






**Guidelines for Entomological
surveillance of Malaria in PoR
Phase - 2019**

**Anti-Malaria Campaign
Ministry of Health – Sri Lanka**

ANTI-MALARIA CAMPAIGN

Guidelines for Entomological surveillance of Malaria in PoR Phase - 2019

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1.0 Background

Sri Lanka has successfully eliminated malaria and has embarked on Prevention of malaria Reintroduction (PoR) phase. Entomological surveillance has been a major component of the malaria elimination strategy of the country. It has to be continued with modifications during the Prevention of Reintroduction (PoR) phase to measure the levels of receptivity. Over the past decades, Anti Malaria Campaign (AMC), has implemented a comprehensive package of entomological surveillance activities among 22 regions throughout the country. These surveillance activities have changed very little from the control through elimination and Prevention of Reintroduction phases even after the country has been certified a malaria free country by WHO. Therefore, an optimal, rather than exhaustive set of entomological surveillance operations, a reviewed new system has been introduced together with the local and international expert views.

Objectives of the Entomological Surveillance Guideline in PoR of Malaria

a. General Objective:

To determine the epidemiology of malaria receptivity in vulnerable settings in PoR Phase of malaria by Entomological monitoring to facilitate vector control measures based on susceptibility to insecticides and its bio efficacy.

b. Specific objectives

1. To assess the receptivity to prevent forward transmission by taking appropriate timely actions within the circumscribed locality when a malaria case is reported.
2. To assess the receptivity of the focus through focused entomological investigations if the vulnerable groups or individuals are identified.
3. To provide evidence on susceptibility status of the vector/s,
4. To provide essential information and monitor changes on bionomics relevant to vector control.
5. To provide evidence through - Operational field research to elucidate the efficacy of vector control.

Methodological Concepts/ Guiding Principles

Following are the types of surveys which should be carried out to meet above specific objectives.

3.0 Types of Entomological surveys

- 1) Reactive spot surveys - Reactive surveys are carried out when a malaria patient is reported according to the scope of work to assess the receptivity in and around patients night out places.
- 2) Proactive spot surveys -carried out in areas where vulnerable populations are residing to assess the receptivity and take appropriate response beforehand
- 3) Extended sentinel site monitoring - carried out in fixed locations to monitor vital entomological parameters monthly to help decision making
- 4) Routine sentinel site monitoring - carried out in fixed locations to monitor vital entomological parameters quarterly (routine) to help decision making

3.1 Operational criteria for site selection for proactive and sentinel surveillance

Site selection for proactive surveys and sentinel monitoring should be based on initial situational analysis carried out on vulnerability and receptivity (as per Annex 1 and 2) by the RMO/Entomologist. The risk categorization to be applied to the vulnerable GN areas and it has to be updated as required. The risk to prevention of re-introduction of malaria is categorized as low, moderate and high (Table 1). It is ideal if the receptivity is monitored for all (high, moderate and low) vulnerable areas. However, given the time and resource constrains, it is advisable that receptivity is assessed for high vulnerable areas to prioritize and resource mobilization.

Table 1. Risk categorization

Receptivity Vulnerability	Low	Moderate	High
Low	Low risk	Low risk	Moderate risk
Moderate	Low risk	Moderate risk	Moderate risk
High	Moderate risk	Moderate risk	High risk

3.2 Summarizing guide to entomological activities in PoR

Table 2 shows at a glance the risk stratification and how each type of survey should be applied in different risk scenarios.

Table 2. Guide to entomological activities based on risk categorization.

