



U.S. President's Malaria Initiative

Estimates of Entomological Indicators in Zambia During Three Years of Indoor Residual Spraying with Pirimiphos-Methyl

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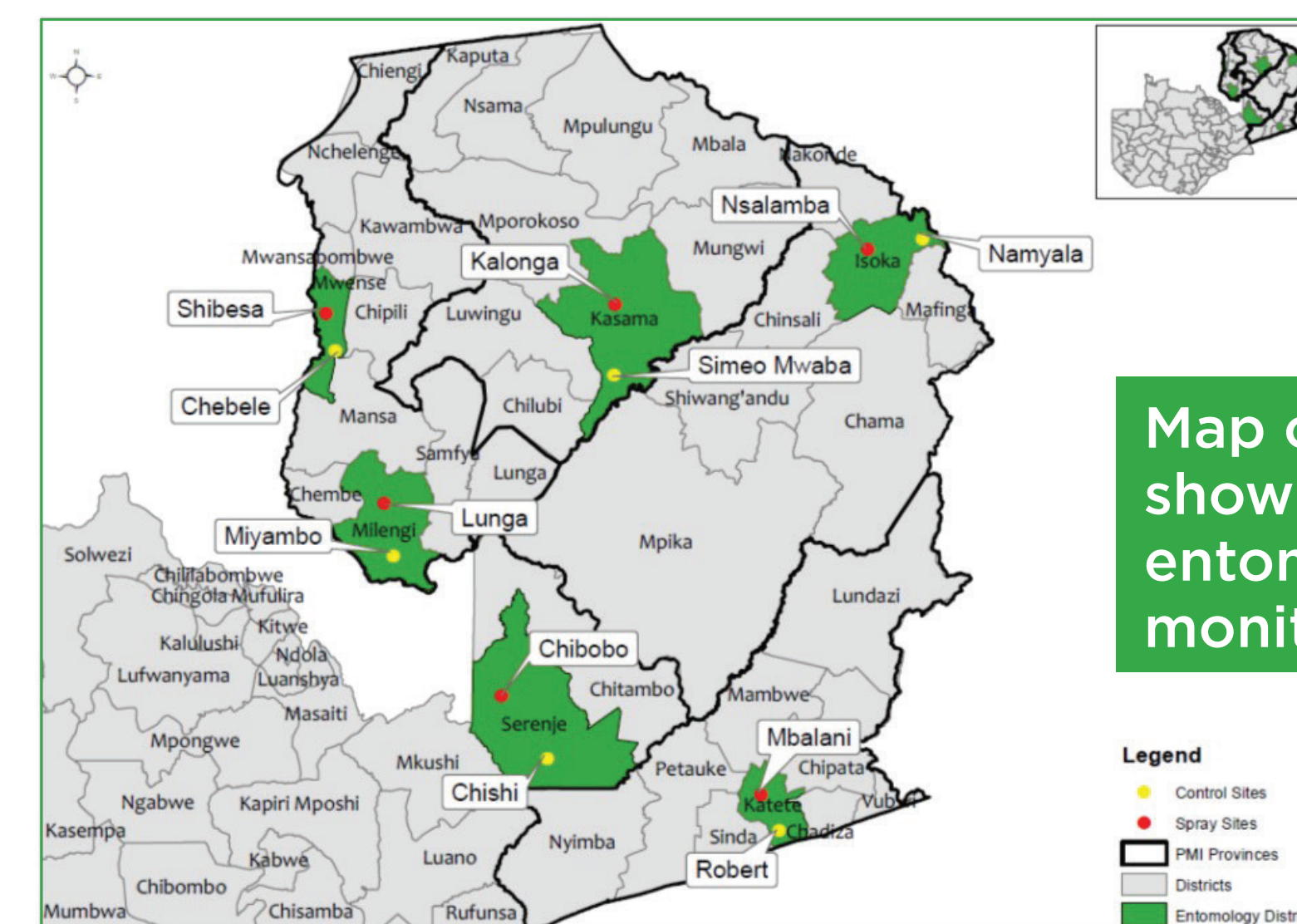
Background

