, five from IRS clusters and five from non-IRS clusters

IRS Clusters			
Village	Village Population	Sentinel houses - CDC LT	Sentinel houses - HLC
Eduardo Mondlane	4600	8	1
7 de Abril	2300	8	1
4 de Outubro	2200	8	1
25 de Junho	2300	8	1
Paz	700	8	-

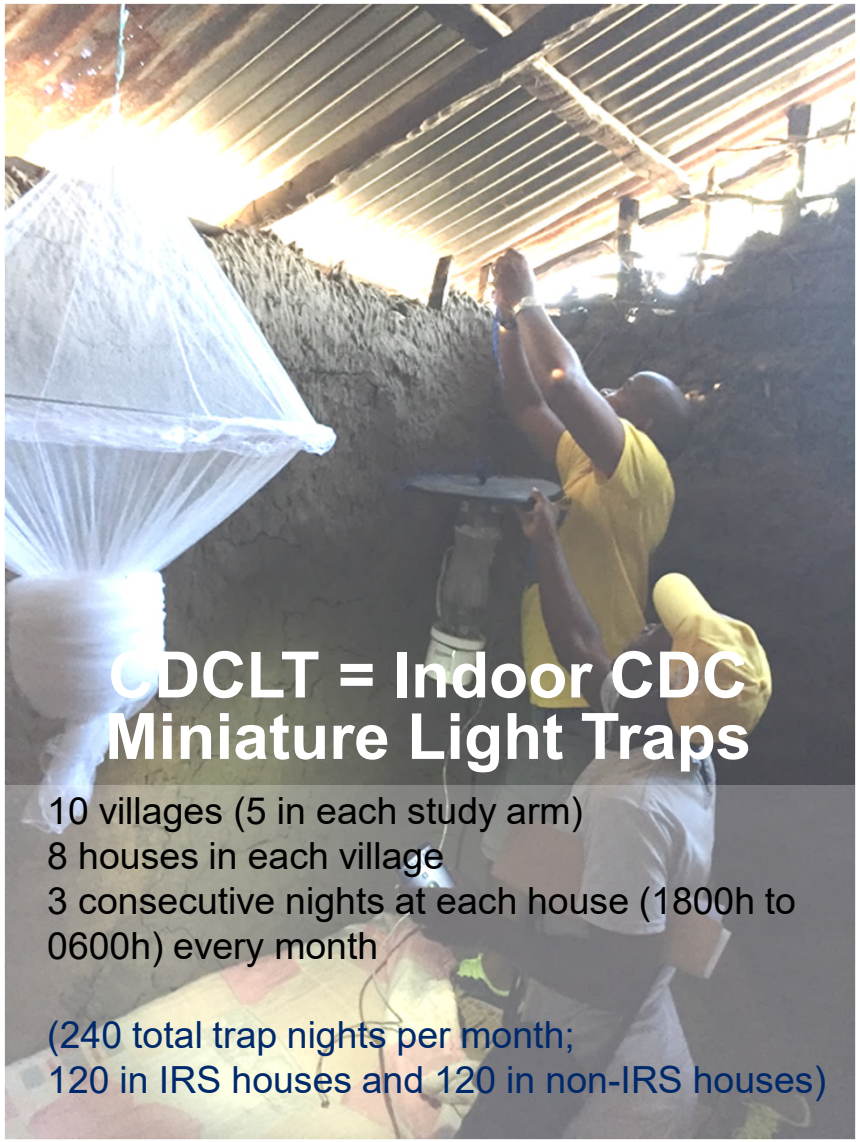
Non-IRS Clusters			
Village	Village Population	Sentinel houses - CDC LT	Sentinel houses - HLC
Zona Verde	3600	8	1
A Luta Continua	1500	8	1
Lua Lua Sede	1300	8	-
Josina Machel	1000	8	1
Mirrongone	400	8	1

IRS = Spray
Pyrethroid-only LLINs
IRS with Actellic®300 CS (PM)

Non-IRS = No Spray/Control
Pyrethroid-only LLINs



Entomological Surveillance Methods



CDCLT = Indoor CDC Miniature Light Traps

10 villages (5 in each study arm)
8 houses in each village
3 consecutive nights at each house (1800h to 0600h) every month

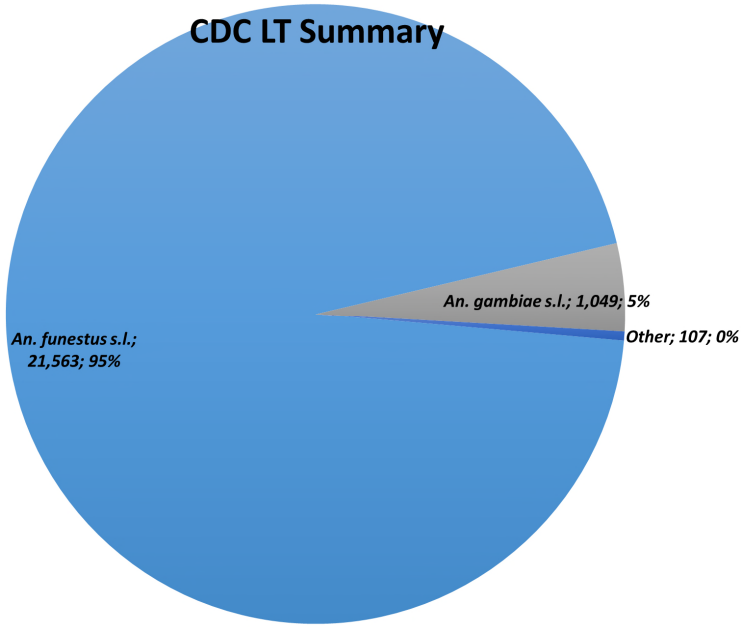
(240 total trap nights per month;
120 in IRS houses and 120 in non-IRS houses)

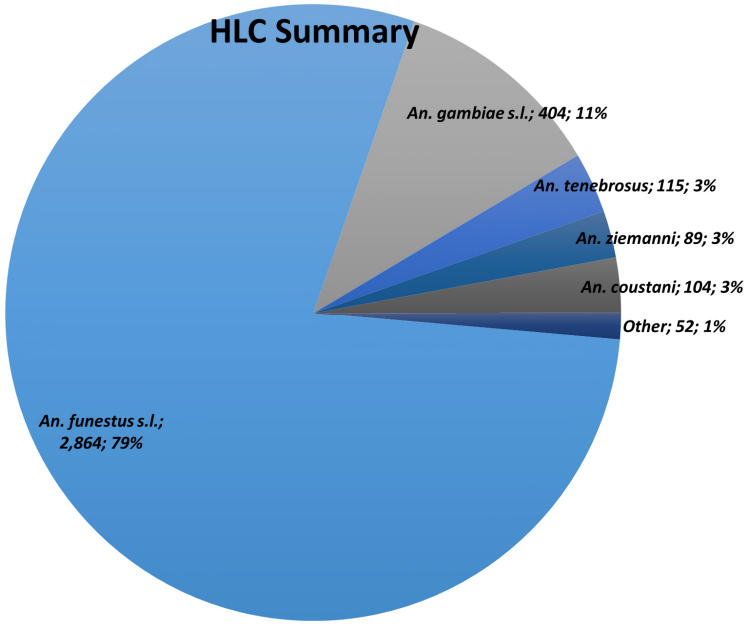
HLC = Indoor/Outdoor Paired Human Landing Collections

8 villages (4 in each study arm)
1 house in each village/paired indoor & outdoor
3 consecutive nights at each house (1800h to 0600h) every month