		Receptivity		
		Low	Mod	High
Vulnerability	Low	No routine surveillance Proactive (1-3 days) Reactive (3-7 days)	No routine surveillance Proactive (1-3 days) Reactive (3-7 days)	Routine surveillance (Quarterly – 5 days) Proactive (1-3 days) Reactive (3-7 days)
	Mod	No routine surveillance Proactive (1-3 days) Reactive (3-7 days)	Routine surveillance (Quarterly – 5 days) Proactive (1-3 days) Reactive (3-7 days)	Routine surveillance (Quarterly – 5 days) Proactive (1-3 days) Reactive (3-7 days)
	High	Routine surveillance (Quarterly – 5 days) Proactive (1-3 days) Reactive (3-7 days)	Routine surveillance (Quarterly – 5 days) Proactive (3-5 days) Reactive (3-7 days)	Extended Routine surveillance (Monthly 7-10 days) Full night landing collections Proactive (3-5 days) Reactive (3-7 days)

Description of different types of surveys as follows;

3.3 Reactive surveys

Reactive spot surveys have to be carried out in all areas with reported cases as per the scope of work to be performed when a malaria patient is reported: imported, relapsing, induced, introduced and secondary cases. In the PoR phase all the reported malaria cases should be covered with entomological survey to evaluate the receptivity status in the areas where the patient has stayed at least one night within the previous two weeks since onset of fever/ clinical features and until diagnosed. It has to be initiated within 48 hours from diagnosis of case and should cover an area

approximately with 1 km radius. (Annexure 3 of scope of work). If vectors or vector breeding places are not detected within the area of 1 km radius in previously malaria endemic areas the survey could be extended more than 1 km.

Techniques to be conducted

- Comprehensive larval survey (All possible mosquito breeding places should be surveyed)
- Indoor hand collections
- Spray sheet collections
- Human landing night collections (preferably full night collection)
- Cattle baited net trap collections and Cattle baited
- Ovary dissection and determination of parous rate
- Detection of infectivity by salivary gland dissections of human biting Anophelines found in HLC
- Detection of infectivity by PCR
- Susceptibility to Insecticides
- LLIN and IRS bioassays, if the area is covered with IRS/ LLIN

The duration of the survey should be 3-7 day. If vectors are detected during the initial survey and/or vector control measures are carried out, a follow up entomological survey should be carried out. It is recommended to carry out a follow up entomological survey in receptive areas even though vectors are not found within 7 days of completion of vector control activities.

3.4 Proactive Surveys (spot checks)

- At least two spot checks should be carried out per month in different locations within the region depending on the vulnerability and receptivity. More vulnerable areas should be covered more frequently if not selected as a sentinel site.
- To be conducted in all above scenarios when a significant risk of re-introduction (e.g. due to the influx of potential source of infection) is there or to include mapping and improve knowledge of key larval habitats in the particular area.
- Special attention should be given to the surveys done in urban areas and should refer to the guide provided for detection of *Anopheles stephensi* and pre and post intervention surveys.

Duration and techniques

- in areas with low/moderate vulnerability and/or receptivity
- in areas with high receptivity and low vulnerability
- in areas high vulnerability and low receptivity

should be completed within 1-3 days with only larval surveys

- In areas with moderate vulnerability and receptivity
- in areas with high receptivity and moderate vulnerability

Larval surveys, cattle baited hut collections, Cattle baited trap collections and human landing catches should be carried out for 3-5 days.

Point to be noted

- When *Anopheles stephensi* is detected in a proactive spot survey, it should be converted to an extended routine sentinel site.

3.5 Sentinel site monitoring

Sentinel site surveillance provides continuous collection of entomological data to observe trends of local vector densities and changes of vector behavior and helps to generate evidence for proper vector management strategy.

3.5.1 Extended routine sentinel site monitoring

With the risk assessment it is advised to carry out continuous monthly monitoring of trends of vector densities only in high risk areas as extended routine sentinel site monitoring.

Hence, an extended routine sentinel site can be defined as a site where periodical entomological surveys are conducted to monitor vector bionomics and seasonal changes in vector densities. The area should include the main vector breeding site/s and a vulnerable population residing around it covering an area of approximately 2 km radius from the centre of sentinel site. The focus could be the main breeding site and the residence of risk population.

e.g. resettlement areas, port of entries, military camps

An extended routine sentinel site monitoring to be carried out in an area where there is high malaria transmission risk (high Vulnerability and Receptivity) over a period.

Criteria for selection

- I. Areas with vulnerable populations (resettlement, migratory populations, foreign workers)
- II. Areas with high receptivity (vector breeding sites present, suitable environmental conditions)

Frequency of monitoring

The extended sentinel surveys need to be carried out at monthly intervals.