- The U.S. President's Malaria Initiative (PMI) has been supporting the Zambia Ministry of Health (MOH) to fund indoor residual spraying (IRS) for malaria control since 2008.
- IRS is an important vector control strategy for the National Malaria Elimination Program in Zambia.
- Due to pyrethroid resistance, Zambia used an organophosphate—pirimiphos-methyl (Actellic® 300CS)—for IRS from 2012 to 2018.
- The PMI Africa Indoor Residual Spraying (AIRS) project conducted IRS annually in 2015, 2016 and 2017 with pirimiphos-methyl in Luapula, Northern, Muchinga, and Eastern provinces.
- AIRS conducted entomological monitoring each year at 12 sentinel sites to assess the impact of IRS on vectors, evaluate the residual efficacy of the insecticide, and determine the status of insecticide resistance.

Methods

Following each IRS campaign, the team:

- Conducted monthly vector surveillance in two monitoring sites (one sprayed and one unsprayed) in each of the six sentinel districts (Isoka, Kasama, Katete, Milenge, Mwenze and Serenje) using pyrethrum spray catches (PSCs) in 15 houses, U.S. Centers for Disease Control and Prevention (CDC) light traps in four houses indoors for four consecutive nights, and human landing catches (HLCs) in four houses indoors and outdoors for four consecutive nights.
- Evaluated residual efficacy of pirimiphos-methyl on a monthly basis using cone bioassays at five sprayed monitoring sites (three mud wall and three cement wall houses per site, using 30 susceptible *Anopheles gambiae* s.s. mosquitoes per house).
- Tested insecticide susceptibility in the six sentinel districts using World Health Organization (WHO) tube assays.



Results and Discussion

- Anopheles funestus* s.l. was the predominant malaria vector identified during the three years of surveillance. Using combined data from the three collection methods, the average number of mosquitoes per collection effort in the sprayed sites was 4.35, 8.87, and 6.44 for *An. funestus* s.l. and 0.36, 0.42 and 0.44 for *An. gambiae* s.l. in 2015, 2016, and 2017, respectively.
- In the sprayed sites, the indoor density of *An. funestus* s.l. one month after IRS (compared to one month before IRS) fell by 17% in 2015, 28% in 2016, and 56% in 2017, while concomitant increases of 73%, 60%, and 47% were observed at matched unsprayed sentinel sites.
- Vector densities and human biting rates returned to pre-spray levels five to six months after IRS, indicating a waning effect of the insecticide sprayed.
- The overall residual efficacy of pirimiphos-methyl was four to five months.
- Local vectors were susceptible to pirimiphos-methyl during all three years of surveillance. Resistance to deltamethrin and bendiocarb was also observed.



