Annual Report 2019

Anti Malaria Campaign
Ministry of Health - Sri Lanka

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Table of Contents

List of Tables

List of Figures

Foreword

The AMC is the focal point for prevention of re-introduction & reestablishment of malaria and ensuring that Sri Lanka malaria is free. AMC has a public health service network through regional malaria offices for the care facilities and partnerships with the curative health sector for the treatment services. This is the 3rd year after Sri Lanka obtained WHO certification as a malaria free country on 5th September 2016. It is a remarkable achievement in Sri Lanka's public health history.

Presently, the two major strategies of the Antimalaria Campaign include continuing case monitoring & surveillance for malaria cases and reactive and proactive parasitological, entomological & vector surveillance. The parasitological and entomological teams conduct regular entomological and parasitological surveys according to guidelines.

This report will facilitate the review, revision and monitoring of the policies and strategic plans to sustain the malaria free status of the country.

Dr Prasad Ranaweera
Director
Anti-Malaria Campaign

Acknowledgements

The Anti-Malaria Campaign (AMC) would like to thank all the stakeholders, especially the international stakeholders as there is a high level of international support for the Health Ministry of Sri Lanka. Their continued support over the century has strengthened the health system in the country with regards to malaria.

The continuous technical feedback received from the technical support community, is always appreciated. Similarly, the contributions by the Director, Consultant Community Physicians, Medical Officers, Parasitologist, Entomologists, staff from the Entomological and Parasitological units, management and finance office personnel and the Regional Malaria Officers and their staff, are all highly noted with gratitude. Furthermore; the Public Health Workers across the country who have done a lot to achieve malaria-free status are also highly appreciated. Information management personnel and the monitoring and evaluation team are valued and remembered for their diligence in handling data.

Finally, the AMC is extremely thankful for the continuous technical and financial assistance provided by the international partners; World Health Organization (WHO) and Global Fund for AIDS, Tuberculosis and Malaria (GFATM) in the year 2019.

1. Introduction

It has been three years since Sri Lanka entered the prevention of reintroduction (PoR) phase of malaria, since the certified malaria elimination in 2016. The last indigenous case was reported in October 2012, following which the AMC was able to maintain zero indigenous cases. Since the elimination, all reported cases were imported cases from travellers returning from abroad, except for the first & only 'Introduced Case' reported in December 2018. AMC was able to maintain zero indigenous transmission for the last seven consecutive years, with the success story continuing throughout 2019.

Being a tropical country, the desirable environment for the breeding of vectors ensures constant receptivity in most parts of the country. The risk of re-introduction & re-establishment of malaria, due to the continuous presence of imported cases is currently the biggest threat to the sustainability of the malaria free status of the country. Over the past seven years, imported malaria cases have been reported from international travellers and Sri Lankan nationals returning from or through the malaria endemic countries. With enhanced surveillance, 53 imported malaria cases were reported in 2019 compared to 48 cases in 2018.

The Anti-Malaria Campaign's activities are conducted in line with the 2018–2022 National Malaria Strategic Plan (NSP) which include the new vision, mission, priorities and strategies.

Vision

A malaria-free Sri Lanka

Mission

Plan and implement a comprehensive programme to sustain intensive surveillance, comprehensive case management, outbreak preparedness, and rapid response for prevention of re-introduction and re-establishment of malaria in Sri Lanka.

Goal

To maintain malaria-free status

Objectives of the Anti-Malaria Campaign

1. To prevent re-introduction and re-establishment of malaria in Sri Lanka
2. To maintain zero mortality due to malaria in Sri Lanka

2. Epidemiology

Sri Lanka successfully sustained its malaria free status for the third consecutive year since the WHO certification of malaria elimination in 2016. Over the past four years Sri Lanka had received approximately 50 imported malaria cases in each year.

2.1 Malaria cases by species since 2012

Sri Lanka has been maintaining zero indigenous cases since 2013. Table 1 provides a categorization by the type of species among the imported cases.

Table 1: Categorization of malaria cases from 2012 – 2019

Year	Total cases	*P. vivax*		*P. falciparum*		*P. ovale*		*P. malariae*		*P. knowlesi*		*Mixed*	
	No	No	%	No	%	No.	%	No	%	No	%	No	%
2013	95	52	54.7%	42	44.2%	1	1.0%	0	0.0%	0	0.0%		
2014	49	28	57.1%	20	40.8%	0	0.0%	1	2.0%	0	0.0%		
2015	36	17	47.2%	17	47.2%	2	5.5%	0	0.0%	0	0.0%		
2016	41	16	39.0%	18	43.9%	5	12.3%	1	2.4%	1	2.4%		
2017	57	27	47.4%	26	45.6%	3	5.3%	1	1.8%	0	0.0%		
2018	48*	30	62.5%	15	31.3%	3	6.3%	0	0.0%	0	0.0%		
2019	53	24	45.3%	24	45.3%	3	5.7%	2	3.8%	0	0.0%		

Including the introduced case – P. vivax

In year 2019, both *P. vivax* and *P. falciparum* were reported at an equal percentage of 45.3% (n=24) out of all cases, and were therefore the predominant types of species. Among the *P. falciparum* cases, one severe case was reported.

2.2 Categorization of malaria cases by country/region of origin

In 2019, majority (54.7%) of the cases were imported from the countries in the African continent. Thirty-four percent (34%) of the imported cases were reported from the travellers and returnees from India (Figure 1).

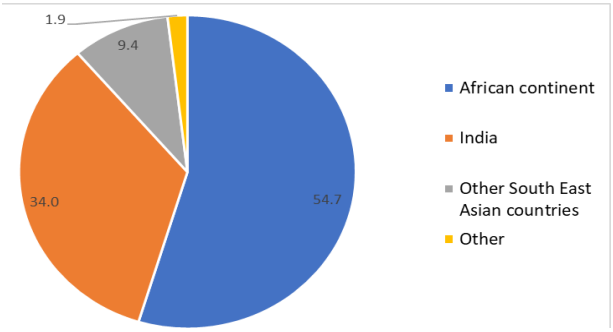


Figure 1:Proportion of imported malaria cases by country/ region of origin in

The type of species by the country of origin is given in detail in Table 2. All the cases reported from India (n=18) were *P. vivax*. From the countries in the African continent, approximately 74% (n=23) cases were *P. falciparum*.

Table 2:Type of species of imported malaria by country of origin in 2019

Country of origin	Species				Total
	Pf	***Pv***	***Po***	***Pm***	
Burundi	1	0	0	0	1
Central African Republic	5	0	0	0	5
Congo	1	0	0	0	1
Ethiopia	0	1	0	0	1
Ghana	1	0	0	1	2
India	0	18	0	0	18
Indonesia	0	1	0	0	1
Kenya	0	1	0	0	1
Liberia	1	0	0	0	1
Madagascar	1	0	0	0	1
Mali	0	0	0	1	1
Mozambique	2	0	1	0	3
Myanmar	0	1	0	0	1
Nigeria	1	0	0	0	1
Pakistan	1	1	0	0	2
Sierra Leone	3	0	0	0	3
Solomon Island	0	1	0	0	1
South Sudan	3	0	0	0	3
Togo	1	0	0	0	1
Uganda	3	0	2	0	5
Total	**24**	**24**	**3**	**2**	**53**

Pf - P.falciparum ***Pv – P.vivax*** ***Po – P.ovale*** ***Pm – P.malariae***

2.3 Malaria cases by the risk category and nationality in 2019

Majority of the cases (83%) were reported from Sri Lankans who have travelled to malaria endemic countries and returned. Thirty five percent (n=19) of these travellers have travelled for the purpose of occupation.

Table 3:Malaria cases by the risk category and nationality in 2019

Nationality	Occupation	Business	Gem Trade	Forces	Pilgrim	Tourist	Other	Total	
								No	Percentage (%)
Sri Lankan	12	6	5	4	8	0	9	44	83.0 %
Non-Sri Lankan	7	0	0	0	0	2	0	9	17%
Total	19	6	5	4	8	2	9	53	100%

2.4 Distribution of malaria cases by districts

Figure 2 provides the distribution of malaria cases by districts from 2017 to 2019. During these three years, most cases were reported from Colombo District, followed by Gampaha district.