(24 total paired collection nights per month;
12 at IRS houses and 12 at non-IRS houses)

Vector Bionomics





An. funestus s.l. was the most abundant vector by far

- 97% of all *An. funestus* s.l. tested were *An. funestus* s.s. (3,300/3,416 screened)

From: The PMI Africa Indoor Residual Spraying Project (PMI AIRS). April 2017. *Mozambique*: *Entomological Monitoring Progress Report*. Maputo, Mozambique: PMI AIRS, Abt Associates
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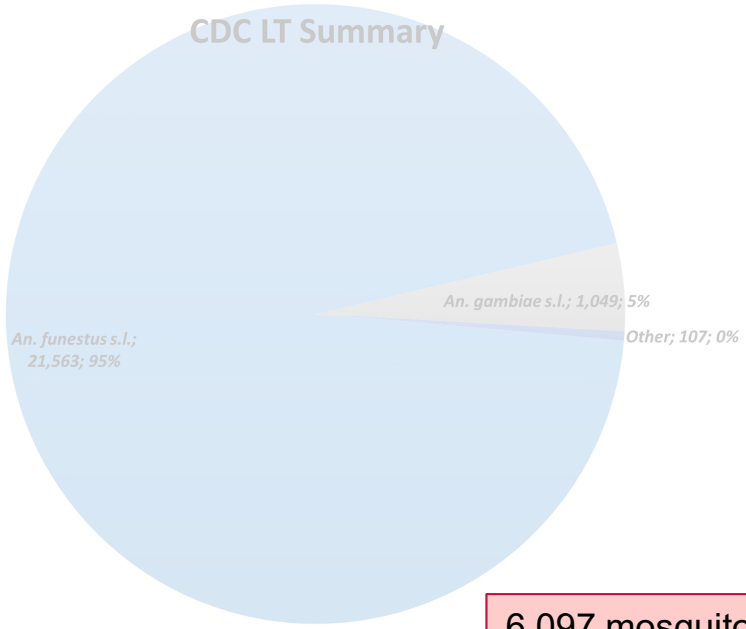
Vector Bionomics



An. funestus s.l. was th
- 97% of all *An. funest*
  (3,300/3,416 screene

6,097 mosquitoes from 14 species were screened for *Plasmodium* DNA

146 were positive for *P. falciparum*

- **137 (94%) were *An. funestus* s.s.; sporozoite rate = 2.7%**
- 3 (2%) were *An. rivulorum;* sporozoite rate = 2.5%
- 2 (1.5%) were *An. gambiae* s.s.; sporozoite rate = 2.4%
- 2 (1.5%) were *An. coustani;* sporozoite rate = 2.0%

From: The PMI Africa Indoor Residual Spraying Project (PMI AIRS). April 2017. *Mozambique*: *Entomological Monitoring Progress Report*. Maputo, Mozambique: PMI AIRS, Abt Associates
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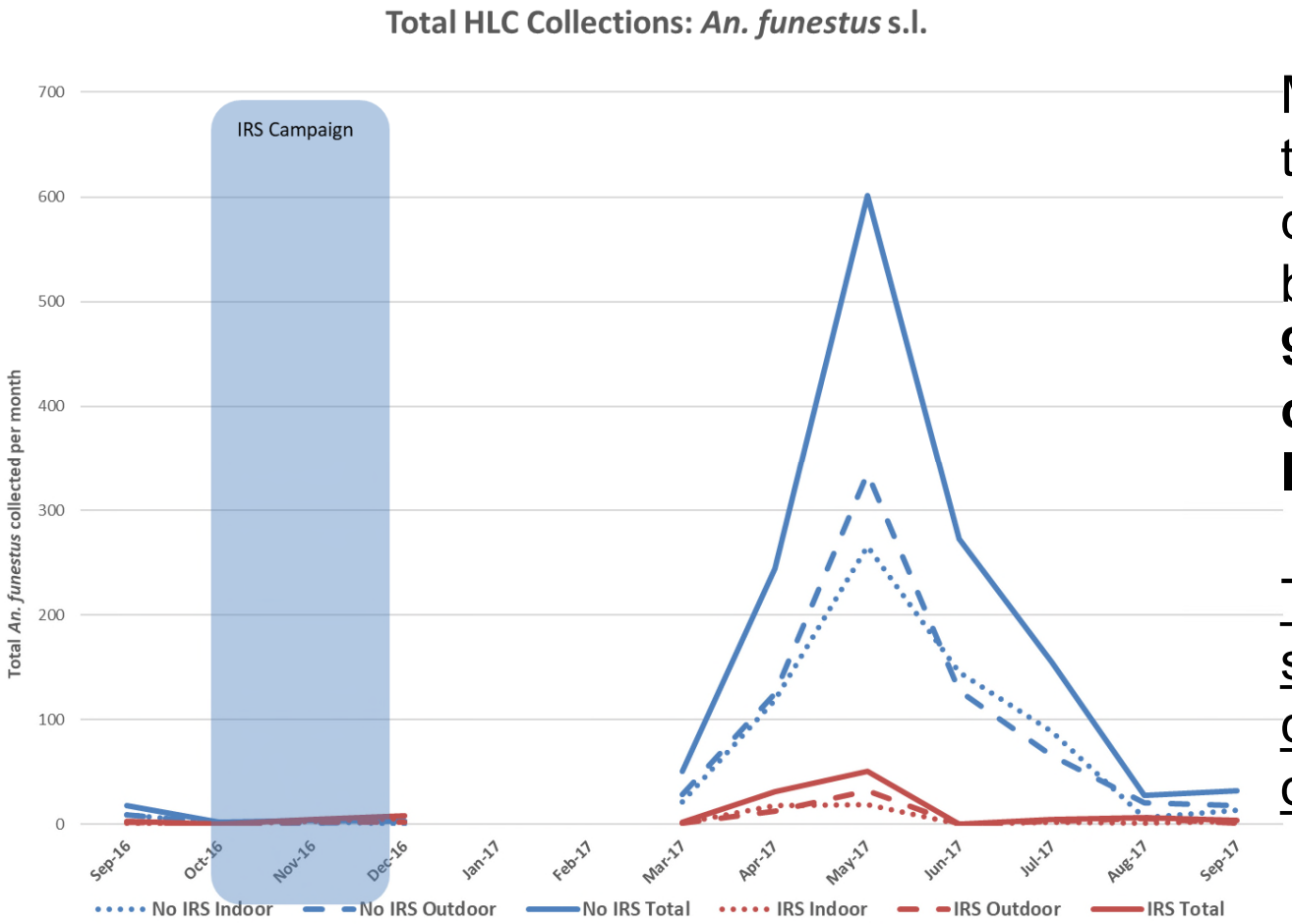
Vector Bionomics – Indoor and Outdoor Feeding