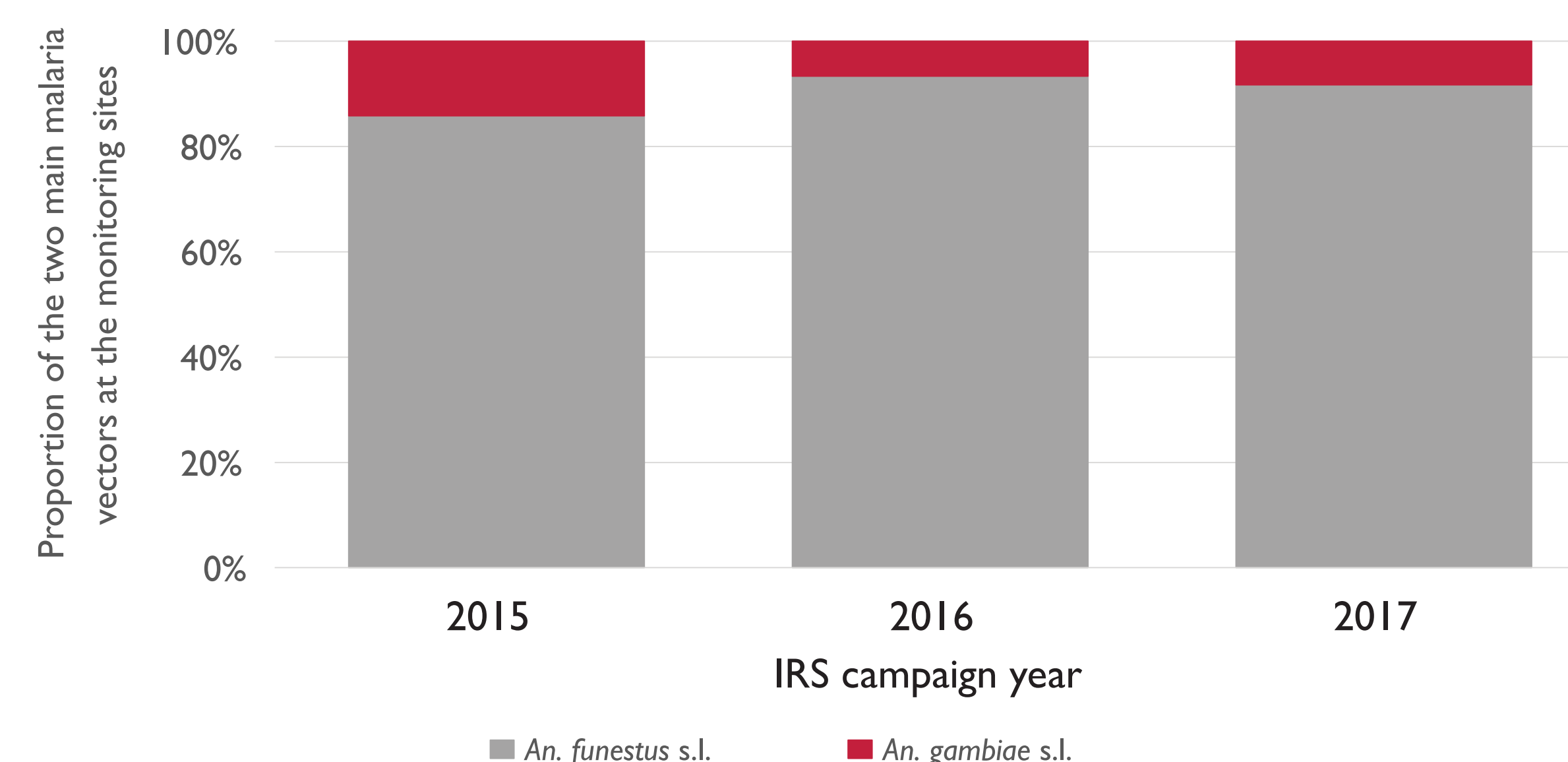
Community volunteer performing outdoor HLC

No. of months of residual efficacy* of pirimiphos-methyl on cement and mud walls following IRS in 2015-2017

