

The Biting Patterns of *Anopheles* Mosquitoes from Three High Malaria Burden Districts in Malawi

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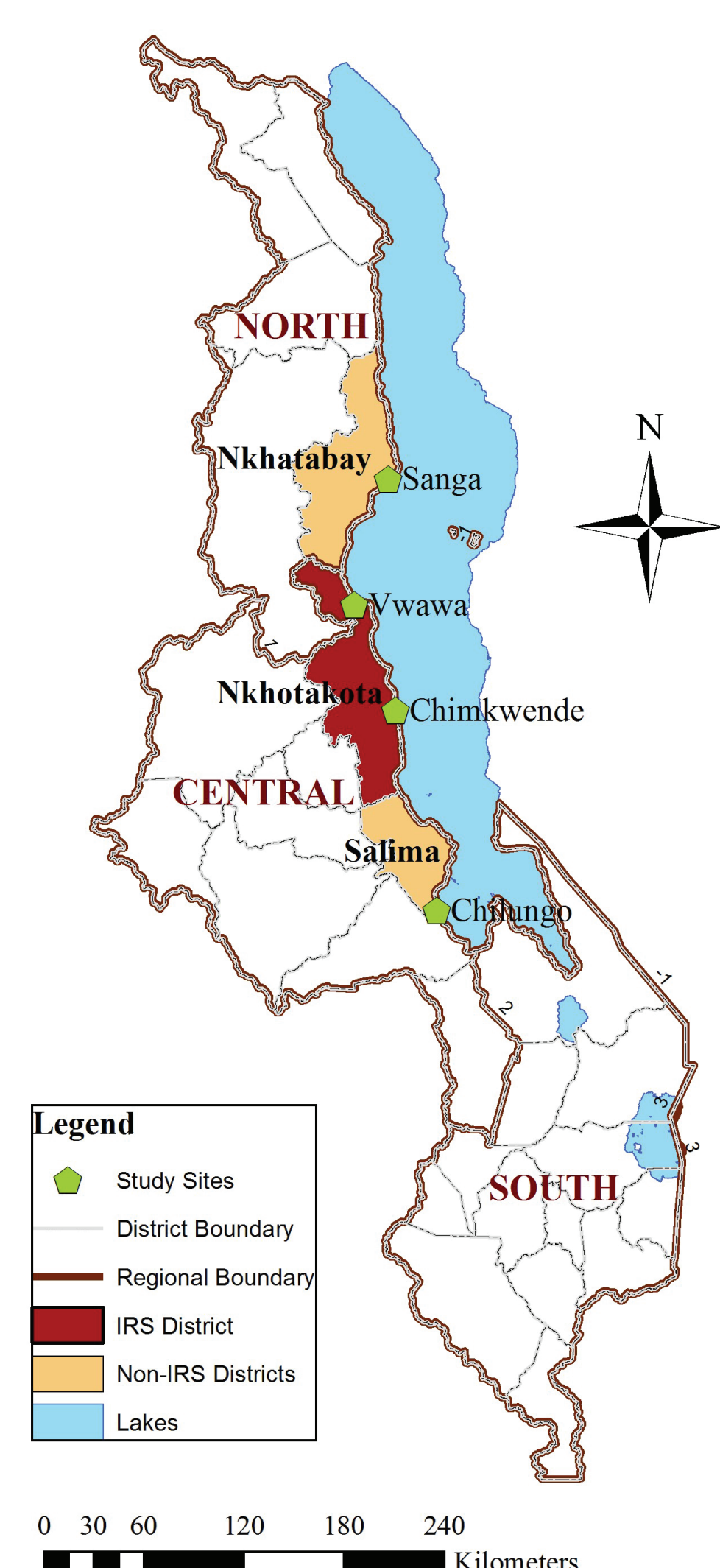
Background

- Malaria is one of the most important causes of morbidity and mortality in Malawi.
- Understanding the biting behavior of malaria vectors is essential in the selection, monitoring and evaluation of vector control interventions.
- This study assessed the biting patterns of malaria vectors in three high malaria burden districts of Malawi as a baseline for monitoring the impact of indoor residual spraying and long-lasting insecticidal nets.