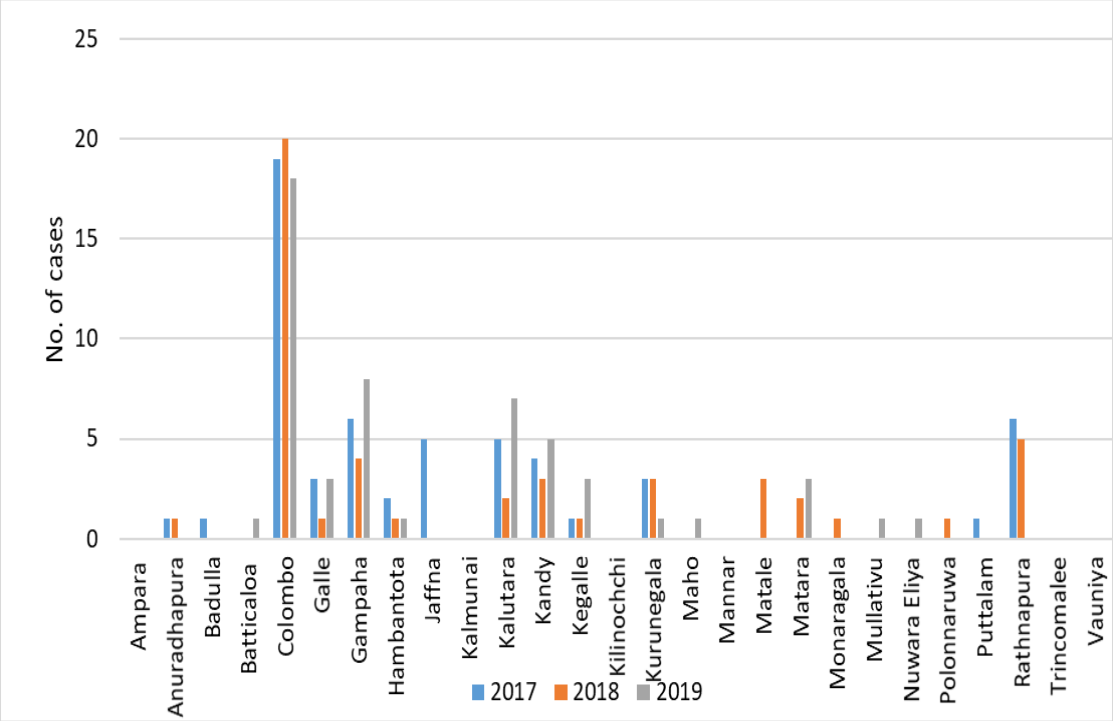


Figure 2:Distribution of Malaria cases by districts from 2017 to 2019

2.5 Malaria cases by sex and age group in 2019

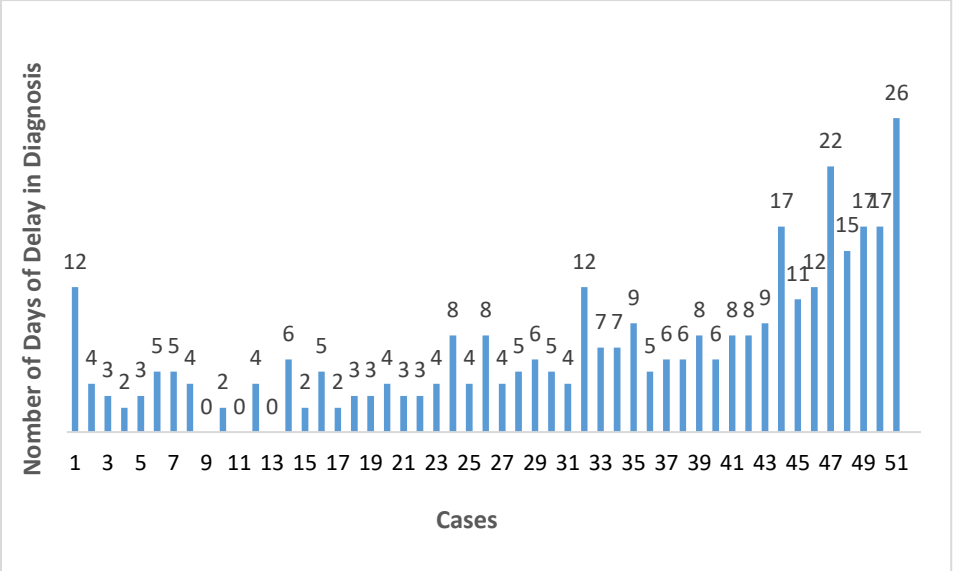
Most cases were reported in males (88.7%). All the cases were reported from people under 40 years, but the majority of the cases (52.8%) were reported among the age group; 21 – 30 years.

Table 4:Malaria cases by sex and age group in 2019

Age	Gender		Total N (%)
	Female N (%)	Male N (%)	
0-10	2 (3.8%)	1 (1.9%)	3 (5.7%)
11-20	1 (1.9%)	18 (33.9%)	19 (35.8%)
21-30	2 (3.8%)	26 (49.1%)	28 (52.8%)
31-40	1 (1.9%)	2 (3.8%)	3 (5.7%)
Total	6 (11.3%)	47 (88.7%)	53 (100.0%)

2.6 Delay in diagnosis of malaria

Thirty-seven cases (69.8%) out of the 53 cases were diagnosed within 7 days of onset of symptoms of malaria.



***One outlier with 104 days of delay was excluded from this graphical representation of data**.

2.7 Mortality from malaria

No deaths due to malaria cases were reported since 2008, up to the end of 2019

Figure 3:Days of delay in diagnosis of malaria from the onset of symptoms in 2019

2.8 Status of drug resistance and drug policy

Parasitaemia of diagnosed malaria patients were assessed daily to detect the efficacy of treatment. All *P. vivax* cases were treated with Chloroquine for 3 days followed by Primaquine for 14 days, doses calculated on individual basis, according to the body weight of each patient. All uncomplicated *P. falciparum* cases were treated with Artemisinin-based Combination Therapy (ACT) followed by a single stat dose of Primaquine. Only one single severe case was treated with IV Artesunate, followed by a single dose of Primaquine. No patients were detected with drug resistance in 2019.

2.9 Chemoprophylaxis

Chemoprophylaxis is provided by AMC Headquarters, Regional Malaria Officers and certain identified MOH regions. Prophylactic drugs used were Chloroquine, Mefloquine & Doxycycline, and was prescribed according to the type of the most prevalent plasmodium species & the existing resistance of the species to Chloroquine at the destination of the traveller.

3. Parasitological Surveillance

The parasitological surveillance in the country is implemented mainly through screening of individuals attending to medical institutions and field level screening done in vulnerable localities. Screenings for malaria are categorized broadly into two categories, which are; Passive Case Detection (PCD) and the Active Case Detection (ACD). PCD is the detection triggered by patients seeking care for their illness from clinicians at health institutes. Active Case Detection (ACD) is carried out in the form of screening high risk groups as Proactive Case Detection or as Reactive Case Detection, in response to detecting a malaria case. Additionally, there are Village / Field level screening or Mobile Malaria Clinics, which are also carried out as surveillance methods. In the past during the endemic phases, there was also an Activated Passive Case Detection (APCD) by screening all fever cases for malaria at the medical institutes. Microscopy is the main diagnostic method while Rapid Diagnostic tests (RDTs) are also being used as a supplementary tool.

3.1 Screening of suspected malaria patients

In 2019, a total of 1,164,914 blood smears were examined by the Public Health Laboratory Technicians attached to Anti Malaria Campaign. The proportions of blood smears screened under PCD, ACD and by screening blood donors and the number of positives by different methods are given in Figure 4.

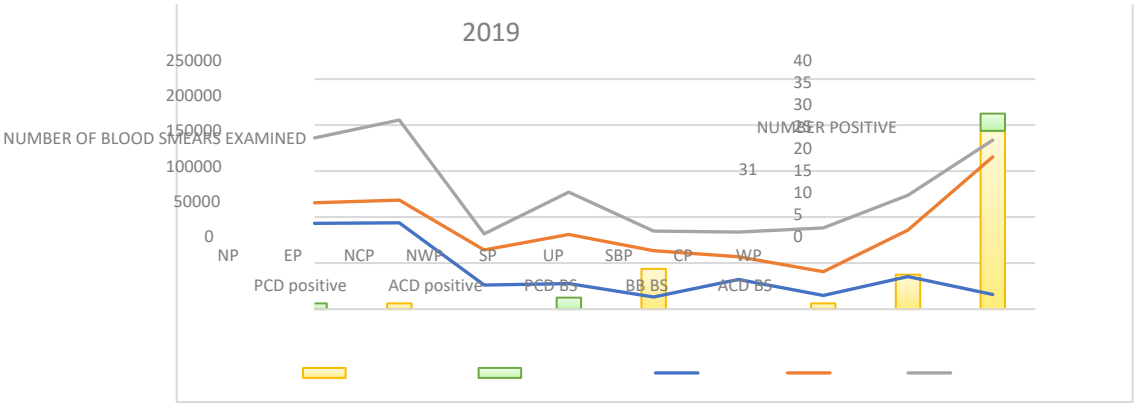


Figure 4:The proportions of blood smears screened under PCD, ACD and by screening blood donors and the number of positives by different methods

3.2 Provision of laboratory items

The Central laboratory at Anti Malaria Campaign Headquarters (AMC HQ) distributed a series of laboratory items required for malaria microscopy to regional malaria laboratories to ensure quality assured and quality-controlled malaria microscopy services throughout the country. As a cost cutting measure, Giemsa powder, Methanol and Ethanol are obtained from the MSD, and the Giemsa stock solution is prepared at the Central Parasitology Laboratory. The prepared stock solution is subject to quality check according to the Standard operating

procedures for malaria microscopy and then distributed. Details of items issued are given in table 5.

Table 5:Laboratory items issued during the year 2019

District/RMO region	Glass Slides	Lancets	Methanol (L)	Giemsa (L)	RDT Kits	Anisol (L)	Isopropyl alcohol/ Ethanol
Ampara	13300	10000	1	3	800	2.5	5
Anuradhapura	25800	10000	2.5	3	500	2.5	2.5
Badulla	3600	0	1	1	0	2.5	5
Batticaloa	17200	50000	5.5	5.5	1250	2.5	12
Hambantota	12000	10000	2.5	2.5	1000	2.5	3.5
Jaffna	35800	50000	2.5	2	1200	-	-
Kalmune	16900	20000	0	3	700	-	-
Kandy	10800	50000	8.5	8	900	2.5	-
Kegalle	244000	20000	3	6	600	-2.5	-
Kilinochchi	5000	10000	2.5	-	125	-	
Kurunegala	3600	-	5	2	825	2.5	-
Maho	3600	10000	-	-	700	-	
Mannar	18300	30000	2.5	1.5	700	-	-
Matale	15800	10000	2.5	2.5	450	-	
Monaragala	10000	20000	-	2	1400		2
Mulativu	20800	20000	2	2	1000	-	1
Polonnaruwa	-	-	1	2	325	-	-
Puttalam	25800	30000	-	2	250	-	-
Ratnapura				-	200	-	-
Trincomalee	29400	30000	-		100	-	-
Vavuniya	15000	20000	2.5	2.5	300	-	-
Total	526700	400000	44.5	50.5	13325	15	31

3.3 Activities related to quality assurance of malaria microscopy

With the aim of improving quality of malaria microscopy services in the country, thirteen (13) two-day in-service training programs were conducted for Public Health Laboratory Technicians (PHLTs) and Medical Laboratory Technologists (MLTs). For private sector Laboratory Technicians, four (04) one-day training programmes were conducted in 2019. Training was provided on the proper preparation and collection of blood smears and microscopical diagnosis of malaria. The Standard Operating Procedures (SOPs) for malaria microscopy and RDTs were also distributed.

3.4 Special parasitological surveillance activities carried out by the Anti Malaria Campaign

During the year 2019, the Anti Malaria Campaign conducted special screening programmes at the Bandaranaike International Airport (BIA) to screen 465 military personnel returning from UN peace keeping missions and 908 special groups returning from malaria endemic countries, when informed by IOM and UNHCR.

4. Entomological Surveillance

Entomological surveillance plays a key role in the efforts being made to prevent malaria re-introduction in Sri Lanka. In 2019, entomological surveillance activities have been carried out according to the revised guidelines for entomological surveillance 2017 and in accordance with the National Strategic Plan 2018-2022. The two main objectives of entomological surveillance were, to assess the receptivity to prevent forward transmission by taking appropriate timely actions within the circumscribed locality when a malaria case is reported and to assess the receptivity of a focus through entomological investigations when vulnerable groups or individuals have been identified.

These entomological investigations are classified in to mainly two categories; spot surveys and sentinel surveys. Spot surveys were carried out as reactive spots when a malaria patient was reported and as proactive spots when vulnerability of a certain area is increased. Fixed site entomological monitoring has been carried out on monthly basis in foci where both the receptivity and vulnerability was high as an Extended routine sentinel monitoring process. Routine sentinel monitoring has been carried out in foci where vulnerability and /or receptivity was moderate to high, on quarterly basis.

Special entomological surveys were carried out in areas where the invasive container breeding *Anopheles stephensi* was found and in urban areas with high human mobility and transportation hubs are present with the view of investigating the distribution of this species in Sri Lanka.