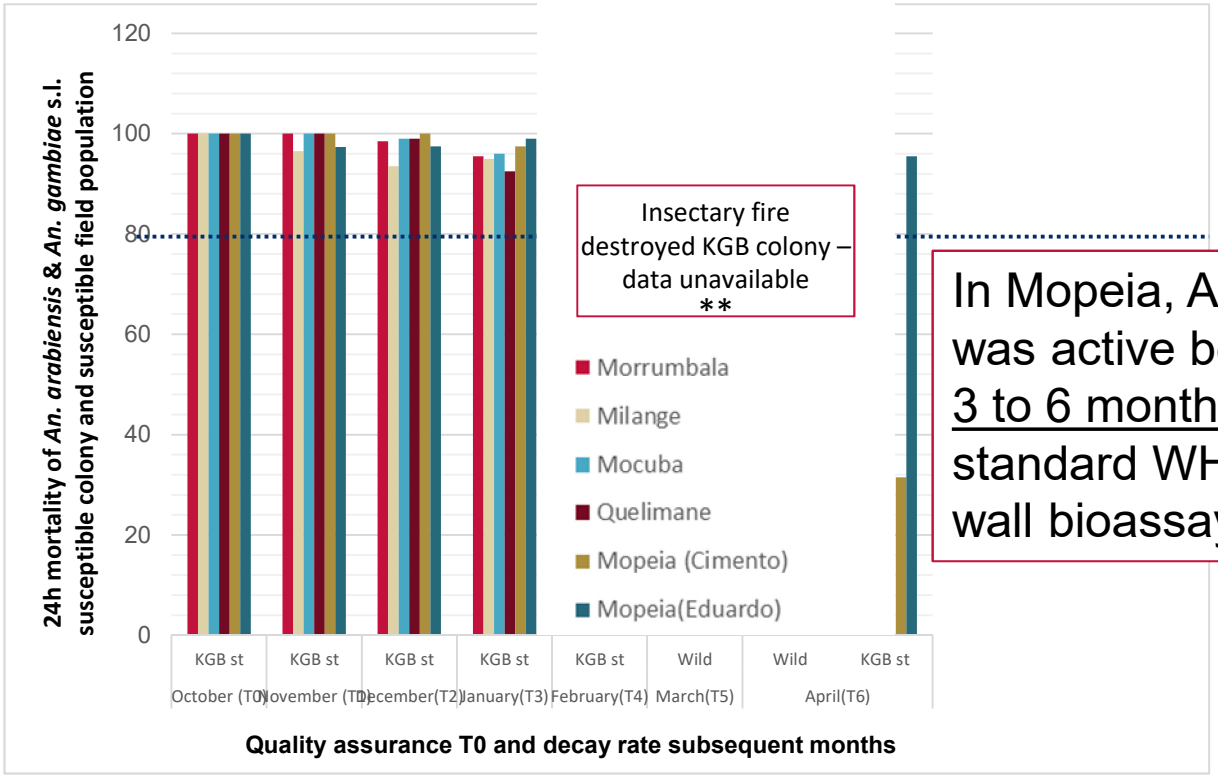


Monthly trends in total *An. funestus* collected via HLC by spray status. **92% fewer were collected from IRS houses**

The trend was the same for mosquitoes collected indoors and outdoors

Susceptibility and Residual Efficacy Tests

Residual efficacy of Actellic® 300CS (WHO wall cone test)

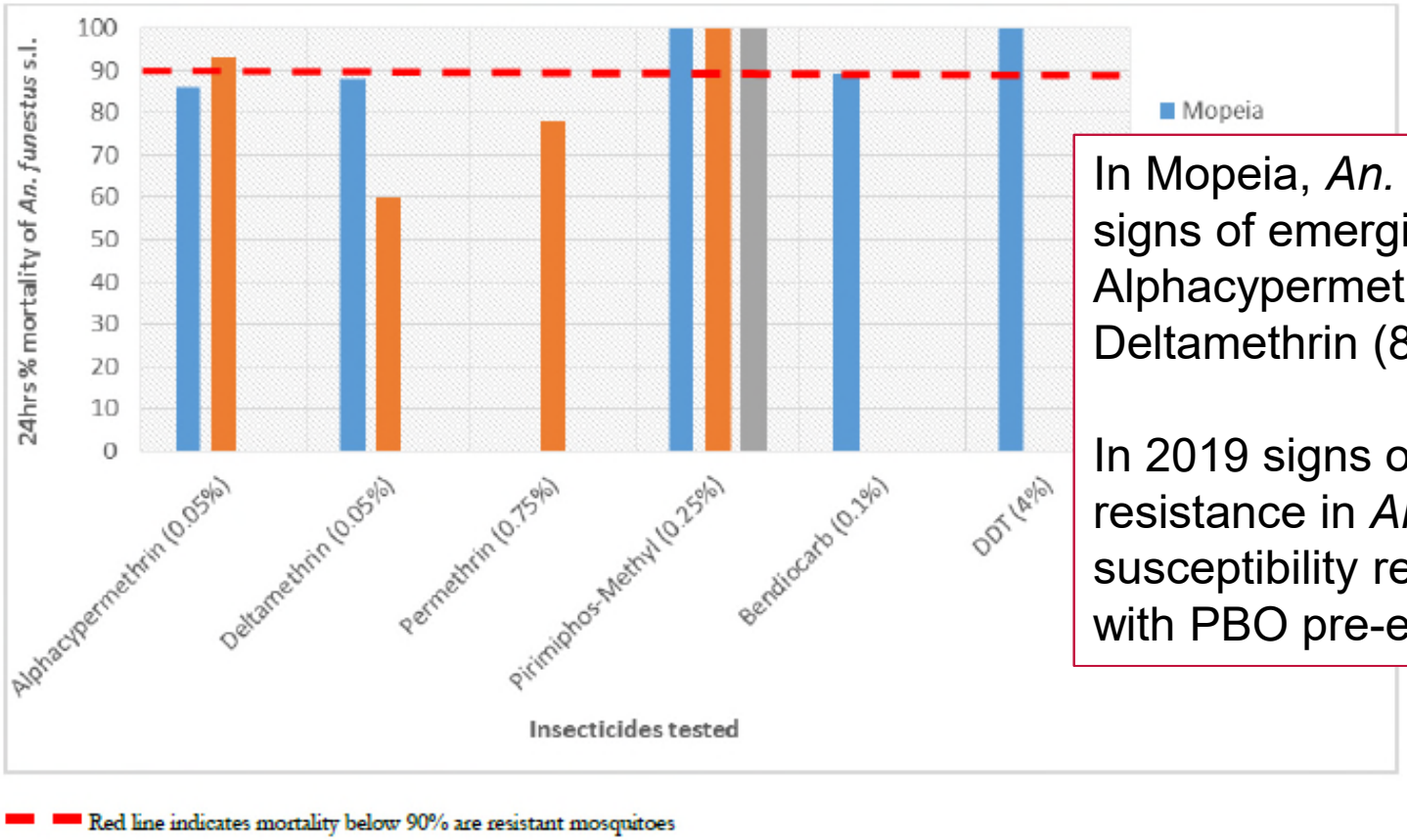


In Mopeia, Actellic® was active between 3 to 6 months in standard WHO cone wall bioassays.

From: The PMI Africa Indoor Residual Spraying Project (PMI AIRS). April 2017. *Mozambique*: *Entomological Monitoring Progress Report*. Maputo, Mozambique: PMI AIRS, Abt Associates Inc.

Susceptibility and Residual Efficacy Tests

Susceptibility of *An. funestus* s.l. - 2017



In Mopeia, *An. funestus* showed signs of emerging resistance to Alphacypermethrin (85%) and Deltamethrin (88%).

In 2019 signs of metabolic resistance in *An. gambiae* s.l. – susceptibility restored to 100% with PBO pre-exposure.