Entomological techniques to be conducted

- Larval Survey
- Cattle-baited Huts (CBH)
- Indoor hand collections/Spray sheet collections
- Cattle baited net trap collections
- Outdoor resting collection and collections/spray sheet collections
- Human landing collection (HLC) partial and full
- Window trap collections when necessary
- Ovary dissections for parity
- Insecticide susceptibility testing (annual basis for each class of insecticides)
- Bio-efficacy testing for vector control interventions

Work plan

A sentinel survey will be carried out for minimum 5 days in each site decided by relevant authorities in the region.

Points to be noted

- It is recommended that the RMO should inform AMC HQ after analyzing the risk factors of a particular site to be monitored as an extended routine sentinel site.
- If primary vector or secondary vectors are not found consecutively for one year in a particular extended sentinel site the location needs to be changed after adequate discussion and recommendations with a panel comprising of Director, RMO, Community Consultant Physicians, Entomologists and relevant officers.

3.5.2 Routine sentinel site monitoring

It is advised to carry out monitoring of vector species composition, abundance and insecticide resistance during peak season of mosquito population in moderate risk areas following the risk assessment.

Hence, a routine sentinel site can be defined as a site where quarterly entomological surveys are conducted to monitor vector abundance and species composition of vector species. The area may include either main vector breeding site/s and/or vulnerable population residing around it covering an area of approximately 2 km radius from the center of sentinel site. The focus could be either the main breeding site or the residence of risk population.

Criteria for selection

- I. Areas highly receptive with low to moderate vulnerabilities
- II Areas highly vulnerable with low to moderate receptivity

Frequency of monitoring

The routine sentinel surveys need to be carried out at quarterly intervals. If primary vector or secondary vectors are not found consecutively for one year in a particular sentinel site the location needs to be changed after adequate discussion and recommendations with technical staff.

Entomological techniques to be conducted

1. Larval Survey
2. Cattle-baited Huts (CBH)
3. Indoor hand collections/Spray sheet collections
4. Cattle baited net trap collections
5. Outdoor resting collection and collections/spray sheet collections
6. Human landing collection (HLC) partial and full
7. Ovary dissections for parity
8. Insecticide susceptibility testing (annual basis for each class of insecticides)

Work plan

A sentinel survey will be carried out for 5 days in each site decided by relevant authorities in the region.

Points to be noted

- It is recommended that the RMO should inform AMC HQ after analyzing the risk factors of a particular site to be monitored as a routine sentinel site.
- When *Anopheles stephensi* is detected in a routine sentinel site, it should be converted to an extended routine sentinel site.

3.6 Insecticide Resistance Monitoring

Monitoring insecticide resistance for a given concentration of an insecticide is useful in detecting insecticide resistance early to prevent failures of vector control interventions. Insecticide susceptibility tests should be performed on major malaria vector species at least once a year using insecticides of all available insecticide classes. WHO standard test kits should be used for the Diagnostic concentrations according to the latest WHO guidelines published in 2016. Priority should be given for insecticides that showed resistance in malaria vectors in the previous years.

The implementation framework should cover the following activities:

- Monitor insecticide resistance of adult mosquitoes to insecticides used by the Anti Malaria Campaign :
 - To detect the presence of insecticide resistance phenotypes in a population using discriminating concentration bioassays in sentinel sites at least on annual basis,
 - To assess the strength of phenotypic resistance by performing bioassays using five and 10 times (5× and 10×) the discriminating concentrations of insecticides in areas where resistance is confirmed by WHO standard bioassays
 - To re-assess the resistance levels in areas where there is possible resistance by standard WHO bioassays against discriminative dosages of insecticides on annual basis
 - To detect the presence of insecticide resistance phenotypes in a population using discriminating concentration bioassays in vulnerable areas when there is a need for vector control.

- Establish baseline or monitor susceptibility of *Anopheles culicifacies*, *Anopheles subpictus* and *Anopheles stephensi* larvae to Temephos and monitor annually in areas where larval source management is implanted or planned to be implemented.

The insecticide resistance data should be entered systematically and analyzed semiannually to determine resistance profile of local vectors. These data will be exploited by the AMCHQ to recommend and prepare plans for procurement of insecticides and for management of insecticide resistance etc.