Forty-four (44) entomological teams have been engaged in entomological surveillance activities during 2019, throughout the 28 regions island wide. A total of 4830 days were spent by the central and regional entomological teams in 2019 and the total number of days spent for entomological activities are given in Figure 5.

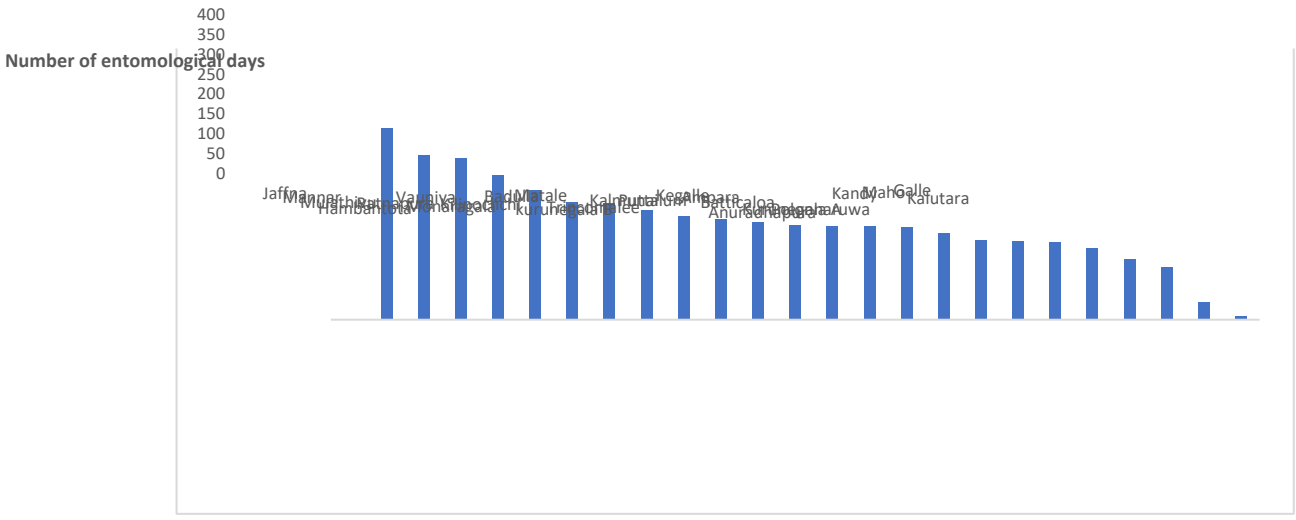


Figure 5:Total number of entomological surveillance days spent by each region in 2019

The entomological days carried out by the regions were totally funded by the government funds in 2019. This is a remarkable performance by the provincial councils and line ministry contributing for entomological surveillance up to the required level as the Global Funds direct grant funding support for subsistence for additional entomological surveillance ceased in 2018. Two semi-annual review programs were conducted in 2019 for entomological surveillance with the participation of all regional staff and technical staff of AMC HQ.

The number and types of different entomological surveys carried out by the regions in 2019 adhering to the entomological surveillance guidelines are shown in Figure 6. A total of 1857 surveys were completed in 2019, out of which, 337 were extended routine sentinel surveys, 248 were routine sentinel surveys, 1187 were proactive spot surveys while 85 were case based reactive surveys.

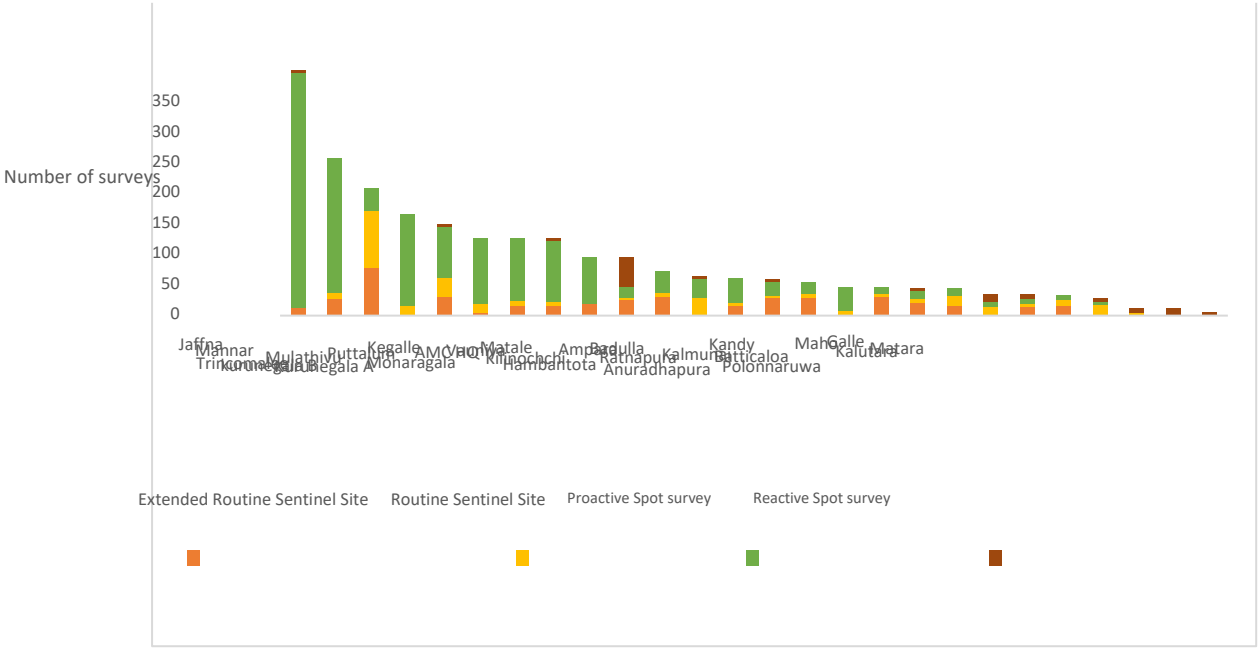


Figure 6:Different types of surveys done by the regions in 2019

There were 25 extended routine sentinel sites belonging to 24 MOH areas and 54 routine sentinel sites in 54 MOH areas in 2019. Figure 7 shows the distribution of the locations of the extended routine and routine sentinel sites in Sri Lanka in 2019.

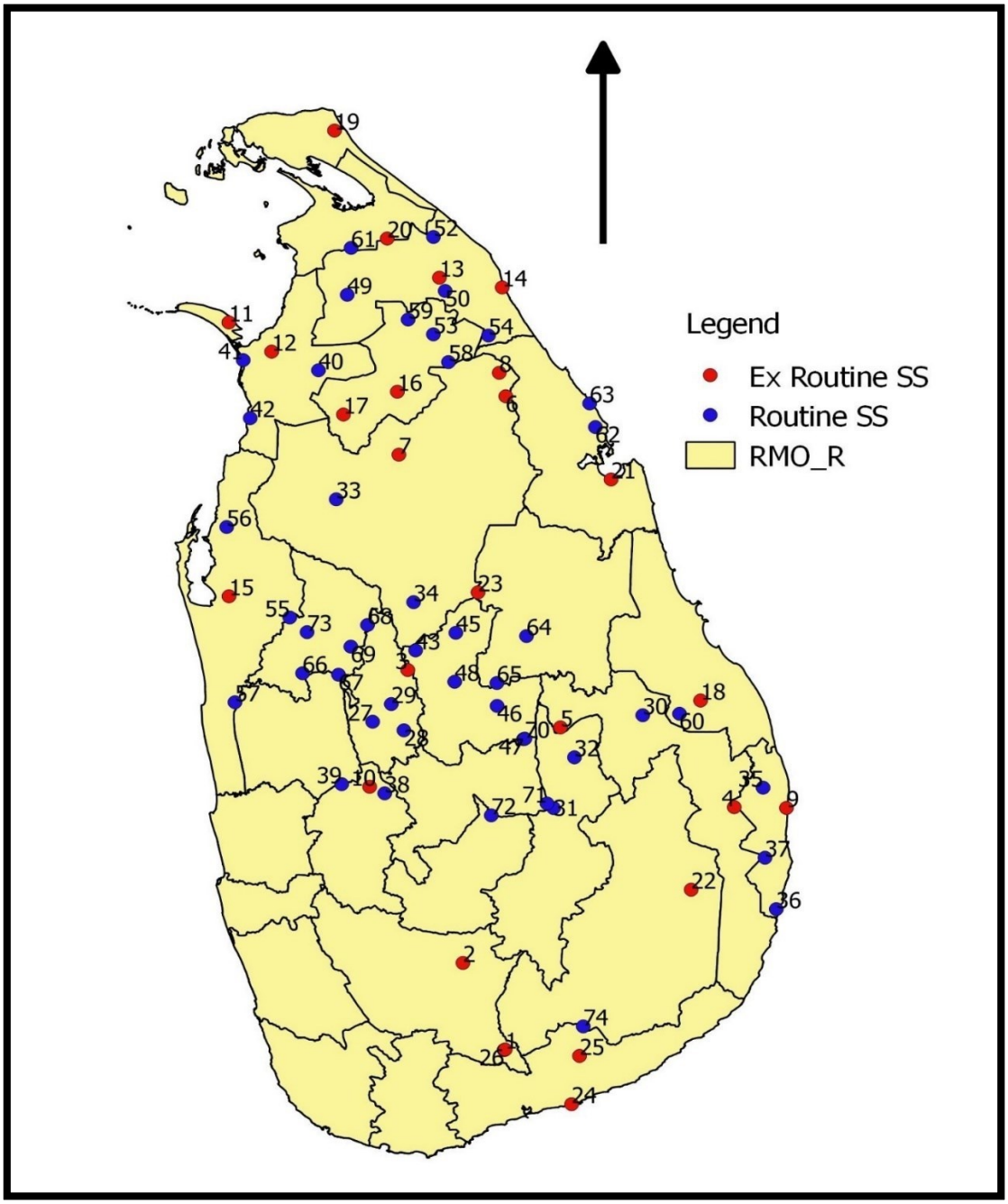


Figure 7:Distribution of extended routine and routine sentinel surveys in Sri Lanka in 2019

4.1 Larval surveys

Larval surveys were conducted in all sentinel sites, proactive and reactive spot surveys, to monitor larval densities and breeding site preferences of malaria vector mosquitoes. Furthermore, larval surveys have been conducted as pre and post intervention larval surveys in areas where invasive *Anopheles stephensi* has been found.

Figure 8 shows the total work output of larval surveys and total number of dips taken by entomological teams attached to RMO regions and AMC HQ in 26 RDHS areas.