From: The PMI VectorLink Project Mozambique. 2018. *Mozambique Entomological Monitoring Annual Report, July 2017- June 2018*. Rockville, MD, USA: The PMI VectorLink Project, Abt Associates

Vector Bionomics Summary

An. funestus s.l. was the primary vector in Mopeia during the trial

Moderate resistance to pyrethroids
(85 – 90% mortality in WHO tube tests)

100% susceptibility to Actellic

Actellic residual efficacy 3 – 6 Months
(WHO wall cone tests)

Equally likely to feed indoors or outdoors during HLC
(*Impact of IRS was the same both indoors and outdoors*)

LLIN use was similar in IRS and non-IRS villages
(both before [60 - 67%] and after [92 – 93%]
a July 2017 mass distribution campaign)

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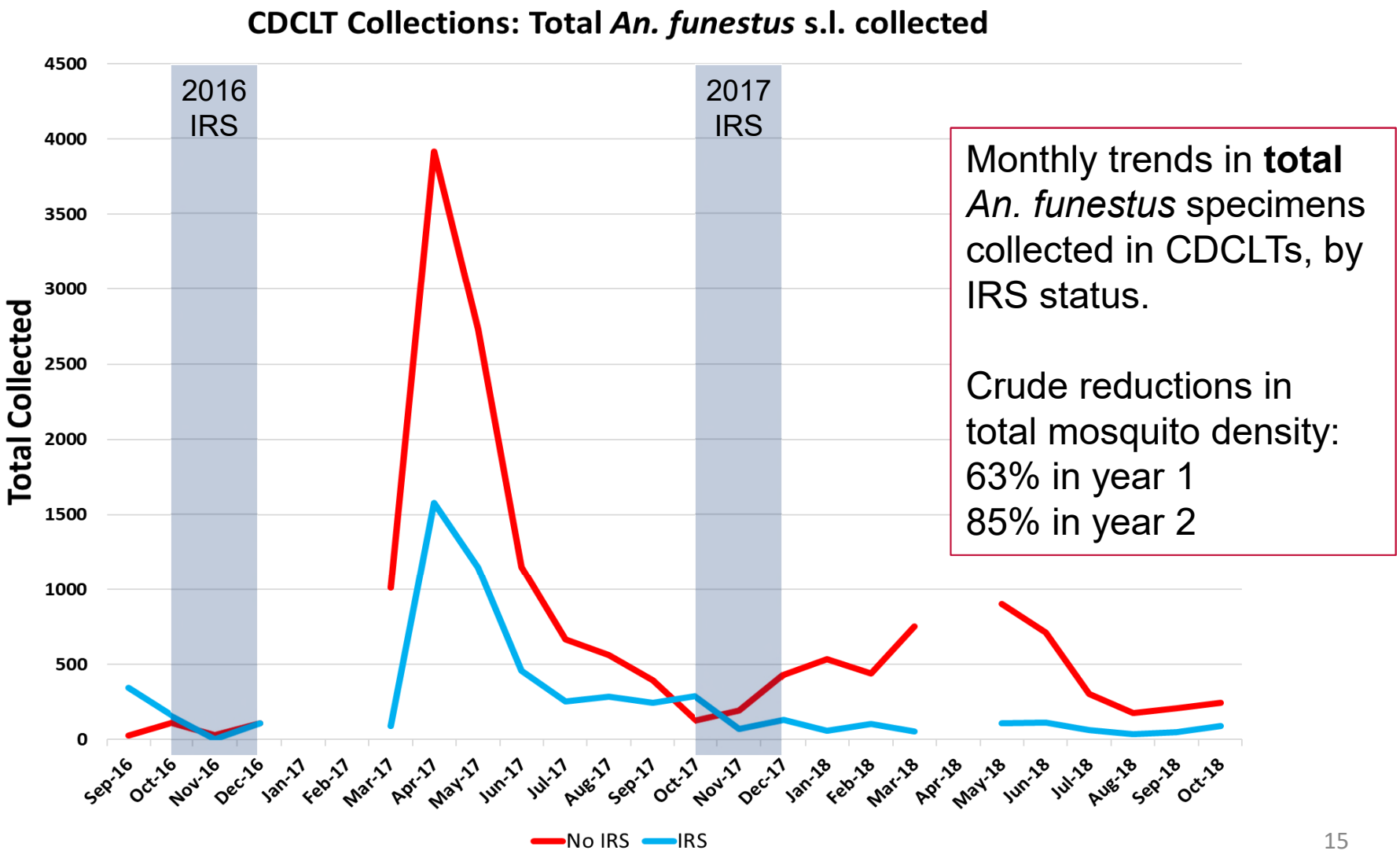
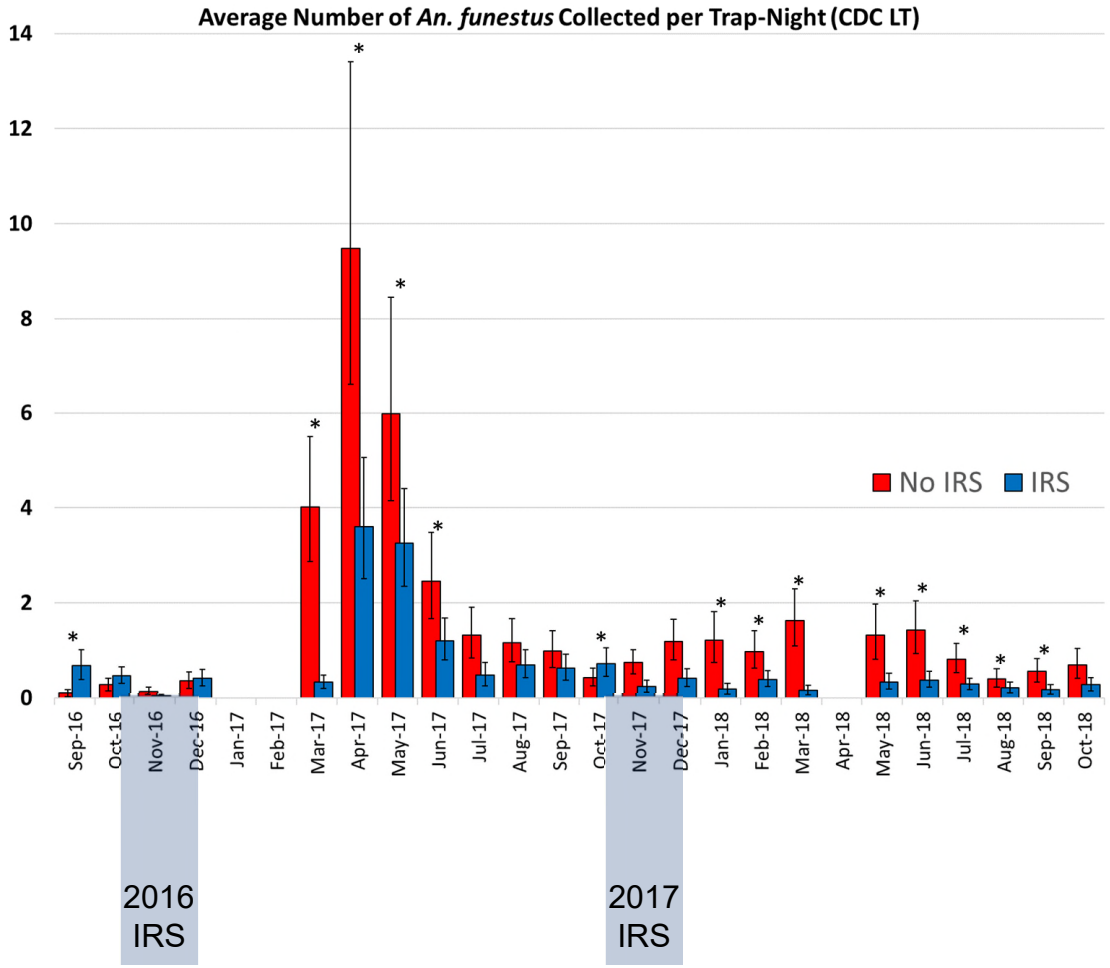
Impact of IRS – *An. funestus* Adult Densities



Monthly trends in **total** *An. funestus* specimens collected in CDCLTs, by IRS status.