3.7 Summary of different types of surveys

Table 3 summarizes the agreements and the entomological surveys to be conducted according to the risk of transmission described in the previous sections.

Table 3. Summary of different entomological surveys

Type of Surveys	Operational Definition/ Objective	Key Entomological Techniques/ Sampling Methods	Parameters/ Indicators	Where to Apply	When to Apply/ Frequency	Duration
Extended Routine surveillance	Monitor trends over time, and carried out in an area where there is high malaria transmission risk (high V and R) over a period or where <i>An. stephensi</i> is reported.	Larval Survey Cattle-baited Huts (CBHC); Indoor and Outdoor resting collection, Human landing collection (HLC)	Larval and adult density; feeding (full night HLC) and resting behavior	Areas highly receptive and highly vulnerable	Monthly	7-10 days
Type of Surveys	Operational Definition/ Objective	Key Entomological Techniques/ Sampling Methods	Parameters/ Indicators	Where to Apply	When to Apply/ Frequency	Duration
Routine Surveillance	Monitor vector species composition and abundance and insecticide resistance carried out during peak season of mosquito population in risks areas.	Larval Survey Cattle-baited Huts (CBH); Indoor and Outdoor resting collection	Larval and adult density; feeding (half night HLC) and resting behavior	Areas highly receptive with low to moderate vulnerabilities; Areas highly vulnerable with low to moderate receptivity	Quarterly	5 days

<p>Spot Checks (Proactive)</p>	<p>Conducted in targeted areas with significant risk of re-introduction (e.g. due to the influx of potential source of infection). To include mapping and knowledge of key larval habitats as LSM is one of the response strategies that may be effective in certain situations.</p>	<p>Larval Survey in all areas; +CBH in areas with Moderate to High Receptivity and Vulnerability; +HLC in areas with Moderate to High Vulnerability and High Receptivity</p>	<p>Larval Density; Adult Density Feeding behavior (partial night collection);</p>	<p>Areas with past history of malaria transmission but no entomological data in the past 3 years; varying levels of vulnerability</p>	<p>As vulnerability changes</p>	<p>1-3 days</p>
<p>Spot Checks (reactive)</p>	<p>For each imported malaria case or cluster (of secondary cases) reported in an area, entomological investigations should be undertaken.</p>	<p>Larval Survey Cattle baited traps, (CB T); Cattle-baited Huts (CBH); Human Landing Catch (HLC) Indoor and Outdoor resting collection</p>	<p>Larval and adult density; feeding (full night HLC) and resting behavior; parity rate determination</p>	<p>Areas with reported cases: imported, relapsing, induced</p>	<p>Case-based</p>	<p>3 – 7 days</p>

4.0 Entomological data mapping in GIS applications

GIS or Google software's should be used to map the entomological findings from different surveys for better understanding and response.

4.1 Mapping of findings of Different types of surveys

Reactive and proactive survey findings should be mapped showing the area sampled and important parameters such as vector breeding sites, locations where various techniques were performed.

4.2 Mapping of vector breeding sites to display an inventory of vector breeding in regions

The data on vector breeding sites generated from sentinel sites and spot checks in MOH areas of the region should be used to map the vector breeding sites. The region should maintain an inventory of potential and active vector breeding sites.

Mapping of vector breeding sites is useful to assess the malaria risk in terms of receptivity and also to facilitate vector control measures if indicated. Vector density is mostly depend upon the temporal and spatial variation of rainfall, and variety of physical factors. Larval densities and presence of different species in different kinds of larval habitats are depend on the size of habitats, vegetation cover and shading of the habitat, water quality and depth of water bodies. Each habitat position should be recorded with hand held GPS or mobile phone application. The extensive mapping of breeding sites provides information on targeted sites that generate adult vectors. In addition, it also served as an indicator of risk of malaria transmission.

5.0 Entomological Staffing Pattern

Entomological data gathered in surveys can be regarded as reliable and acceptable only when they have been done by a qualified entomological staff under the direct competent supervision.