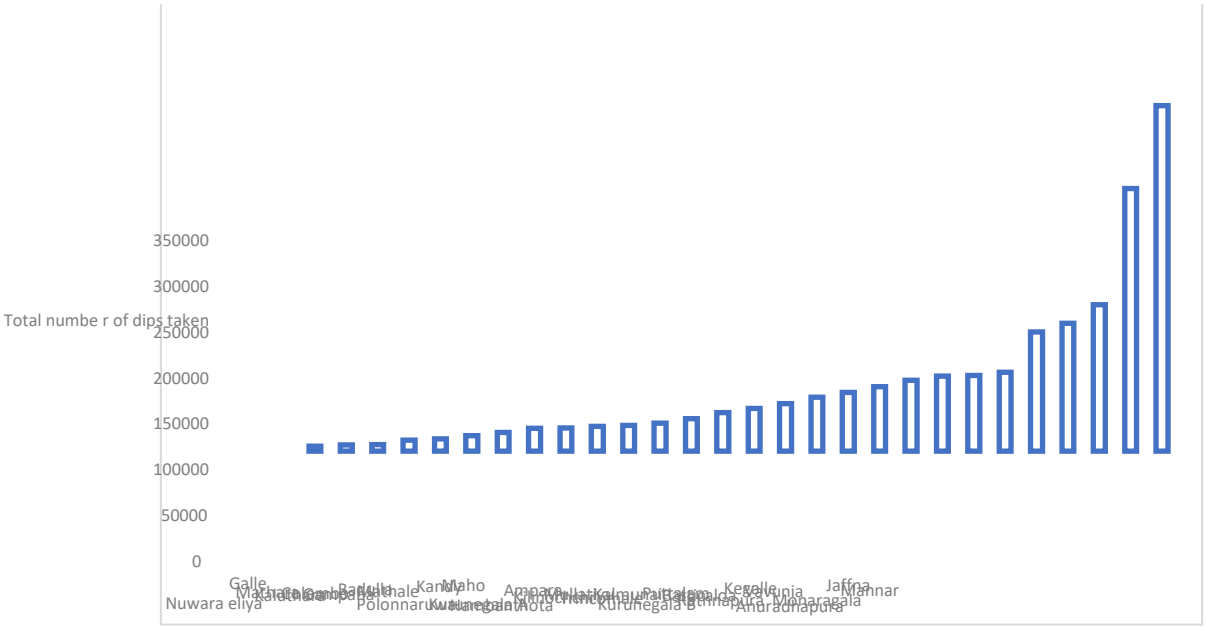


Figure 8:Total Number of dips taken by the regions in 2019

4.2 Breeding Habitats of malaria vectors

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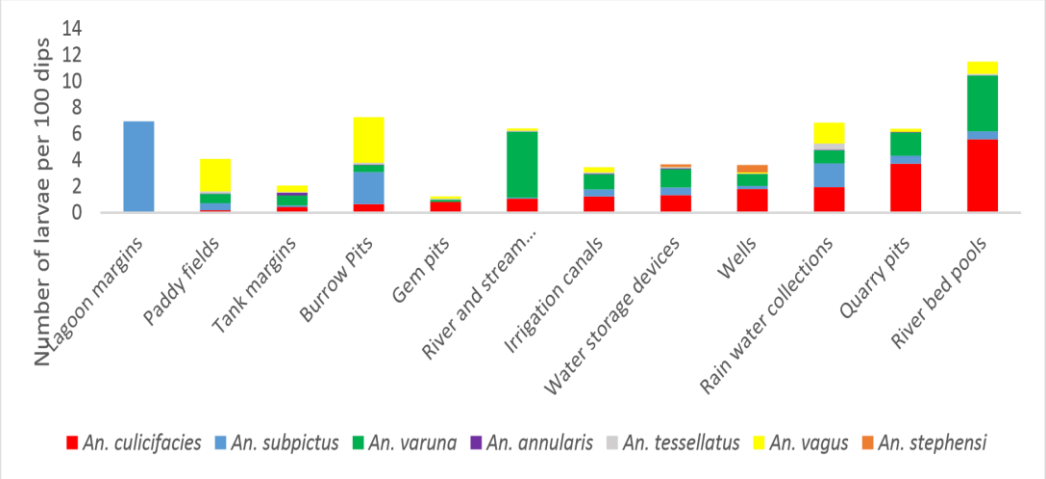

Figure 9:Relative density of major malaria vector larvae and secondary vector larvae in different breeding habitats

Figure 9 shows the results of larval surveys carried out in all RMO regions showing breeding habitat preferences of major malaria vector and secondary vectors. Larval surveys done in 2019 indicate that the highest density of *Anopheles culcifacies* was found in River bed pools. Other breeding sites contributing to *An. culicifacies* breeding are; quarry pits, rain water collections and wells, water storage devices, irrigation canals, river and stream margins, gem pits, burrow pits, tank margins and paddy fields. Highest density of *An. subpictus* was recorded from the

lagoon margins while *An. varuna* highest densities were recorded from river margins. *An. annularis* was found from tank margins whereas *An. tessellatus* was found in rain water collections and *An. vagus* was mostly found from burrow pits.

4.3 Larval Densities of malaria vectors

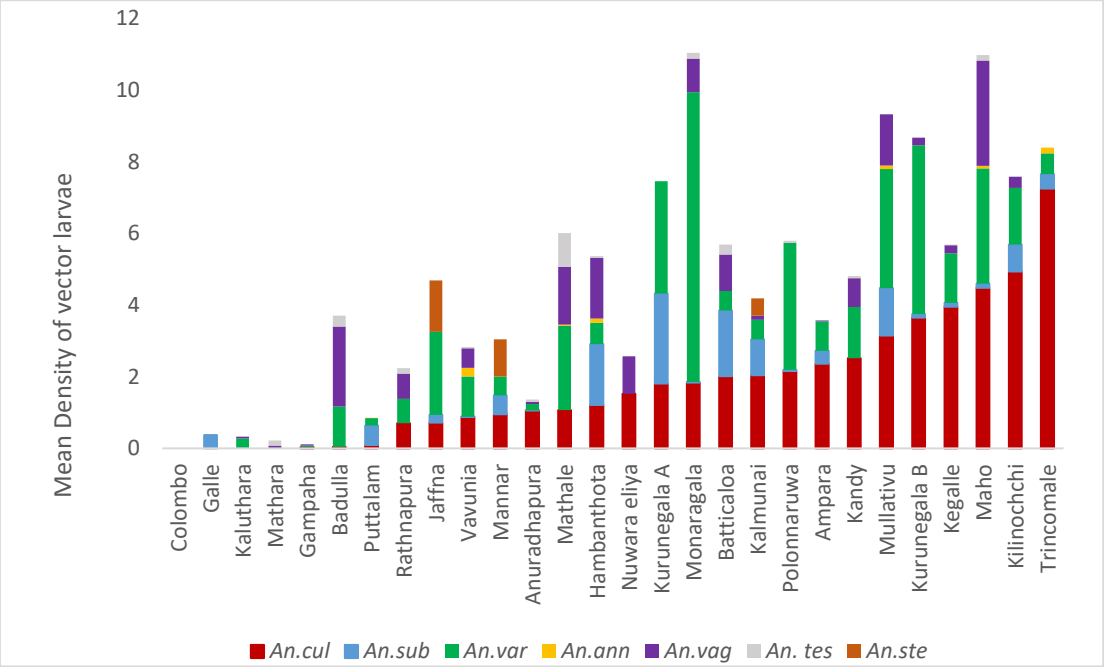

Figure 10:Mean densities of malaria vector larvae in each region in 2019

Comparison of larval densities of major vector and the secondary vectors by the districts is shown in figure 10. Trincomalee District of Eastern Province has recorded the highest densities of *Anopheles culicifacies* larvae in 2019.

Highest densities of *Anopheles subpictus* was recorded from Kurunegala A while *Anopheles varuna* highest density was recorded from Moneragala from the 2019 larval surveys. Further, *Anopheles annularis* highest density was from Vavuniya, *Anopheles vagus* highest density was from Maho and *Anopheles tessellatus* highest density was from Mathale. *Anopheles stephensi* highest density was recorded from Jaffna in 2019.

4.4 Larval surveys for Anopheles stephensi

Special container surveys were conducted to investigate the presence of *Anopheles stephensi* throughout the country. The breakdown of such larval surveys done in regions where *Anopheles stephensi* has been reported and from regions where it has not been reported in the country is shown in table 6.

Table 6:Number of container type larval surveys done in 2019 for An. stephensi

Region	Number of Larval surveys
An stephensi reported regions; Jaffna, Mannar, Kalmunai	1233
An. stephensi not reported regions	292

4.5 Breeding site preference of Anopheles stephensi

Anopheles stephensi has been observed breeding in domestic wells and water storage items in the areas it has been found. Domestic wells are continuing to be the most preferred breeding site. Figure 11 shows the breeding site preference of *Anopheles stephensi.*

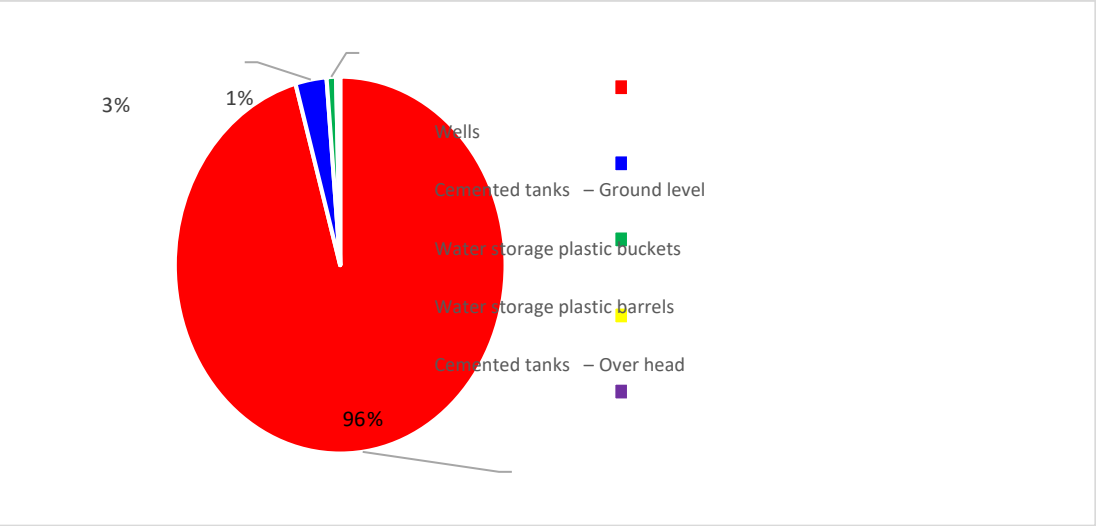

Figure 11:Breeding site preference of Anopheles stephensi in 2019

4.6 Cattle Baited Cadjan Hut Collections

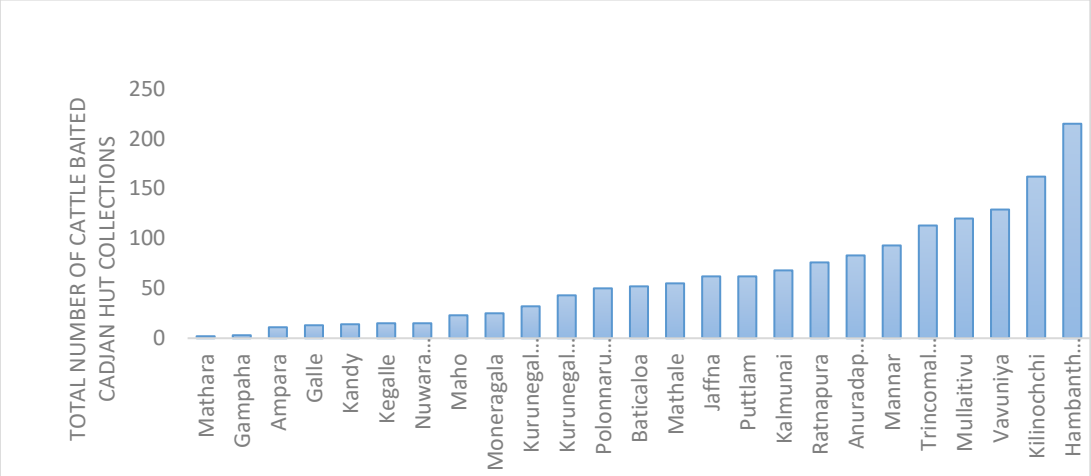

Figure 12:Total number of Cattle baited Cadjan hut collections carried out in 2019 by districts