Methods

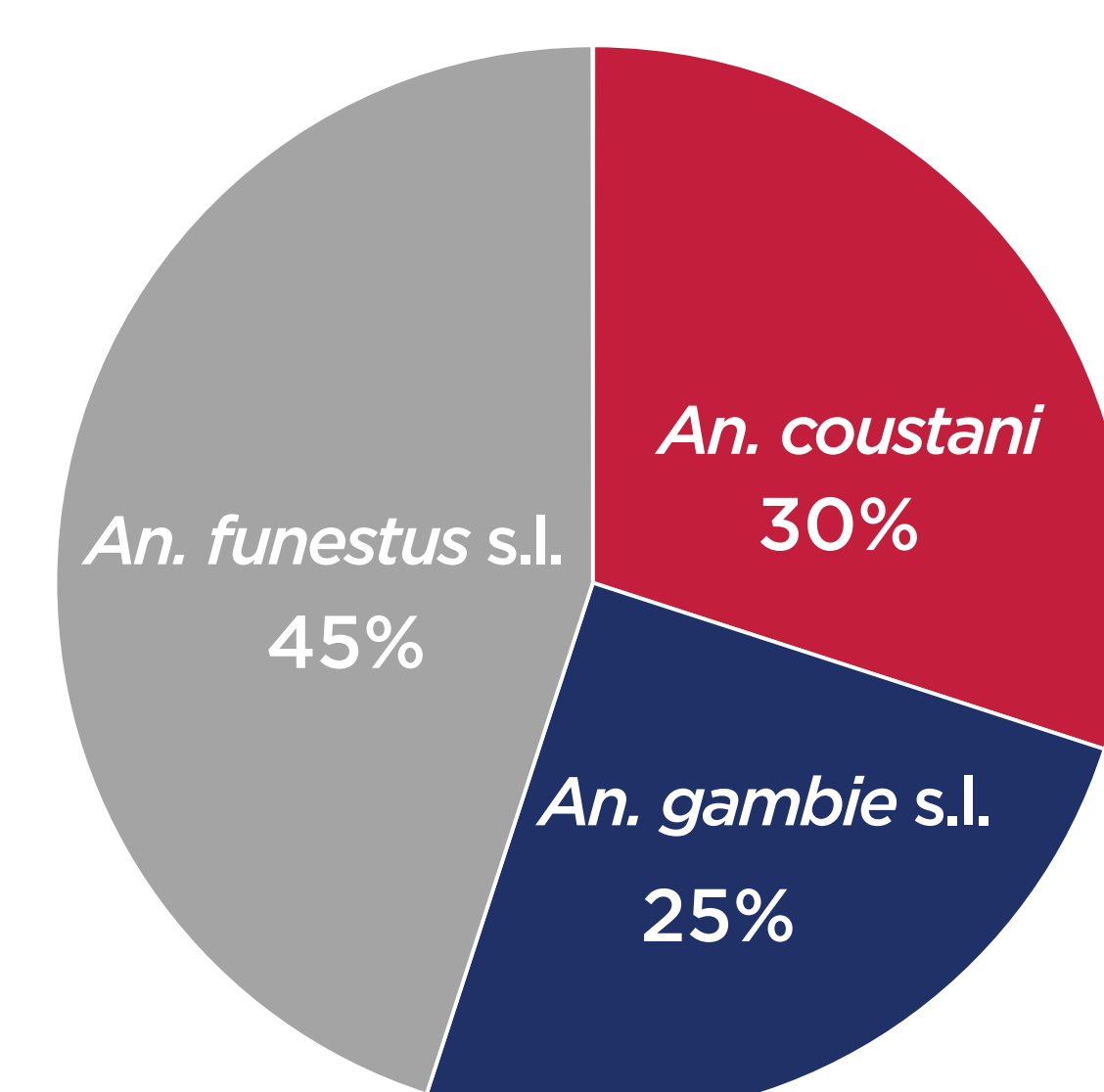
- *Anopheles* human-biting patterns were monitored for four nights in two houses using human landing catches (HLCs) both indoors and outdoors every three months, from July 2018 to June 2019, from 4 sites in Salima, Nkhatakota and Nkhata Bay Districts (Figure 1). The same houses were visited during the 4 collection periods performed quarterly.
- Adult mosquitoes were morphologically identified to the species level and species specific by PCR.
- *Plasmodium falciparum* (PF) sporozoite rates were determined by ELISA.