Crude reductions in total mosquito density:
63% in year 1
85% in year 2

Impact of IRS – *An. funestus* Adult Densities



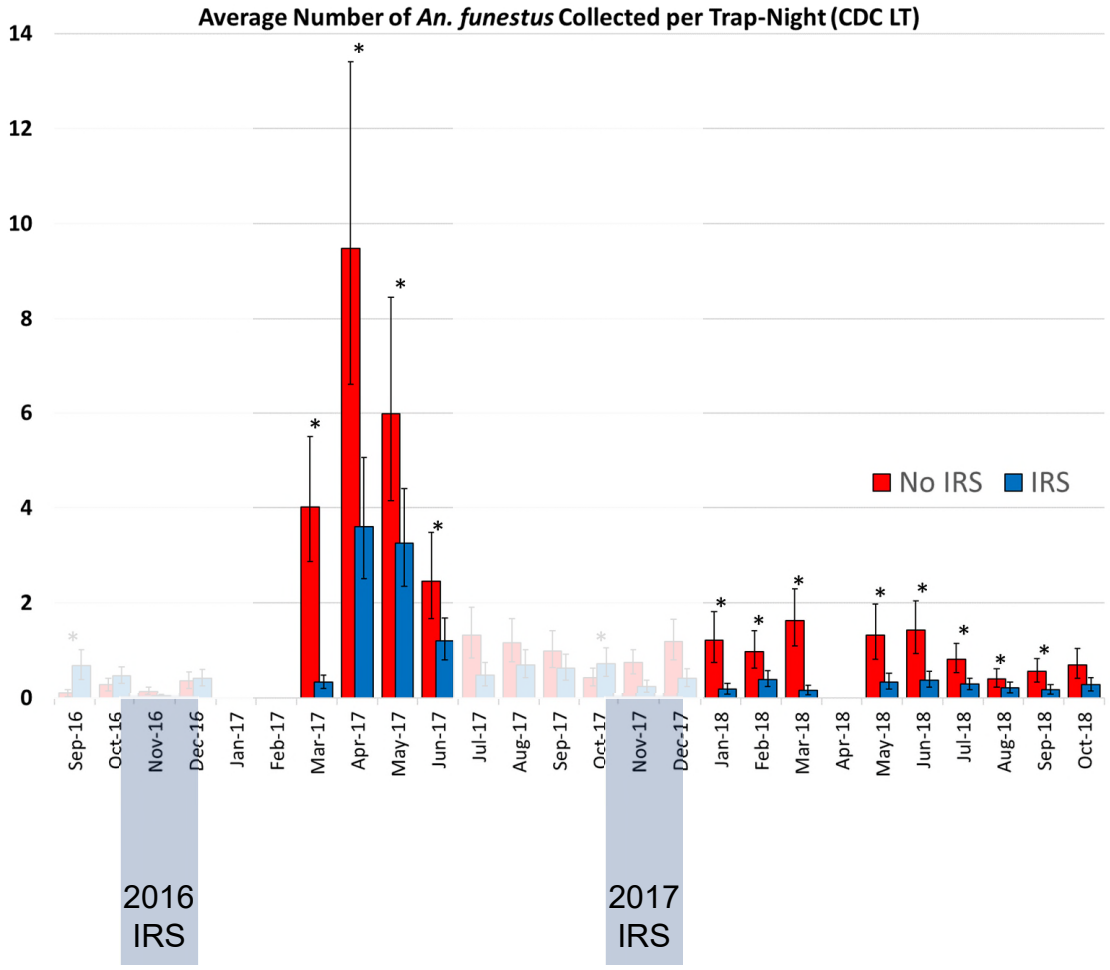
Monthly differences in the mean number of *An. funestus* collected in CDCLTs **per trap night** between non-IRS and IRS sites.

Averages are the geometric mean number of mosquitoes collected per trap-night.

* = significant difference

Reductions were greatest in the months shortly after the end of the spray campaigns, with reductions of close to 90%.

Impact of IRS – *An. funestus* Adult Densities



Monthly differences in the mean number of *An. funestus* collected in CDCLTs **per trap night** between non-IRS and IRS sites.

Averages are the geometric mean number of mosquitoes collected per trap-night.

* = significant difference

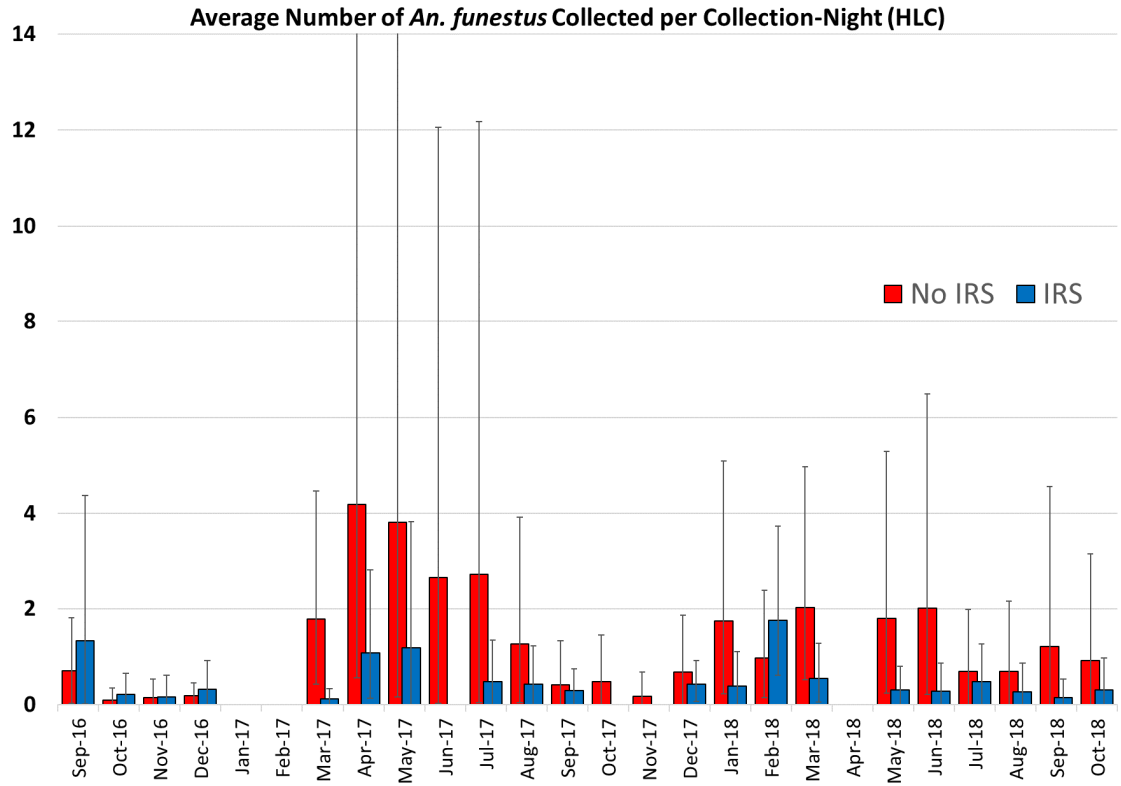
Reductions were greatest in the months shortly after the end of the spray campaigns, with reductions of close to 90%.