Results of cattle baited hut technique is often used as an indicator for prevalence of indoor biting and resting vector populations. Figure 12 above shows the total work output cattle baited hut collections in different regions of Sri Lanka in 2019. Highest number of cattle baited Cadjan hut collections were carried out in Hambanthota district followed by Kilinochchi and Vavuniya districts.

Figure 13 below shows the malaria vector densities in Cattle baited Cadjan hut collections reported by different regions in 2019.

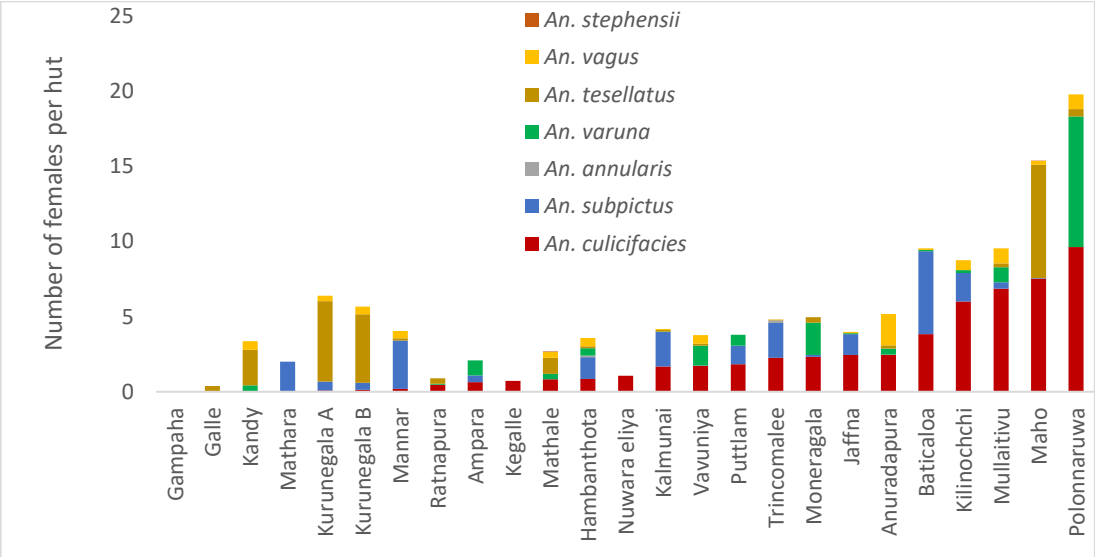

Figure 13:Mean densities of malaria vector adults collected from cattle baited Cadjan huts by each region in 2019

Highest densities of An. culcifacies was found in Polonnaruwa District during 2019 followed by Maho region of Kurunegala District. Highest densities of An. subpictus was found in Baticaloa

District followed by Mannar District. An. annularis was found only from three Districts namely, Hambanthota, Trincomalee and Anuradapura. An. varuna highest density was from Moneragala district while An. tessellatus highest density was found from Maho region and An. vagus highest density was found from Anuradapura Dsitrict. Mannar and Jaffna Districts reported very low densities of An. stephensi from Cattle baited Cadjan hut collections.

4.7 Cattle Baited Net Trap Collections

Results of cattle baited net trap technique is often used as an indicator for prevalence of outdoor biting and resting vector populations. Figure 14 shows the total work output of cattle baited net trap collections in different regions of Sri Lanka in 2019. Highest number of cattle baited net trap collections were carried out in Hambanthota district followed by Ratnapura and Vavuniya districts.

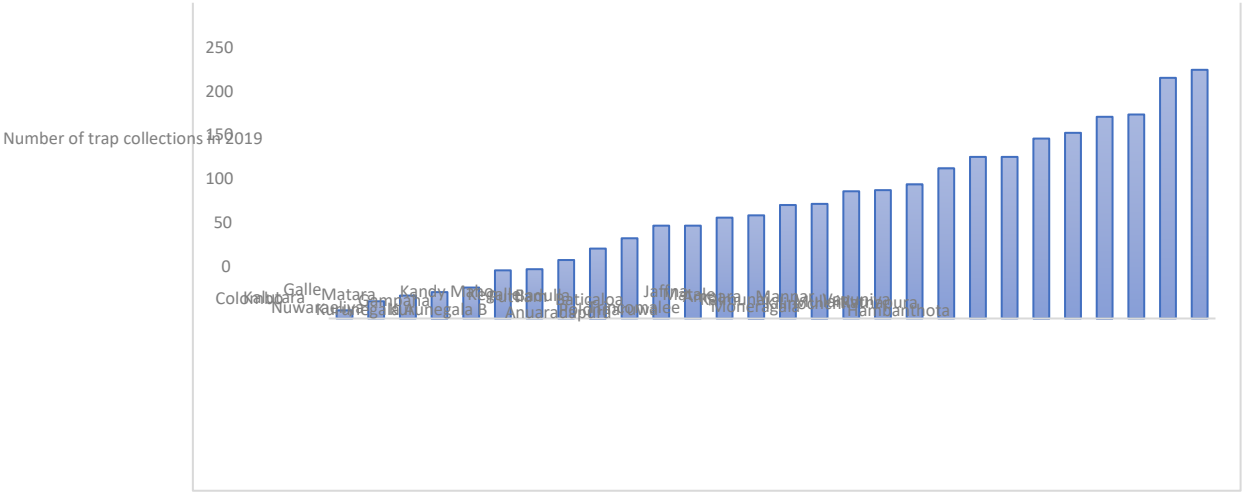

Figure 14:Total number of Cattle baited net trap collections carried out by regions in 2019

Figure 15 below shows the malaria vector densities in Cattle baited net trap collections reported by different regions in 2019. Mannar and Jaffna Districts reported very low densities of *An. stephensi* from Cattle baited net trap collections.

Highest densities of *An. culcifacies* was found in Kurunegala B region during 2019 followed by Kurunegala A region. Highest densities of *An. subpictus* was found in Trincomalee District. *An. annularis* highest density was from Kurunegala A region and *An. varuna* highest density was from Maho region of Kurunegala District while *An. tessellatus* highest density was found from Monergala region and *An. vagus* highest density was found from Kandy District.

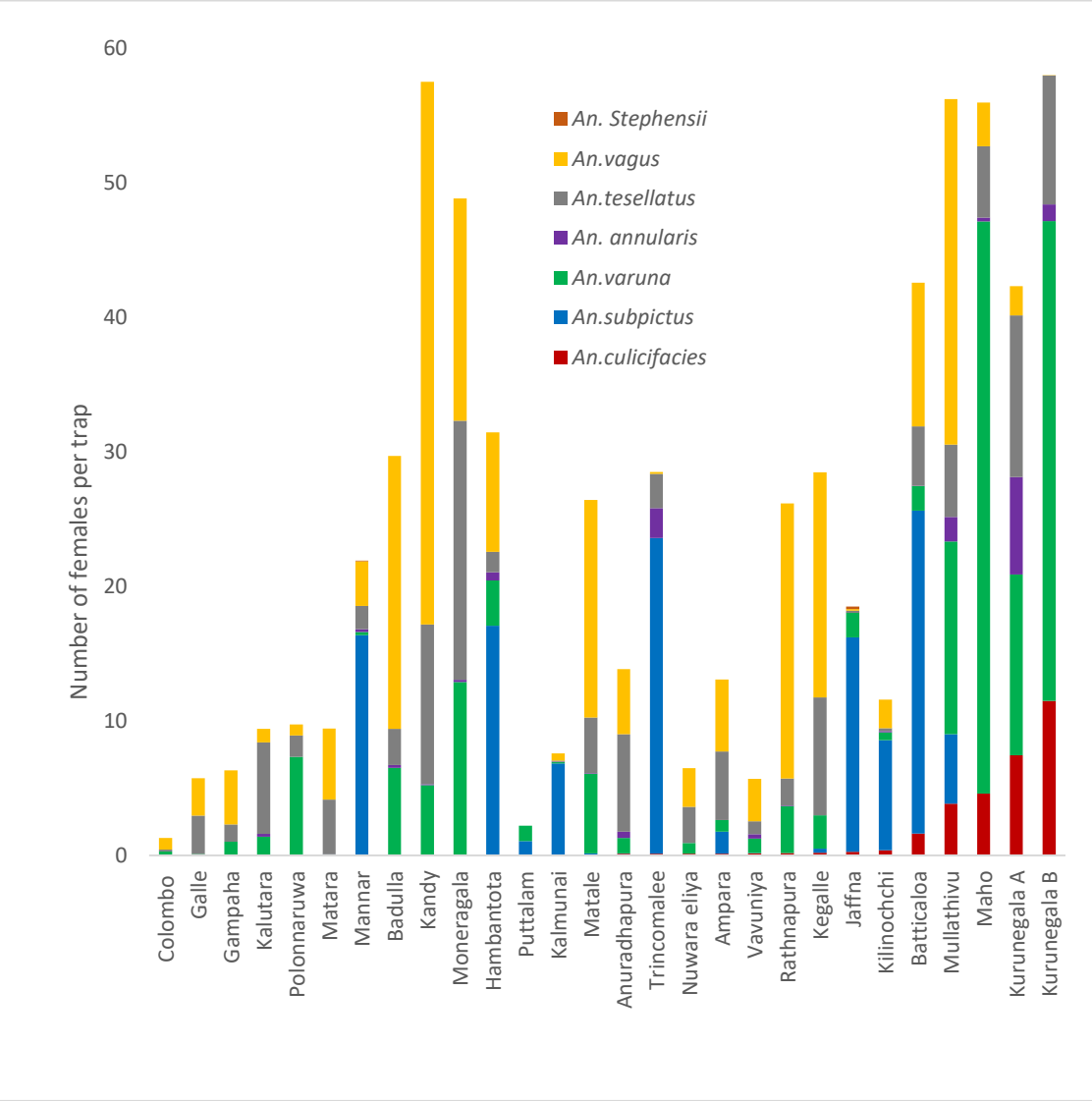

Figure 15:Mean densities of malaria vector adults collected from cattle baited net traps by each region in 2019

4.8 Indoor Hand collections

Hand collection of indoor resting *Anopheles* mosquitoes was performed in many of the RMO regions. This technique provides useful information such as seasonality of indoor resting of vectors and their resting sites inside human dwellings.