Figure 1:
Human landing sentinel sites in the three districts



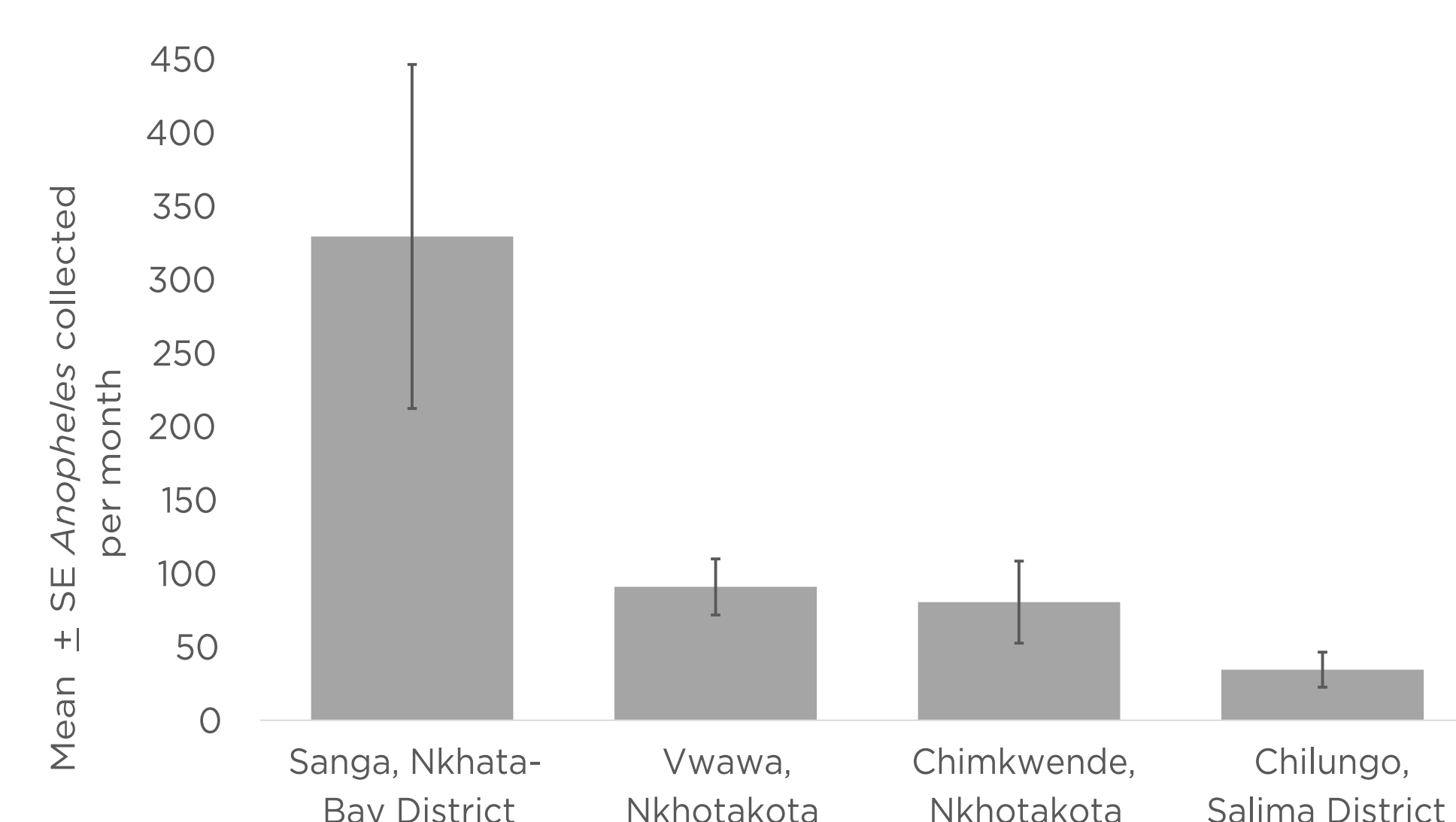
- *An. funestus* s.l. was the most abundant species collected using HLC from all the three districts.