Entomological surveys are carried out by the trained entomological teams attached to the Regional Malaria Offices and Anti Malaria Campaign Headquarters.

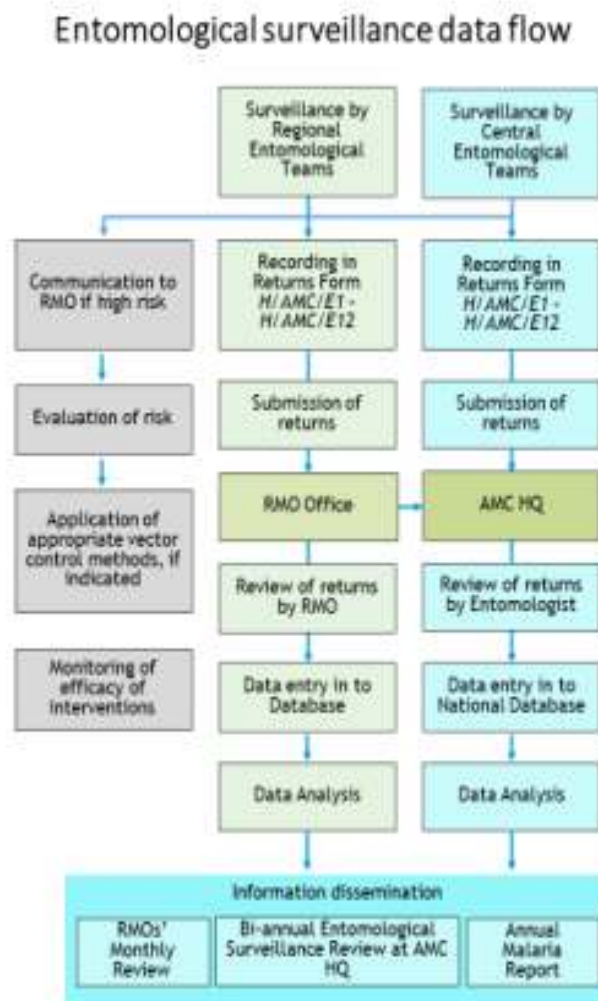
Composition of malaria entomological team

The number of members in an entomological team is eight for the regional teams and it is usually comprised of one or two Health Entomology Officers (HEO), 01 or 02 Public Health Field Officer (PHFO), five junior category staff including spray machine operators (SMO)/Health Assistants(HA)and a driver. Health Entomology Officer is the team leader and he/she is responsible for performing the techniques according to the SOPs and the guidelines and reporting.

6.0 Reporting

The entomological data collected through the different types of surveys are to be used for decision making and the data are to be stored at regional and HQ level as hard copies and soft copies. They should be presented in monthly reviews, semi-annual reviews and annual reports.

Figure 2. Entomological surveillance data flow in Anti Malaria Campaign.



6.1 Reporting deadlines

Reactive surveys

Findings of the survey should be communicated to RMO by respective Health Entomology Officer in charge of the team on daily basis and RMO should communicate AMC HQ regarding important findings immediately over the phone with Entomologists and the technical staff of AMC HQ. Final report should be submitted to the RMO by respective Health Entomology Officer in charge of the team immediately-after completion of the survey. RMO should send the final report via fax or email to Entomologists of AMC HQ immediately. A hard copy of each data set is to be forwarded to the Anti Malaria campaign Headquarters via post.

Proactive surveys

To be submitted to RMO within 3 days after completion of survey; To be submitted to AMC HQ within 10 days after completion of the survey.

Sentinel entomological surveillance

To be submitted to RMO within 3 days after completion of survey; To be submitted to AMC HQ within 10 days after completion of the survey.