Highest number of houses inspected for indoor resting mosquitoes was done in Hambanthota region followed by Ratnapura (Embilipitiya), Baticaloa and Trincomalee regions (Figure 16).

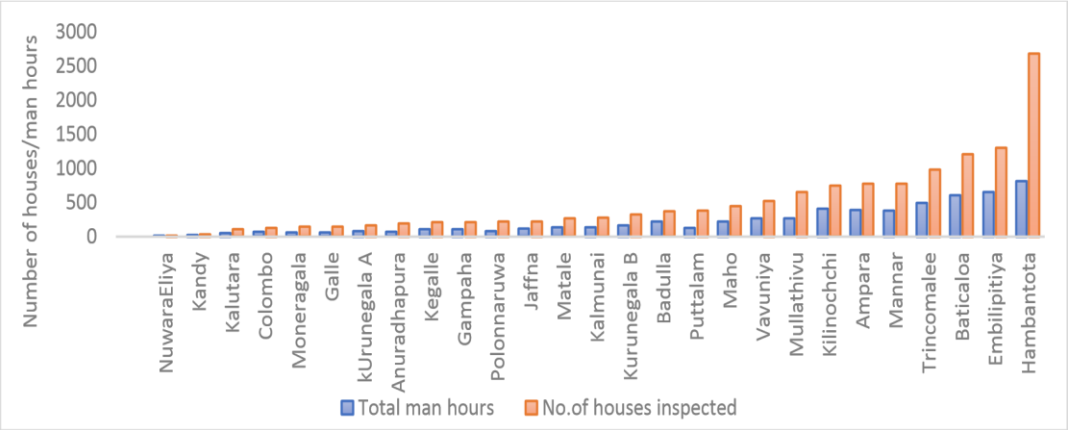

Figure 16:Mean densities of malaria vector adults collected from cattle baited net traps by each region in 2019

Major malaria vector *Anopheles culicifacies* was recorded in very low densities in some of the regions. Highest indoor resting habit of *An. culicifacies* was found in Jaffna and Mullaitivu Districts of Northern Province. Highest indoor resting density of secondary vector *An. subpictus* was found in Kalmunai region of Easter Province in 2019 (Figure 17).

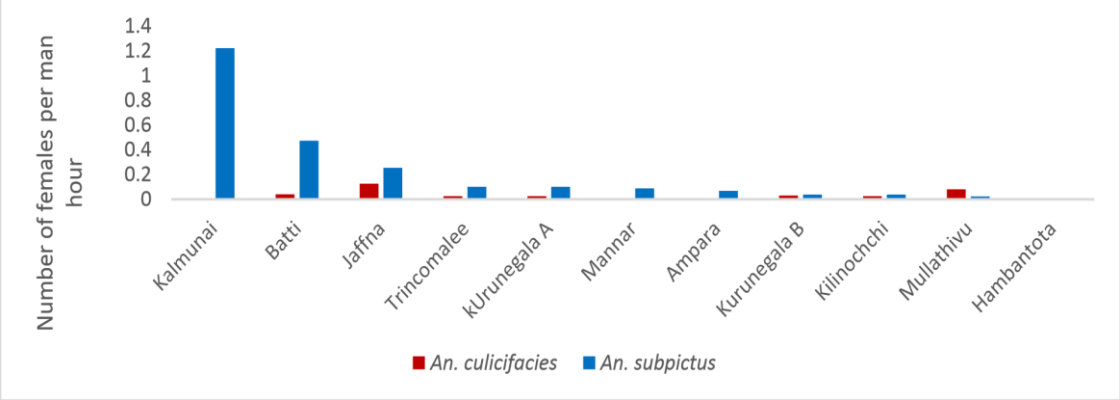

Figure 17:Mean density of An. culicifacies and An. subpictus indoor resting densities

Human landing catches serves as a good indicator of assessing the risk of malaria transmission in the malaria elimination phase as there is no indigenous transmission. Results of partial night (6.00 p.m.to 9.00 p.m.) human landing catches in different regions in 2019 are as given in following figure 18. This shows the total work output of human landing catches spent in man hours in different regions. Mullaitivu, Ratnapura and Moneragala regions have spent the highest total man hours indoor and outdoor.

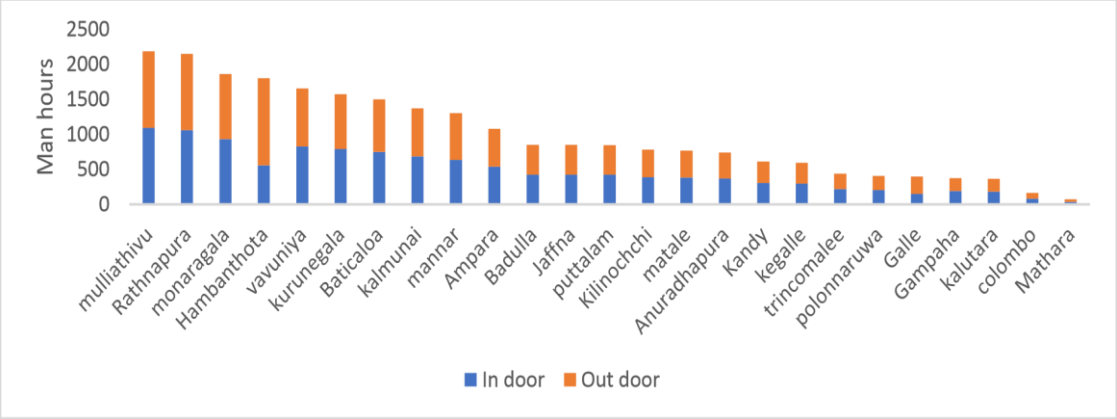

Figure 18:Total man hours spent in different regions in human landing catches in 2019

4.9 Biting Preferences of Malaria Vectors

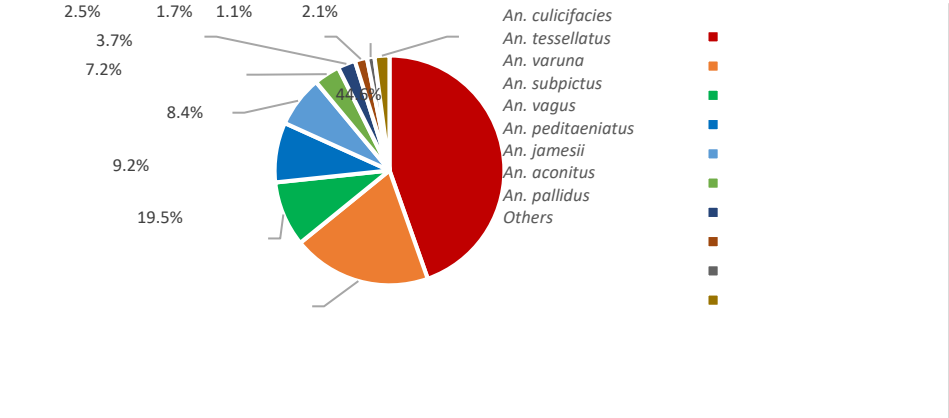

Figure 19:Percentage of human biting preferences of Anopheles species caught in human landing catches in all regions

Despite the malaria eliminated situation in the country the human landing catches were continued to assess the risk of malaria transmission. As per above figure 19, *Anopheles culicifacies*, the primary malaria vector was found more abundantly (44.6%), followed by *Anopheles tessellatus* (19.5 %), *Anopheles varuna* (9.2%) and *Anopheles subpictus* (8.4%). The other noticeable human biting species were *Anopheles vagus* (7.2%), *Anopheles peditaeniatus and Anopheles jamesii*.

4.10 Monitoring Insecticide resistance in malaria vectors

Resistance to insecticides used for IRS and LLINs were tested on the main malaria vector being *Anopheles culicifacies* and other secondary vectors, in 57 sites in 46 MOH areas. WHO tube bioassay test was conducted for diagnostic concentration of each insecticide. *An. culicifacies* did not show resistance to any of the insecticides tested in 16 MOH areas (table 7 and figure 20).

Table 7:Susceptibility of An. culicifacies to insecticides in 2019

RMO Rigion	MOH	Insecticide	No. of replicates	No. of mosquitoes	Corrected mortality	Status
Mullaithivu	Oddusudan	Deltamethrin 0.05%	1	20	100%	S
Ampara	Uhana	Deltamethrin 0.05%	6	100	100%	S
Mullaithivu	Mullaithivu	Deltamethrin 0.05%	1	20	100%	S
Kandy	Rikillagaskada	Etofenprox 0.5%	4	100	100%	S
Trincomalee	Kuchchaweli	Etofenprox 0.5%	1	15	100%	S
Trincomalee	Uppuweli	Etofenprox 0.5%	2	50	100%	S
Anuradhapura	Horowpothana	Lambdacyhelothrin 0.05%	2	55	100%	S
Anuradhapura	Horowpothana	Lambdacyhelothrin 0.05%	4	80	100%	S
Mathale	Wilgamuwa	Lambdacyhelothrin 0.05%	5	100	100%	S
Trincomalee	Trincomalee	Lambdacyhelothrin 0.05%	1	10	100%	S
Monaragala	Siyabalandu wa	Lambdacyhelothrin 0.05%	3	51	100%	S
Kurunegala A	Ganewatta	Lambdacyhelothrin 0.05%	1	15	100%	S
Puttalam	Puttalam	Lambdacyhelothrin 0.05%	2	30	100%	S
Puttalam	Karuwalagas wewa	Lambdacyhelothrin 0.05%	4	100	100%	S

Maho	Maho	Lambdacyhelothrin 0.05%	5	100	100%	S
Mullaithivu	Oddusudan	Propoxur 0.1%	2	35	100%	S
Kilinochchi	Karachchi	Propoxur 0.1%	4	100	100%	S
Kurunegala B	Wariyapola	Propoxur 0.1%	5	100	100%	S
Kilinochchi	Karachchi	Fenitrothion 1%	4	100	100%	S