The significant impact of IRS lasted for at least:

6 months in year 1

9 months in year 2

An. funestus – IRS Impact on HLC Nightly Densities

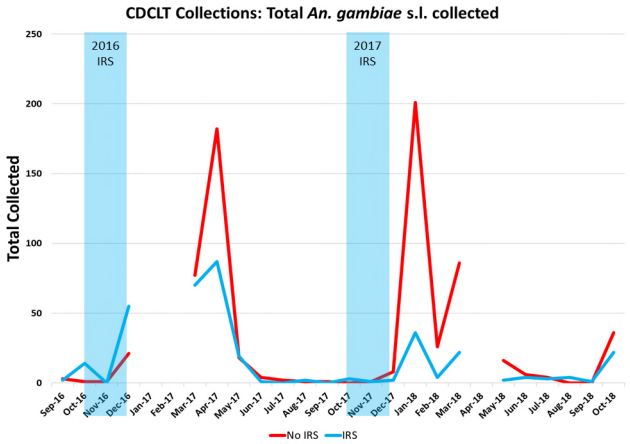


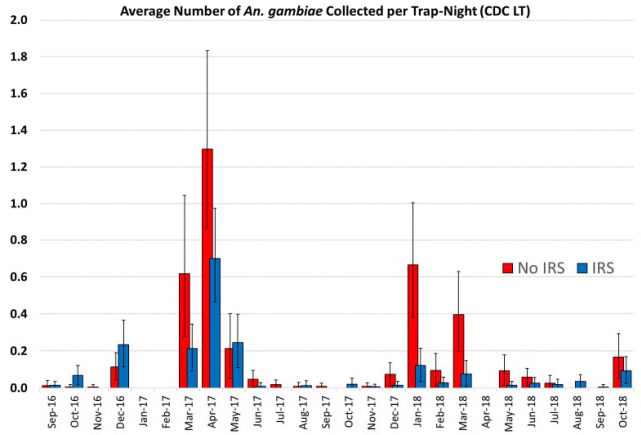
Monthly differences in the mean number of *An. funestus* collected per night by HLC, between non-IRS and IRS sites.

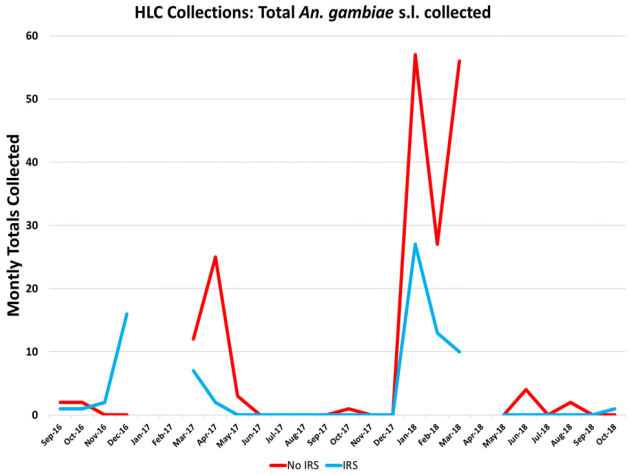
Means presented are the geometric mean number of mosquitoes collected per collection-night.

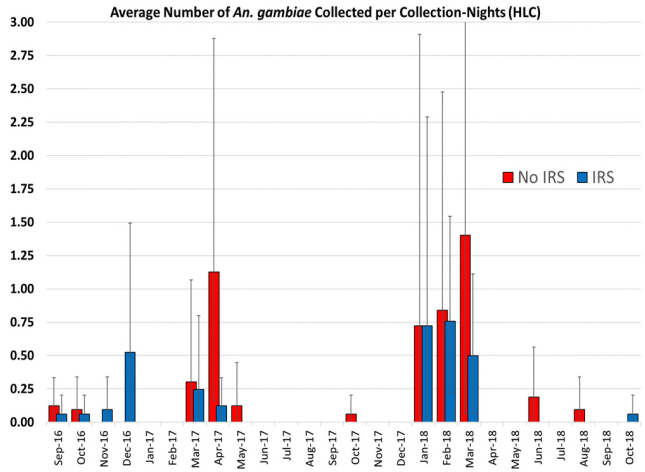
Overall reductions were larger than those observed with the CDC LTs, but also more variable – too few mosquitoes collected for a robust interpretation.

Impact on *An. gambiae*









All the trends observed in the *An. funestus* population were similar in *An. gambiae*, even though:

- Substantially fewer *An. gambiae* were collected throughout the entire study
- Numbers are too few for any robust statistical analysis
- Some evidence that *An. gambiae* was a secondary vector during the trial (1.5% of all Pf positive mosquitoes)

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Summary and Future Work

The IRS campaigns in Mopeia had a substantial impact on reducing exposure to *An. funestus*

63% - 80% fewer *An. funestus* in indoor CDCLT collections from IRS clusters vs. non-IRS clusters

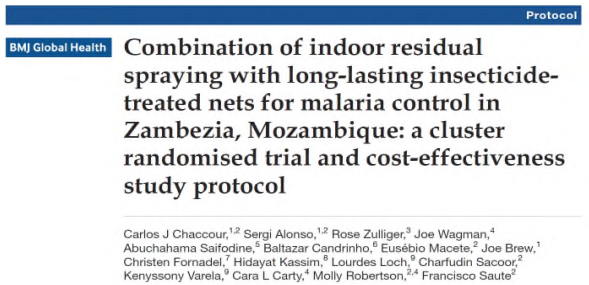
More than 80% fewer *An. funestus* collected during HLCs in IRS clusters vs. non-IRS clusters
(*Impact was similar in both indoors and outdoors*)

Significant reductions maintained for several months
At least
6 months in 2017
At least
9 months in 2018

Though not implicated as primary malaria vector during the trial, the same trends were observed in the *An. gambiae* s.l. population

Summary & Future Work

- Molecular screening of mosquito samples is still ongoing
  - Hoping for a more accurate determination EIR and trends in transmission exposure
- Aligning these entomological results with the epidemiological results
  - Convincing evidence of significant additional protection against malaria when using 3GIRS in addition to standard (pyrethroid-only) LLINs in Mopeia



Questions and Discussion

Thank you, Obrigado, Merci!