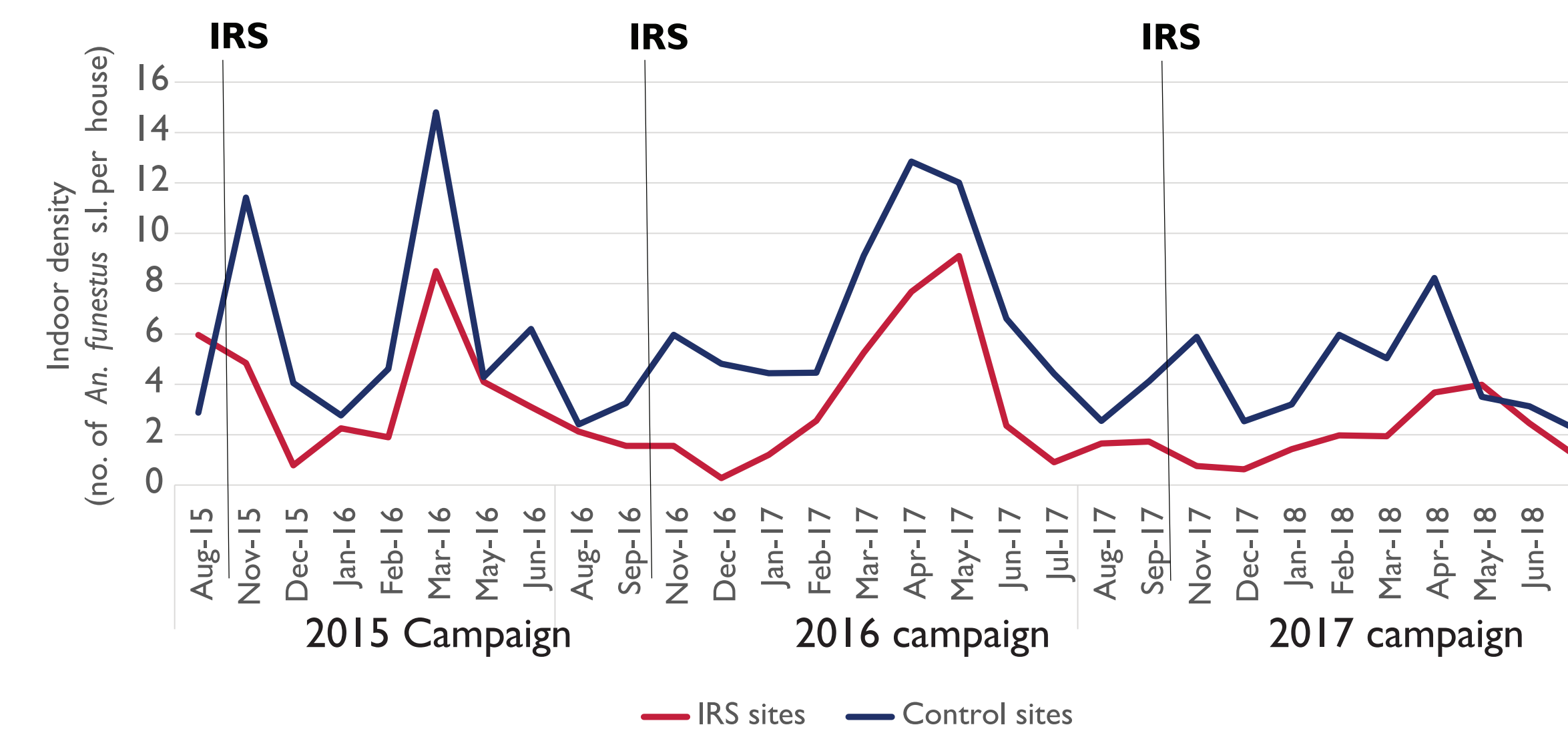
District	Cement walls			Mud walls		
	2015	2016	2017	2015	2016	2017
Kasama	5	6	4	4	4	4
Katete	5	4	6	4	4	5
Isoka	5	6	5	5	5	5
Milenge	2	5	6	3	5	4
Mwenze	5	4	6	5	4	4
Mean	4.4	5	5.4	4.2	4.4	4.4
Minimum	2	4	4	3	4	4
Maximum	5	6	6	5	5	5
Overall Mean Residual Efficacy	4.9			4.3		

*At least 80% mortality of exposed mosquitoes.