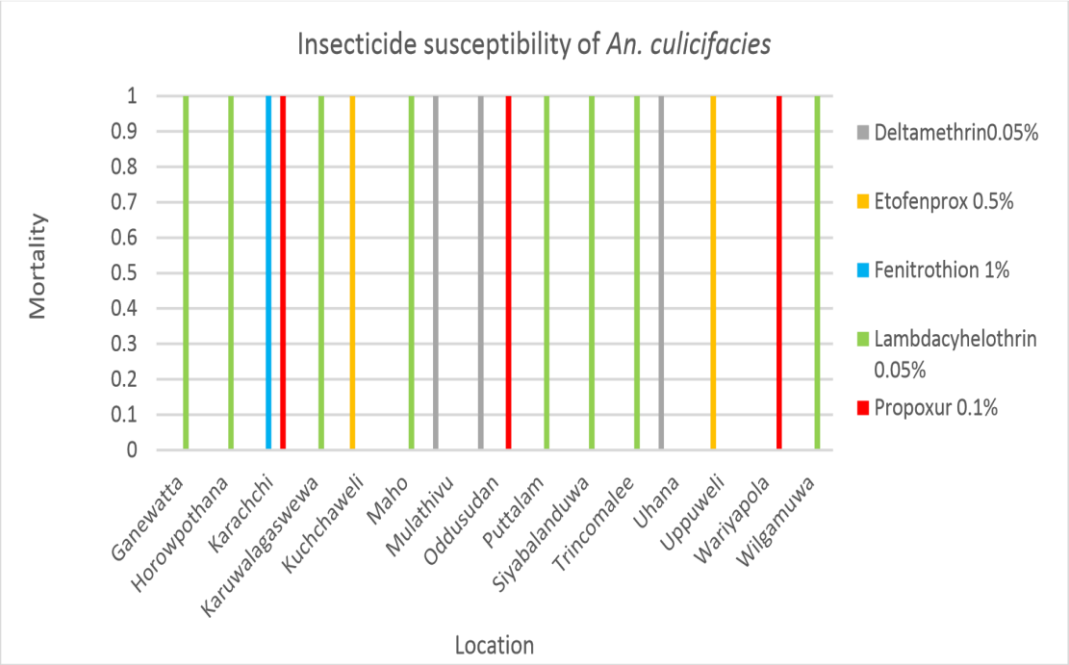

Figure 20:Susceptibility of An. culicifacies to insecticides in 2019

As per details given in below table 8 & figure 21, *An. subpictus* showed confirmed resistance (CR) to Malathione 5% in Vaunathivu MOH area and possible resistance (PR) to pyrethroids in Addalachchenai, Batticaloe, Vavunathivu, Alayadiwembu and to Propoxur 0.1% in Palei MOH areas. In all the other tested areas it was susceptible.

Table 8:Susceptibility of An. subpictus to insecticides in 2019

RMO Region	MOH	Insecticide	No of replicates	Number of mosquitoes	Corrected mortality	Status
Baticaloa	Vavunathivu	Malathion 5%	5	100	83%	CR
Mannar	Mannar	Fenitrothion 1%	4	100	100%	S
Mannar	Mannar	Pirimiphos methyl 0.25%	4	100	100%	S
Mannar	Mannar	Cyfluthrin 0.15%	4	100	100%	S
Baticaloa	Baticaloa	Deltamethrin 0.05%	4	100	100%	S
Baticaloa	Baticaloa	Deltamethrin 0.05%	4	100	100%	S
Hambanthota	Tangalle	Deltamethrin0.05%	4	100	100%	S
Trincomalee	Muthur	Deltamethrin0.05%	1	20	100%	S
Kalmunai	Addalachchenai	Deltamethrin0.05%	4	100	93%	PR
Hambanthota	Hambanthota	Deltamethrin0.05%	4	100	100%	S
Jaffna	Jaffna	Etofenprox 0.5%	4	100	99%	S
Trincomalee	Uppuweli	Etofenprox 0.5%	1	25	100%	S
Baticaloa	Baticaloa	Lambdacyhelothrin 0.05%	4	100	94%	PR
Baticaloa	Baticaloa	Lambdacyhelothrin 0.05%	6	140	100%	S
Trincomalee	Uppuweli	Lambdacyhelothrin 0.05%	2	40	100%	S
Trincomalee	Trincomalee	Lambdacyhelothrin 0.05%	4	100	100%	S
Kalmunai	Addalachchena	Lambdacyhelothrin 0.05%	2	50	96%	PR
Baticaloa	Vavunathivu	Lambdacyhelothrin 0.05%	4	100	95%	PR
Kalmunai	Aliyadiwembu	Lambdacyhelothrin 0.05%	4	100	91%	PR
Mannar	Mannar	Lambdacyhelothrin 0.05%	4	100	100%	S
Trincomalee	Uppuweli	Permethrin 0.75%	1	20	100%	S
Trincomalee	Muthur	Permethrin 0.75%	1	20	100%	S
Kilinochchi	Palai	Propoxur 0.1%	4	100	97.9%	PR
Batticaloa	Kiran	Propoxur 0.1%	4	100	100%	S

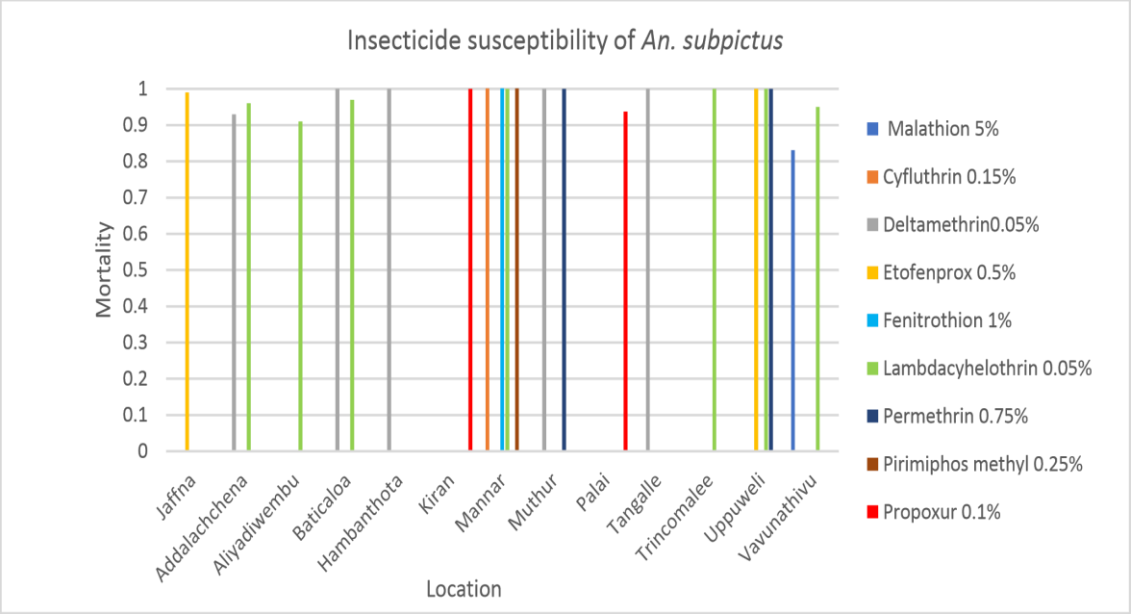

Figure 21:Percentage Mortality of An. subpictus to insecticides in 2019

An. stephensi adults showed confirmed resistance for Pirimiphos methyl 0.25% in Jaffna MOH area. However, WHO susceptibility test done for *An. stephensi* larvae was susceptible to diagnostic concentration of Temephos in the same MOH area.

4.11 Training programs for Entomology Division

One Entomologist was trained at Vector Control Research Center, India on vector control and Entomology, one HEO was trained at Kasetsart University, Thailand, on mosquito surveillance and taxonomy.

Fifty-eight Health Entomology Officers were trained in the in-service training program at Anuradhapura for entomological techniques. Thirty-eight Health Entomology Officers were trained on GIS applications in 2019.

5. Vector Control Activities

5.1 Core vector control activities

Vector control activities in the PoR phase are conducted taking vulnerability and receptivity in to consideration. IRS application and distribution of LLIN are the core vector control methods carried out. IRS is only carried out in general for reactive vector control. LLIN distribution is done for reactive vector control as well as for vulnerable population.

IRS used in 2019 in Sri Lanka is Lamda Cyhalothrin 10% WP, which is in the Pyrethroids class. Approximately 100 kg of Lamda Cyhalothrin was used by the AMC in 2019. Table 9 gives the total number of premises/houses and the population protected through the use of IRS in 2019.

Table 9:Total number of premises/houses and the population protected by application of IRS in 2019

RMO Region	Premises/ Houses	Population protected
Ampara	30	160
Anuradhapura	66	245
Badulla	--	--
Batticaloa	270	710
Colombo	--	--
Gampaha	--	--
Hambantota	11	62
Jaffna	--	--
Kalmunai	--	--
Galle	--	--
Kandy	--	--
Kegalle	--	--
Kilinochchi	--	--
Kurunegala-A	112	540
Kurunegala-B	--	--
Maho	61	243
Mannar	--	--
Matale	--	--
Matara	--	--
Moneragala	302	1423
Mullativu	--	--
Nuwara Eliya	--	--
Polonnaruwa	19	84
Puttalam	--	--
Ratnapura	--	--
Trincomalee	--	--
Vavuniya		
TOTAL	**871**	**3467**

A total of 871 premises were sprayed with IRS and 3467 persons protected. Of the total 27 RMO regions, only 08 regions required the use of IRS.

Moneragala was the region which had the highest number of premises covered (n=302) and persons protected (n=3467) through IRS. The application of IRS was conducted in Moneragala in 2019 as 2nd and 3rd round IRS application for the 2018 introduced case in Siyambalanduwa area.

Long Lasting Insecticidal Nets (LLIN) used in the Anti Malaria Campaign in 2019 is PermaNet 2.0. The insecticide contained in PermaNet 2.0 is deltamethrin. The Table 10 describes the distribution of LLIN by regions in 2019.

Table 10:Long Lasting Insecticidal Net (LLIN) distribution by regions in 2019

RMO Region	No. distributed
Ampara	916
Anuradhapura	1169
Badulla	1067
Batticaloa	1697
Colombo	--
Galle	--
Gampaha	--
Hambantota	2408
Jaffna	2426
Kalmunai	229
Kalutara	--
Kandy	278
Kegalle	--
Kilinochchi	4103
Kurunegala-A	468
Kurunegala-B	652
Maho	990
Mannar	302
Matale	1517
Matara	--
Moneragala	1728
Mullativu	1113
Nuwara Eliya	--
Polonnaruwa	40
Puttalam	1936
Ratnapura	2423
Trincomalee	3185
Vavuniya	1294
TOTAL	**29941**

A total of 29941 LLIN have been distributed in 2019 in the entire country. Maximum number of LLIN has been distributed in Killinochchi (n=4103) and Trincomalee (n=3185) regions respectively. LLIN is used as a core vector control method in reactive vector control activities if primary vector is present in the entomological surveys. In addition, LLIN is also distributed among vulnerable population in receptive areas.