Figure 2:
Aggregated *Anopheles* species composition from HLC collections in 4 sentinel sites



- The highest number of *Anopheles* mosquitoes were collected from Sanga sentinel site, Nkhata-Bay.

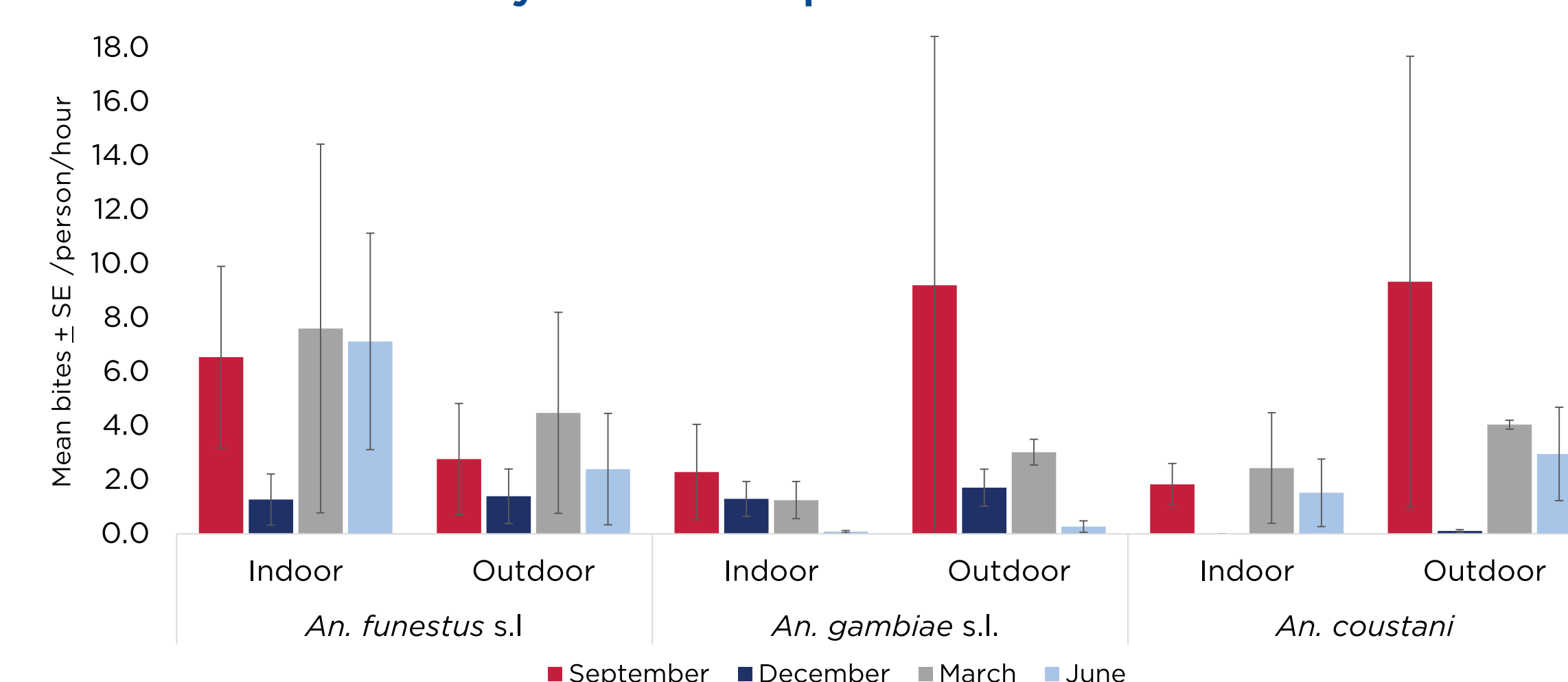
Figure 3:
Mean number of *Anopheles* mosquitoes collected per month at each sentinel site