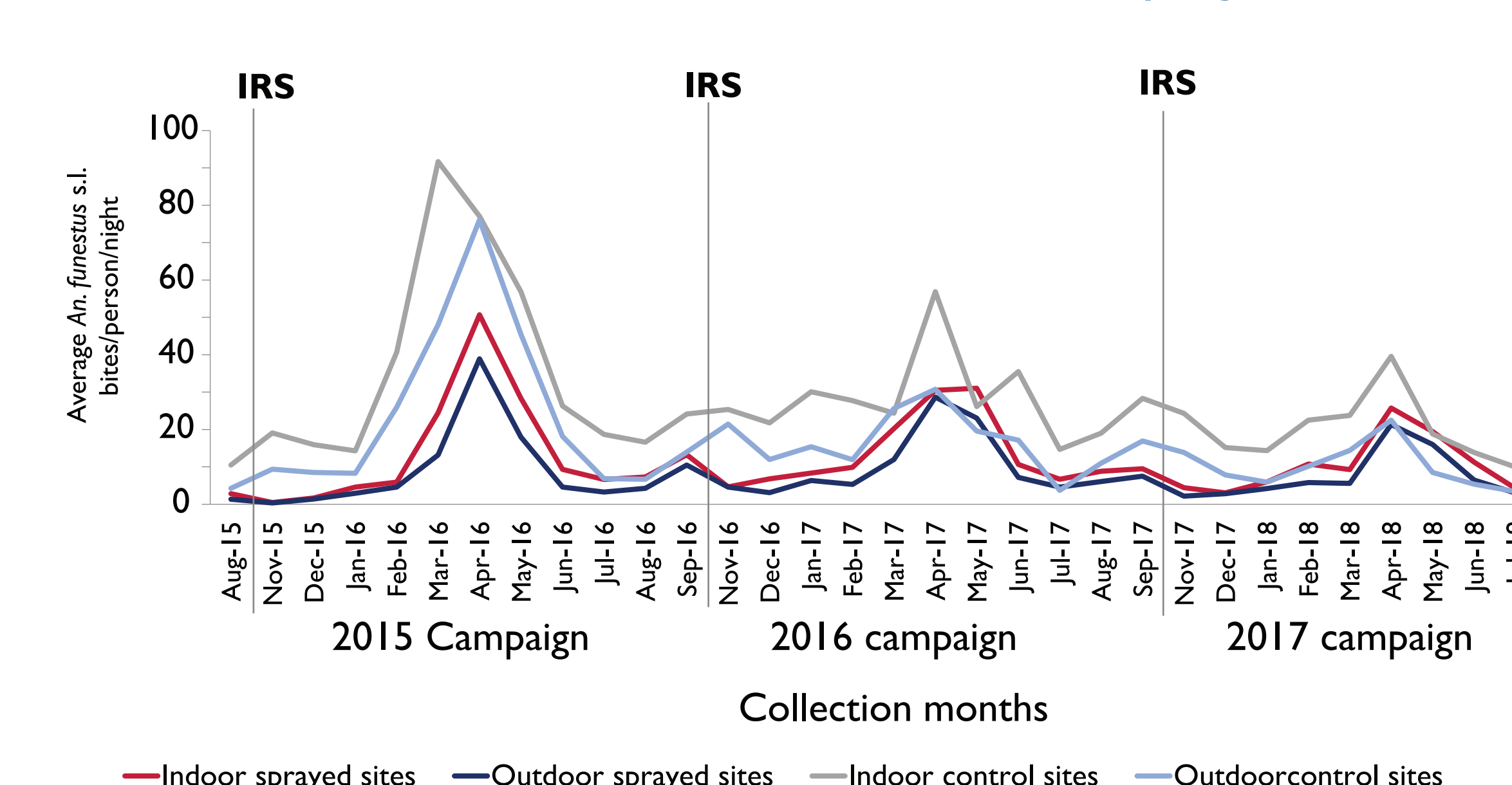
Proportion of the two main malaria vectors at the monitoring sites in each of the campaign years 2015-2017



Monthly indoor resting density (by PSC) of *An. funestus* s.l. over the 2015, 2016, and 2017 IRS campaigns



Human biting rate of *An. funestus* s.l. over the 2015, 2016, and 2017 IRS campaigns



Conclusions

- IRS with pirimiphos-methyl was effective at reducing mosquito populations in this area of Zambia.
- The duration of the effectiveness of pirimiphos-methyl was 4-5 months in a region with 7-8 months of peak malaria transmission.
- Longer-lasting insecticides will be used for IRS in Zambia in the 2019 campaign. Other recommendations, such as spraying twice per year, or using next generation insecticide-treated nets (ITNs), may also need to be considered at these sites.

Key References

- The President's Malaria Initiative (PMI)/Africa Indoor Residual Spraying Project. August 2016. Zambia Entomology Report, 2015. Bethesda, MD. PMI Africa IRS (AIRS) Project Indoor Residual Spraying (IRS 2) Task Order Six, Abt Associates.
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