5.2 Supplementary vector control methods

Larval source management (LSM) is carried out as a reactive and a proactive vector control method. Two common LSM conducted are the use of Temephos as larvicidal and the introduction of larvivorous fish. Larvivorous fish were introduced into wells and abandoned pits as a biological method of vector control. Both methods are used in *An. Stephensi* control and elimination activities as well.

5.3 Use of space spraying

Space spraying is not advocated by AMC as a main vector control method. It has a limited role in reactive vector control. Whenever, space spraying is applied, the decision to apply, extent and the timing of space spraying is decided through discussions between RMO and the AMC HQ.

5.4 Reactive vector control activities

Table 11:Reactive vector control activities conducted in 2019 in Sri Lanka by MOH area by activity

RMO region	MOH area	Vector control activities conducted				
		IRS	LLIN	Temephos	Fish introduction	Space spraying
Kalutara	Beruwela					✓
Kegalle	Warakapola					✓
Galle	Imaduwa					✓
Kalutara	Agalawatta					✓
Anuradhapura	Anuradhapura NNP	✓	✓	✓		
Kandy	Panvila		✓	✓		
Batticaloa	Arayampathi		✓	✓	✓	
Batticaloa	Arayampathi			✓	✓	✓
Batticaloa	Batticaloa	✓		✓	✓	✓
Batticaloa	Batticaloa	✓		✓	✓	✓
Batticaloa	Kopay		✓	✓	✓	
Kandy	Kandy MC			✓		✓
Hambantota	Okewela					✓
Hambantota	Ambalantota					✓
Maho	Maho		✓	✓	✓	✓
Mullaitivu	Oddusudan		✓	✓	✓	
Matale	Dambulla					✓
Matara	Weligama				✓	
Matara	Athureliya					✓
Galle	Habaraduwa					✓

A total of 53 imported cases were detected in 2019. Based on the night stay of the individual (as per the guidelines), 84 reactive spot surveys were done in 84 locations in 2019. Following the entomological surveillance findings, 64 Sites did not require vector control. In the remaining 20 sites, vector control activities were conducted. IRS was applied in 03 sites and LLIN was distributed in 06 sites. Temephos application, fish introduction and space spraying were done in 10, 08 & 14 Sites respectively. In certain instances, more than one vector control methods were conducted & in 20 sites vector control activities were done. These twenty sites and the type of vector control activity conducted in each site are given in the Table above. (Table 11)

6. Monitoring & Evaluation

6.1 Monthly Progressive Review Meetings

The monthly progress review meetings were initiated in 2009 and continued on with the participation of Regional Malaria Officers, Stakeholders for Tri Forces Sri Lanka, Sri Lankan Police, representatives of NGOs and the Anti Malaria Campaign Technical Officers. This took place once a month to evaluate the progress made at the regional and central level in the past month. The practical recommendations on the achievements and sustainability of the malaria-free country were also discussed at these meetings. The RMOO provided a report on the work carried out in the regions during these review meetings. The feedback from AMC / HQ, allowed the establishment of suitable responses through strategies and policies.

6.2 Technical Support Group

The Director General of Health Services has appointed a Technical Support Group (TSG) to provide properly considered evidence-based strategic and technical advice and recommendations to the Anti-Malaria Campaign (AMC) to keep Sri Lanka, malaria free. Members do not represent associations or groups but act in their individual capacity to provide guidance and advice to the AMC. The TSG is chaired by the Director General of Health Services. Current TSG comprises 17 members with a wide range of expertise in the fields of malaria control and elimination, including parasitology, epidemiology of malariology, pharmacology, general medicine, vector control and biology, sociology and disease control. In addition to these outside individuals, TSG also has members from the Ministry of Health at the central and provincial levels and AMC headquarters. Additional experts with particular areas of expertise may be invited to attend the TSG meetings as temporary advisers or as co-opted members in order to respond to unique problems as they arise. The TSG functions as a mere consultancy body to advise and guide the DGHS and AMC Director. The Minister of Health facilitates and supports the TSG's meetings and events. Also the Ministry of Health provides the necessary financial aids to carry out these activities. The membership of the TSG members is reviewed and updated according to requirements every three years. Throughout year 2019 successful maintenance of the Prevention of Reintroduction of malaria process, the representatives of TSG provided the support and strategic advice to the AMC.

6.3 Case Review Committee

The Case Review Committee (CRC) is a subcommittee of the TSG which reviews the actions performed in case identification and classification; of both imported and indigenous cases. The CRC meets once a month to discuss the basic aspects of the case and the resolution. The Committee shall recognize any lapses in the response and shall advise accordingly.

6.4 Information management

The AMC headquarters has been supplied with information on suspected cases via the hotline which is available 24/7 across the country. This number is published in the website of AMC. Anyone from the public or any health worker is able to call this number. This number is answered by a medical officer at AMC head office with the guidance of Consultant Community Physicians, who are experts in malaria case management. All the case data are entered into the Electronic Information Management System (EIMS). This system can be accessed by the regional malaria officers (RMOs) and staff who are involved with AMC activities.

GIS mapping created at the national and regional level on EIMS dashboard, can be viewed at the regional and national levels. E-mails are used to connect with the RMOs, which therefore reduces paper consumption and speeds up data dissemination.

7. Infrastructure and Human Resources

7.1 Carder details

At the end of year 2019, AMC Headquarters had the following categories of staff. The number of staff in each category as at the end of year 2019 is shown below. (Table 12)

Table 12:The number of staff in each category as at the end of year 2019

Designation	Approved cadre as at 31.12.2019	In position
Director	1	0
Deputy Director	1	1
Consultant Community Physician (Medical Consultant)	3	2
Medical Officer	8	5
Accountant	1	0
Entomologist	4	3
Parasitologist	1	1
RMO / AMO (Registered/Assistant Medical Officer)	1	0
Special Grade Health Entomological Officer	1	0
Special Grade PHLT	2	0
Special Grade PHI	1	0
Health Entomology Officer	6	6
Medical Laboratory Technologist	3	0
Public Health Inspector	4	3
Public Health Laboratory Technician	13	13
Information and Communication Technology Assistant	2	1
Development Assistant	3	2
Medical Record Assistant	1	0
Public Health Field Officer	10	9
Public Management Assistant	15	13
Medical Supplies Assistant	3	3
Telephone Operator	1	2
Cinema Operator	1	1
Health Driver	15	09
Health Laboratory Aide	2	1
KKS	1	1
Lift Operator	2	2
Saukya Karya Sahayaka (Junior)	20	20
Saukya Karya Sahayaka (Ordinary)	25	18
Spray Machine Operator	10	20
Development Officer	5	4
Saukya Karya Sahayaka Casual	0	2
Pharmacist	1	0
Plumber/ Pump Machine Operator	1	0
Management Assistant	-	1
TEMPORARY		
CCP	-	1
PGIM Trainee MO	-	2
Total	**169**	**145**

7.2 Vehicles

Adequate number of vehicles in good condition is an important factor in an effective programme to prevent re-introduction of malaria. The table 13 shows the available number of vehicles in AMC headquarters in 2019.

Table 13:Availability of vehicles in AMC/HQ during 2019

Serial No	Vehicle No	Type of Vehicle	Working Condition
1	WP PE 8966	CAB	Running
2	WP GP 2558	VAN	Running
3	WP GP 2556	VAN	Running
4	42-9399	MOTOR LORRY	Running
5	WP LC 0249	MOTOR LORRY	Running
6	WP NA 3117	VAN	Running
7	WP NB 4568	VAN	Running
8	WP NB 4567	VAN	Running
9	WP PE 8975	CAB	Running
10	WP KK 6977	JEEP	Running
11	WP JL 8129	CAB	Not Running
12	WP PE 8974	CAB	Running
13	WP PE 8972	CAB	Running
14	WP PE 2025	CAB	Running
15	WP AAD 0185	TRISHOW	Running
16	WP WF 5034	MOTOR BICYCLE	Not Running

7.3 Buildings

The Anti-Malaria Campaign Headquarters is located at the Public Health Complex at 555/5, Elvitigala Mawatha, Colombo 5.

The Director's room, Deputy Director's room, GFATM Project Director's room, Consultant Community Physicians' room, Medical Officers' room, GFATM project office, library, computer room, telephone exchange and auditorium are in the 3rd floor. The Administration branch, finance branch, record room and stores are located in the 5th floor. The Central Parasitology Laboratory and Entomology Laboratory are located in the 6th floor.

8. Funding

The government of Sri Lanka (GoSL) allocates funds for the Anti Malaria Campaign through the Ministry of Health, Nutrition and Indigenous Medicine. In 2019, The GoSL allocated Rs. 27 million as capital expenditure to AMC headquarters. The recurrent expenditure borne by the GoSL for AMC headquarters for year 2019 was Rs. 139.68 million. The recurrent expenditure of the Regional Malaria Office staff is borne by the respective Ministries of Provincial Councils.

The Global Fund to fight AIDS, Tuberculosis and Malaria (GFATM) was a collaborative partner and a major funding source for the AMC up to the year 2018, through the New Funding Model Grant of GFATM which extended from 2016 – 2018, following elimination of malaria in Sri Lanka to sustain the malaria free status. Since 2019, GFATM introduced a different model of funding by which payment will be granted for AMC on completion of routine work – completion of Work Plan Tracking Measures (WPTM). At the end of year 2019, with the completion of WPTM 1 & 2 which included the major tasks of establishing a procurement committee and the introduction of the PoR Strategy, the GoSL allocations which are used on these particularly identified activities USD 875,000 were reimbursed by GFATM in the following year. WPTM activities incurred 375,000 USD while the rest of 500,000 USD incurred was for the WPTM 2. This is under the 'Budgetary Support' mechanism instead of 'Grants', and the reimbursement funds are deposited in the 'Malaria Dollar Account' under the GF at the Treasury, as a payment for completion of routine work by the AMC.

Table 14:Key performance indicators identified

Indicator	Target Expected %	Expenditure target %
Proportion of confirmed malaria cases that received first line antimalarial treatment at public health sector facilities	**100 %**	**100 %**
Proportion of malaria cases that received first line treatment at private sector facilities	**100 %**	**100 %**
Percentage of confirmed cases fully investigated and classified	**100 %**	**100 %**

The World Health organization (WHO) is also a technical and funding partner for AMC. The WHO supported the activities of AMC in 2019 by providing financial assistance to conduct 10 programmes for capacity building for clinical management in four provinces, and also financially supporting the participation at international trainings on clinical management of malaria and by financing participation of technical officers for regional trainings on malaria.