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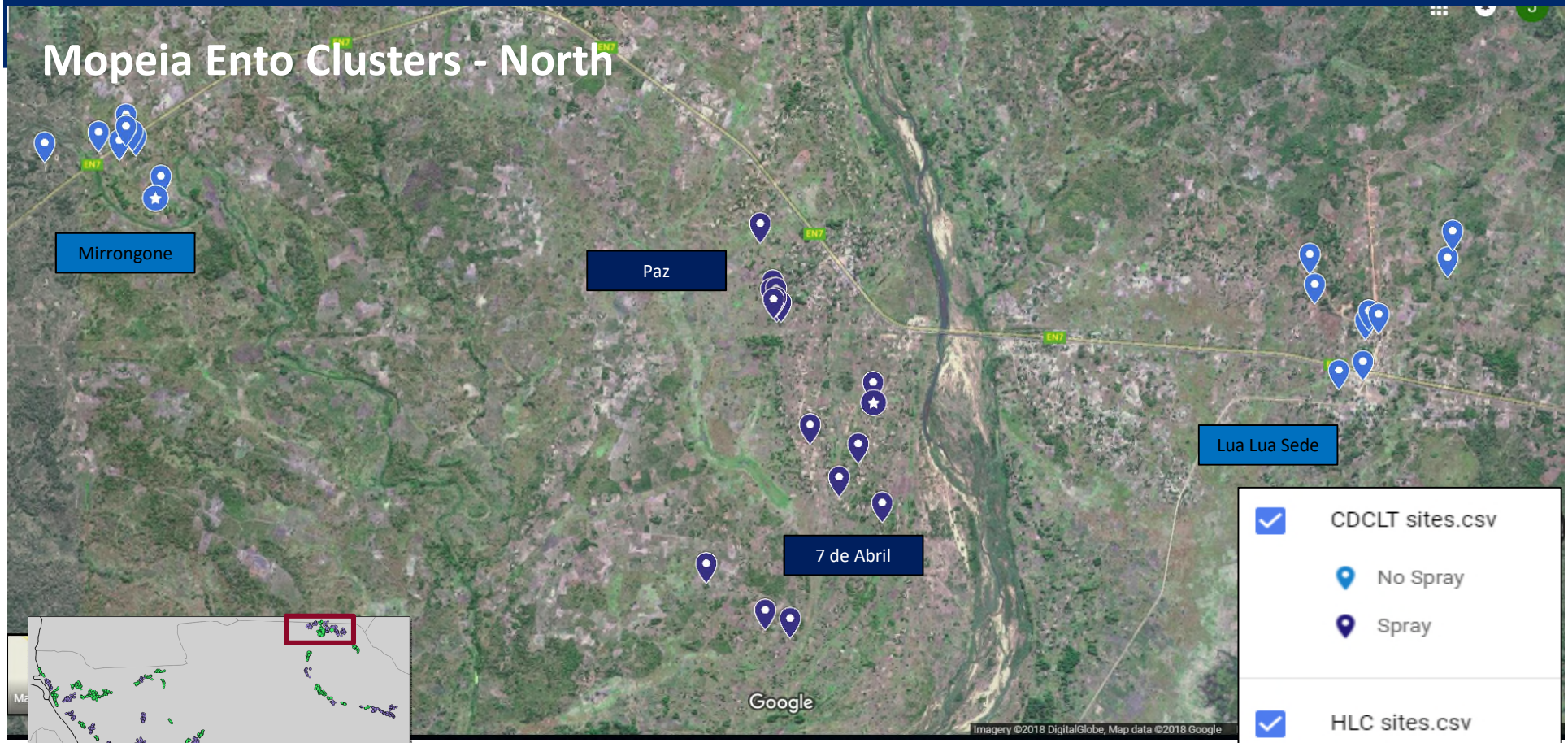
Backup Slides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HLC sites.csv
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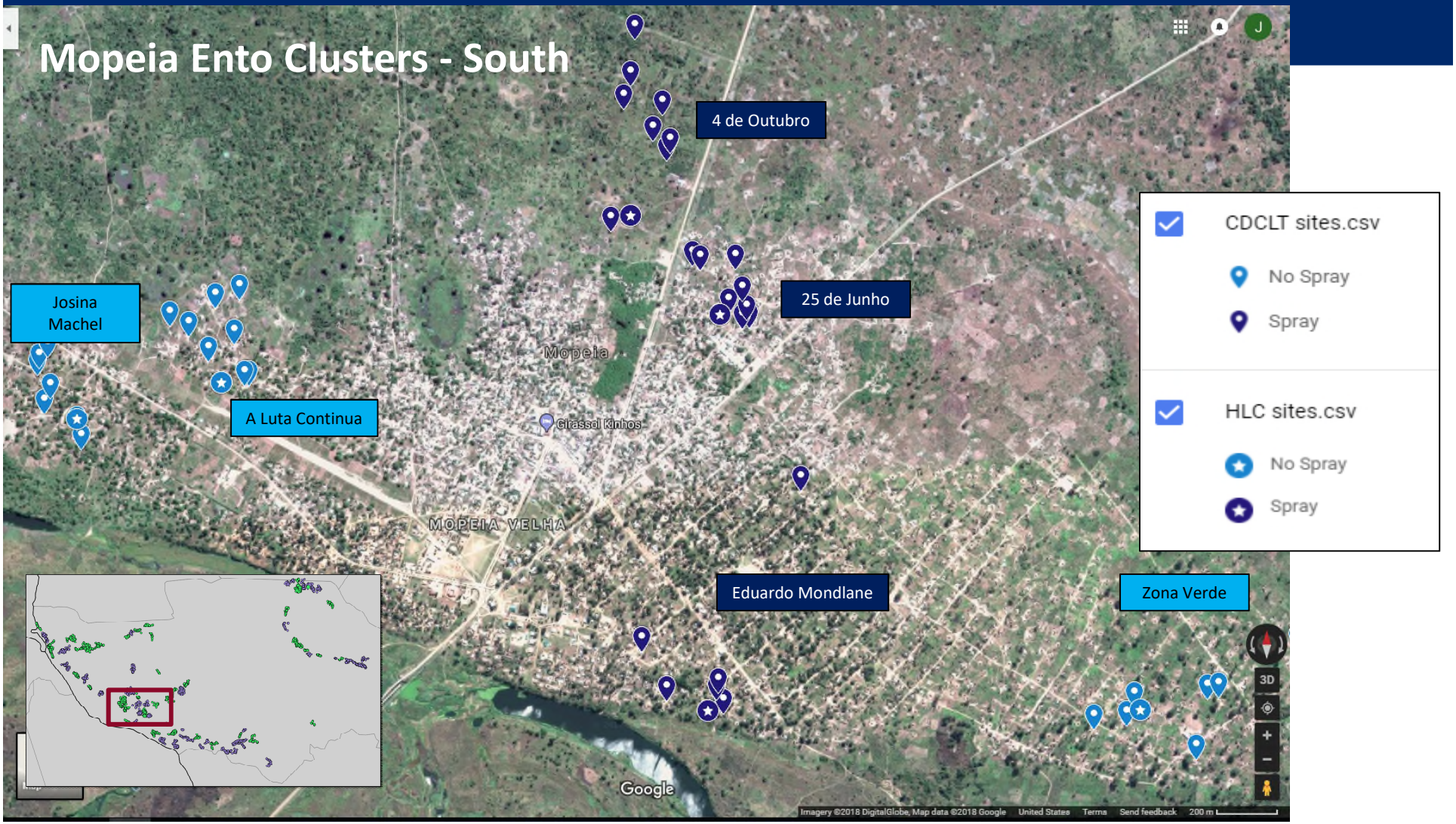
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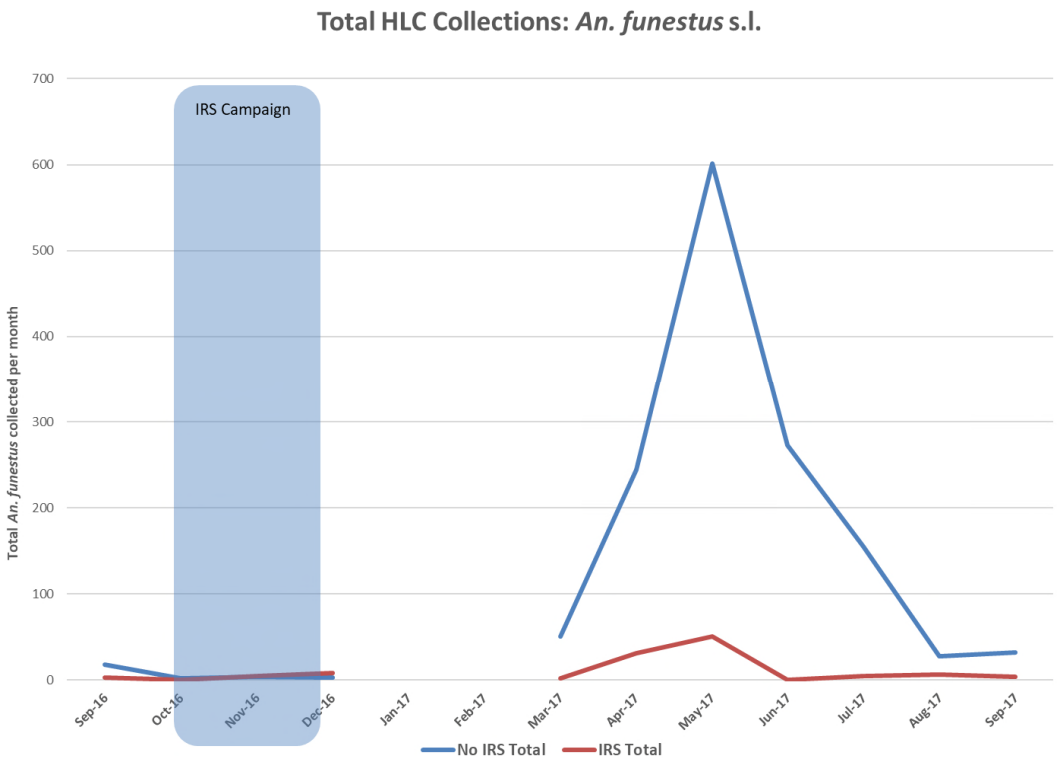
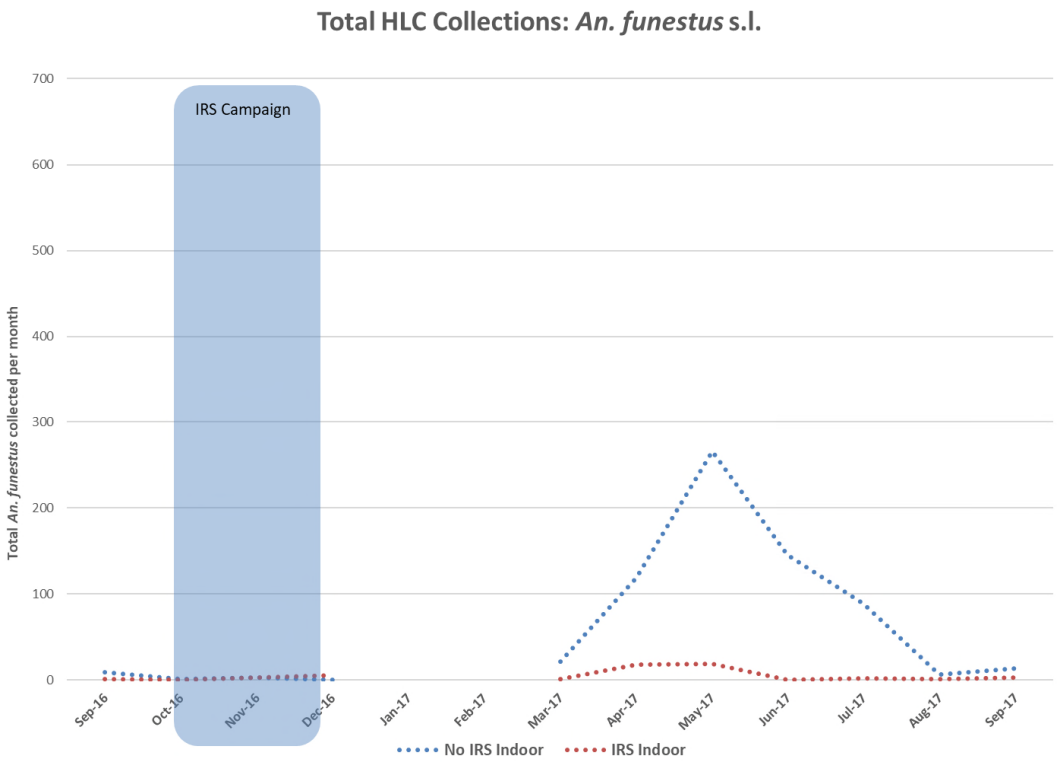
Vector bionomics – Indoor & Outdoor feeding