Annex 1

Baseline Receptivity Measuring Guide: Apply this for relevant GN Division level and apply for the vulnerable areas

Serial Number	Factor	Possible Scenario	Weightage
1	Presence of potential breeding places of primary vector as identified by RMO for the region based on past data, seasonality and classical breeding sites of primary vector.	Present Absent	2 0
2	Discovery of the primary vector**	Larva Adult	4 4
3	Discovery of the secondary vectors**	Larva Adult	1 1
4	Presence of Human biting behavior	Primary vector Secondary vectors	5 2
5	Presence of parous mosquitoes	Primary vector Secondary vectors	4 2
6	Being a previous malaria endemic area	Yes No	1 0
7	Presence of developmental projects creating more breeding sites	Yes No	1 0

****Primary vector – *Anopheles culicifacies***

*****Secondary vectors-*Anopheles subpictus*, *Anopheles annularis*, *Anopheles varuna*, *Anopheles vagus* and *Anopheles tessellatus***

- *Time period considered is past three years*

Special instructions to be considered:

- If infective *Anopheles* are detected receptivity categorization should be ‘High’ regardless of the other factors.
- If life stages (larva or adult) of *Anopheles stephensi* are detected receptivity categorization should be ‘High’ regardless of other factors.
- If more than one possible scenario are present take all of them for weightage.

Score	Level of Receptivity
< 3	Low
3-9	Moderate
> 9	High

Annex 2. Vulnerability Guide: Apply this for GN level

Serial Number	FACTORS	Possible scenario	Weightage
1	No of imported malaria cases in the previous 3years	detected within one year detected within past 2 years detected within past 3 years	4 per case 3 per case 2 per case
2	Locality with high risk of importing malaria	<ul style="list-style-type: none"> ● Ports of entries 2 ● Illegal Entry routes 2 ● Tourist areas with outdoor night time activities , 2 ● Other tourist areas 1 ● Asylum camps 1 ● Detention Camp 1 ● Institutes having Students/researchers from endemic countries 1 ● Re- settlement areas with Sri Lankan returnees from endemic countries within 1 year 2 ● Camps for security forces with travel to malaria endemic countries 1 ● Factories which transfer labour within malaria endemic countries 1 	
3	Presence of immigrants population from malaria endemic countries.	<ul style="list-style-type: none"> ● Illegal fishermen, agricultural workers from India etc 3 ● Legal - Foreign workers including construction workers, migrants with Tourist visa foreigners 2 	

		<p>coming for business/entertainment</p> <ul style="list-style-type: none"> For any risk group the duration of stay is more than 3 months stay or frequent travelers to malaria endemic countries or frequent turn over. Aggregation of high risk groups 	<p>add 1 each to the relevant category</p> <p>1 for 2- 10 persons, 2 for 10-30, 3 for more than 30</p>
4	Local people working in malaria endemic countries	<ul style="list-style-type: none"> Gem traders/miners Businessmen UN peace keeping missions Other workers (1) <p>above points per person should be doubled if chemoprophylaxis not given.</p>	<p>2</p> <p>1</p> <p>1</p> <p>1</p> <p>Maximum 4 points</p>
5	Local people returning from malaria endemic countries such as pilgrims, returnees from safaris, tourists, students/trainees, travellers attending functions/seminars within one year	<ul style="list-style-type: none"> people not given chemoprophylaxis for people with chemoprophylaxis 	<p>1 per person</p> <p>0.5 per person</p>
6	Localities at close proximity to India- Risk of importing infected mosquitoes	Coastal borders with anchorage facilities	2

*Previously malaria endemic area – Dry and intermediate zones

Within the endemic countries some provinces/regions having high malaria endemicity that too should be considered when deciding the vulnerability.

Score	Level of vulnerability
< 3.0	Low
3-5	Moderate
> 5	High

Annex 3. Entomological Surveillance for *Anopheles stephensi*

- Entomological surveillance plan should be developed and implemented for *An. stephensi* by the RMO with coordination of the entomologist of the district in consultation with AMC HQ.
- Carry out entomological surveys comprise of larval surveys of all potential mosquito breeding sites covering following areas of the region including;
 - Urban/ town areas with abundance of wells, over head tanks/ ground tanks and other water storage containers.
 - Transportation hubs eg: main bus/railway stations (especially stations where buses/trains coming from *An.stephensi* positive regions).
 - Areas with sea and coastal entries, fishing harbours and air ports.
- If a locality found as positive for *An. stephensi*, the locality should be considered for a possible extended routine sentinel site, according to the existing Guideline on Entomological Surveillance.

Data formats and reporting

- Record the entomological findings in entomology formats.