Results

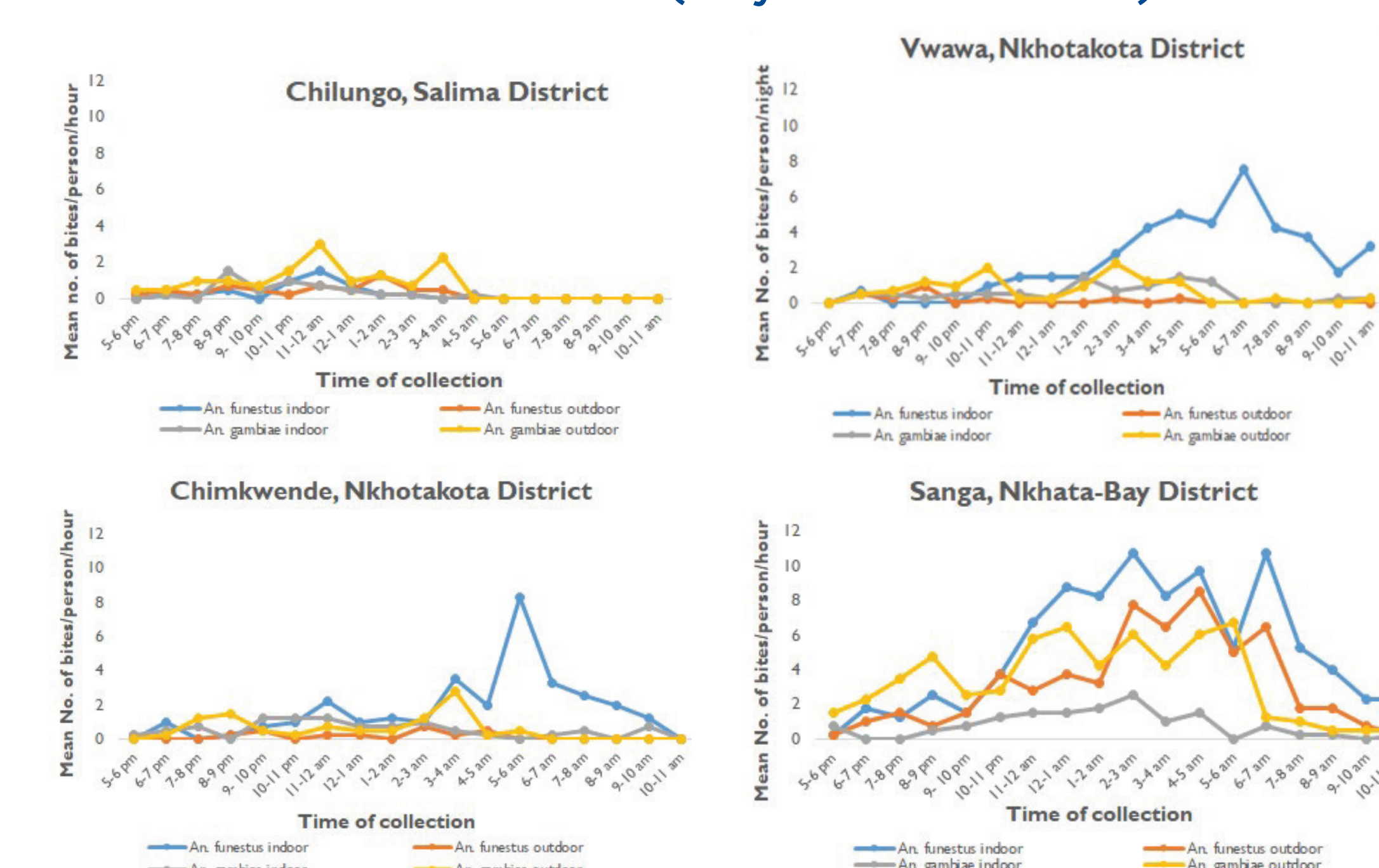
- There were seasonal variations in *Anopheles* human biting rates (HBRs) recorded both indoors and outdoors.
- More mosquitoes were collected during the Sep 2018 quarterly collection than the three other quarters.