Monthly trends in total *An. funestus* collected via HLC by spray status.

Looking at all mosquitoes (collected indoors and outdoors) – **92% fewer were collected from IRS houses**

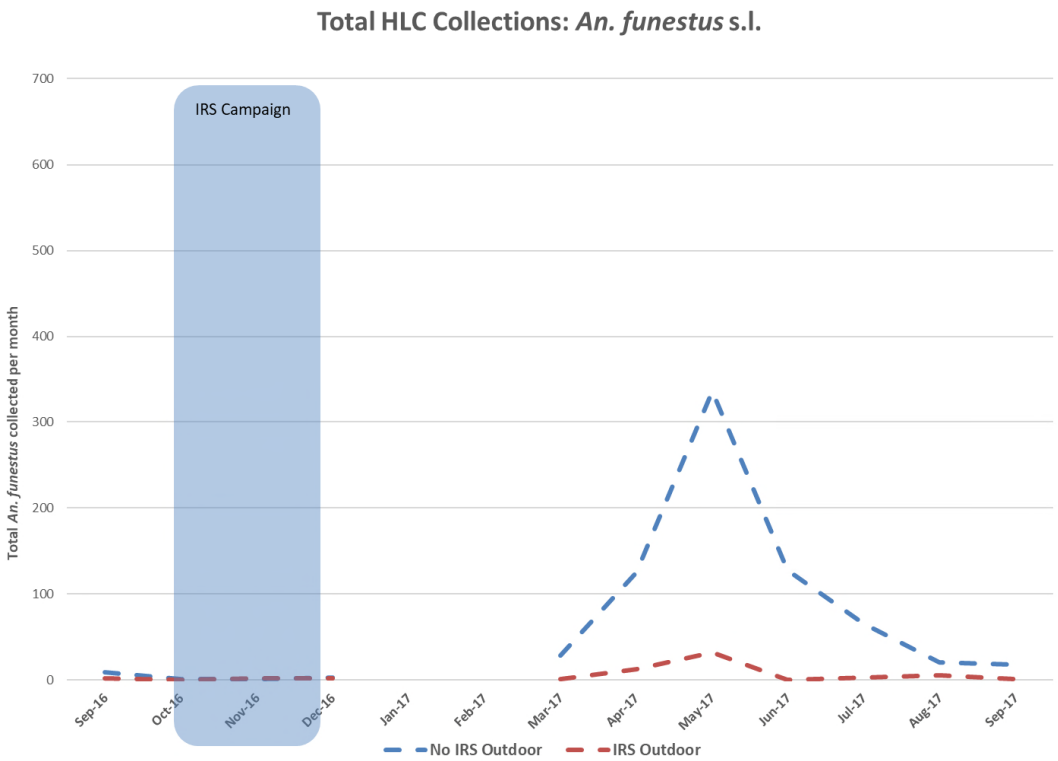
Vector bionomics – Indoor & Outdoor feeding



Monthly trends in total *An. funestus* collected via HLC by spray status.

The trend was the same for mosquitoes collected indoors…

Vector bionomics – Indoor & Outdoor feeding



Monthly trends in total *An. funestus* collected via HLC by spray status.

The trend was the same for mosquitoes collected indoors**…and outdoors**