

## **RBM Vector Control Working Group**

### **Larval Source Management Work Stream**

#### **Progress Against 2011 Work Plan – Prof. Steve Lindsay**

Professor Lindsay presented the Larval Source Management (LSM) work stream progress in 2011, including a work stream meeting held at the American Society of Tropical Medicine and Hygiene, in Philadelphia, USA. The meeting covered the following:

- Historical use of LSM
- Cochrane Review of LSM
- Role of LSM in malaria control today
- Presentation of the draft WHO position statement on larviciding
- Group discussion of the WHO position statement

The ASTMH meeting concluded that the draft WHO position statement needed more work to take into account contextual differences (e.g. where the breeding sites were “*Few, Fixed and Findable*”) to reflect existing evidence for the efficacy and cost-effectiveness of LSM; countries need technical guidance on determining if LSM has the potential to play a complementary role in their overall malaria vector control efforts, and if so, technical guidance on implementation and evaluation. There is a need for tools to support: a) evidence-based decision making related to LSM b) good management of LSM initiatives and c) quality control of larval control products. There is evidence that in some situations LSM has an impact. The Cochrane Review of LSM revealed a 69% reduction in incidence (in the six eligible studies with data), a 75% reduction in parasite prevalence (in six studies), but no evidence for reduction in spleen rates (three studies). Entomological analysis is currently being finalized and the draft will be submitted to Cochrane Group by end February 2012.

The other three deliverables have all been postponed until 1<sup>st</sup> Quarter 2012: the decision-making framework for LSM, development of the template on country case studies, and development of an operational manual on LSM.

#### *Discussion*

Discussions on the potential role of LSM in malaria control led to a consensus that it is not to be recommended as a stand-alone intervention, but can potentially play a role in specific ecological circumstances to address persistent transmission ‘hot-spots’ during the elimination phase, including through aerial application of larvicides. LSM could also potentially aid in combating both physiological and behavioural resistance.

The suitability of the Cochrane methodology for evaluating community protection interventions such as IRS and LSM was questioned. While it was agreed that the methods are not optimally suited to these types of intervention, from a policy-makers’ perspective a Cochrane review carries a lot of influence and may be the only acceptable option. It was suggested that there is nothing in the Cochrane review methodology that prevents the examination of long-term mass effects, but the types of trials required are likely to be very expensive. It was acknowledged that before significant investment is committed to LSM, we need evidence on cost per DALYs averted. Also, because LSM is primarily a complementary intervention, its impact needs to be evaluated in terms of the additive

effect and cost-effectiveness on top of the primary interventions. It was noted that despite a lack of solid evidence in many situations, some countries are already planning to implement large-scale larviciding operations and therefore require guidance.

Several brief examples of the successful use of LSM were discussed, including those in urban areas in Dar es Salaam, Tanzania and Khartoum, Sudan.

A proposal was made that the WHO “Manual on environmental management for mosquito control, with special emphasis on malaria vectors” (1982) and the “Manual on larval control operations in malaria programmes” (1972) be revised and updated.

**3rd Larval Source Management Work Stream Meeting  
Tuesday 7th February 2012  
IFRC Salle V, Geneva, 13:00-15:00**

**Leader: Prof. Steven Lindsay  
Rapporteurs: Ms Lucy Tusting & Dr. John Silver**

***Summary of 2nd Meeting, Philadelphia, December 2011 – Prof. Steve Lindsay (LSHTM)***

Steve Lindsay briefly summarised the main conclusions of the 2<sup>nd</sup> meeting.

***Cochrane Review of LSM for Malaria Control – Ms Lucy Tusting (LSHTM)***

Lucy Tusting gave an update on the Cochrane Review, the objective of which is to compare mosquito larval source management (excluding biological control with fish) for malaria control with no larval source management, applied either alone or in combination with other malaria control interventions. 13 studies are eligible for inclusion in the final analysis. There is evidence that LSM is associated with a 69% reduction in incidence (95%CI 58-77% (in six studies) and a 75% reduction in prevalence of parasitaemia (95%CI 49-88%) (six studies). There is no evidence for a significant reduction in prevalence of splenomegaly (three studies). Due to unreported data, meta-analysis is not possible for the following entomological outcomes: EIR, human biting rate, density of adult anophelines.