Figure 4:
Mean *Anopheles* HBRs in the three districts by collection place and month



- In general, more biting occurred during the latter part or morning hours of the night for both *An. gambiae* s.l. and *An. funestus* s.l.
- About 24% *An. funestus* s.l. biting occurred indoors in Nkhatakota and Nkhata-Bay Districts between 6:00-11:00am.
- There was no distinct peak biting time for *An. coustani*.

Figure 5:
The biting pattern of *An. gambiae* s.l. and *An. funestus* s.l. in the three districts (July 2018-June 2019)



- The highest annual entomological inoculation rate (EIR) of *An. gambiae* s.l. was estimated at 23.02 infective bites/person/night (ib/p/n) in Salima District.
- The highest *An. funestus* s.l. annual EIR was estimated at 83.7 ib/p/n in Nkhata-Bay District (Table 1).

Table 1. Entomological parameters of malaria transmission, *An. funestus* s.l. and *An. gambiae* s.l. in all the three districts, July 2018 - June 2019

District	Quarters	<i>An. gambiae</i> s.l.			<i>An. funestus</i> s.l.			Total
		Nightly EIR	Quarterly EIRs	Estimated Annual EIR=Σ Quarterly EIRs	Nightly EIR	Quarterly EIRs	Estimated Annual EIR=Σ Quarterly EIRs	
Nkhata-Bay	Sep-Nov	0	0		0.21	19.1		
	Dec-Feb	0	0		0.212	19.1		
	Mar-May	0	0	0	0.066	6.1	83.7	83.7
	Jun-Aug	0	0		0.43	39.5		
Nkhatakota	Sep-Nov	0	0		0.425	38.7		
	Dec-Feb	0	0		0.003	0.3		
	Mar-May	0.043	3.9	3.932	0.007	0.6	47.9	51.83
	Jun-Aug	0	0		0.091	8.3		
Salima	Sep-Nov	0	0		0	0		
	Dec-Feb	0.152	14		0	0		
	Mar-May	0.101	9.2	23.02	0.157	14.5	14.5	37.5
	Jun-Aug	0	0		0	0		

Conclusions

- *An. gambiae* s.l. morphologically identified were confirmed by PCR as *An. arabiensis* and *An. gambiae* s.s. All *An. funestus* s.l. were identified as *An. funestus* s.s.
- *An. funestus* s.s. is the primary vector of malaria based on the high sporozoite rates and Entomological Inoculation Rates recorded in all the three districts.
- *An. funestus* s.s. fed primarily indoors at night although a substantial proportion of indoor biting occurred between 6:00 and 11:00 am.
- Community education would be important to create awareness of the risk of indoor bites in the late morning hours.