Preliminary conclusions are that LSM reduces morbidity from malaria where breeding sites are fixed, discrete and easily identifiable; therefore, in some settings LSM may complement other methods of vector control in malaria control and elimination programmes. However LSM requires major financial, technical, and operational inputs. The main limitation of the review is the lack of well-conducted trials. Participants were requested to help contact study authors to collect further data. The final steps are to finalise the entomology data, submit a draft review (end February 2012), update the search and submit for final review. The authors are: John Gimnig (CDC), Julie Thwing (CDC), Steve Lindsay (LSHTM), Ulrike Fillinger (LSHTM), Lucy Tusting (LSHTM), Kimberly Bonner (CDC), Rob Newman (WHO) and Christian Bottomley (LSHTM).

***2011/2012 Work Stream Deliverables – Prof. Steve Lindsay (LSHTM) and Dr. Shiva Murugasampillay (WHO)***

The Work Stream was allocated funding from RBM for four 2011 deliverables:

- a. 2<sup>nd</sup> meeting at ASTMH, Philadelphia, December 2011
- b. Decision-making framework for deciding if LSM should be used
- c. Country case-studies on LSM
- d. Operational manual on LSM

The first task was completed in December 2011. The completion date for the remaining three has been postponed (with agreement from RBM) until the end of April 2012, to allow the results of the Cochrane Review to be taken into account. Steve Lindsay and Shiva Murugasampillay presented draft structures for these three deliverables to gain input from the Work Stream.

### **Decision-Making Framework**

The decision-making framework will be a booklet designed for program managers to assist in decision-making on whether LSM should be considered for vector control. A possible template for this would be the Insecticide Resistance Action Committee (IRAC) 2011 publication 'Prevention and Management of Insecticide Resistance in Vectors of Public Health Importance'. The following structure was proposed:

- What is LSM?
- Evidence for efficacy
- Economics of LSM
- Minimum requirements before embarking on LSM
- Where to do LSM and where not to
- When to start LSM and when to stop
- What's needed for implementation
- What's needed for monitoring
- Role in IVM

### *Discussion*

The following were considered by participants to be important: (1) basic product characteristics, (2) an emphasis that this handbook is only for malaria and (3) differentiation between urban and rural. It was also suggested that advice on the selection of methods and materials for LSM (e.g. environmental modification vs larviciding) could be included. The framework should also describe how LSM can be integrated into general city improvements and emphasise that LSM is not a standalone intervention. The framework could highlight where there is likely to be the greatest need for LSM, i.e. locations where LLINs and IRS have reached their maximum practical effect and in situations where LLINs and IRS are insufficient. As malaria declines, LSM will play a role in targeting 'hot spots' of transmission. LSM should be integrated into the control of other insects and disease vectors. Participants also noted that outdoor transmission is significant in some places; the community must take charge of LSM in the context of IVM because the old, colonial vertical style of management no longer has a place; and local ecology is very important in deciding where LSM is appropriate.

Participants were informed that with regards to the WHO position statement, around 100 people were consulted, of which around 50 replied. Comments have been taken into account and the latest draft is very different to previous drafts. The position statement originated from the position that the question was not whether or not LSM is appropriate, but a question of where it is and is not indicated. These areas need to be conservatively described. It is generally agreed that LSM will be most effective where breeding sites are few, fixed and findable, but it is not yet clear how best to identify these areas. However LSM is likely appropriate in urban and highly arid areas. The latest draft has also evolved to focus on larviciding and Africa only, due to the huge diversity of vector species worldwide.

The suggestion of extracting data from the studies rejected for the Cochrane review is considered useful in this respect.

It was noted that because larvicides constitute a wide range of substances they may therefore be a useful tool for the management of insecticide resistance. It was noted that when deciding where LSM should be conducted, whether or not it will work is a more important factor than whether or not there is a need due to factors such as insecticide resistance.

Caution was advised when considering whether or not to set up a LSM program. It would be sensible to begin LSM in country by building up infrastructure for LSM in urban areas, where LSM will more likely be effective but where there is not necessarily high malaria transmission or a resistance problem.

### **Case-Studies**

These will be exemplars of what it takes to run a successful LSM program for those interested in establishing a LSM program. The following locations were suggested: (1) Malindi, Kenya, (2) Dar-es-Salaam, Tanzania, (3) Zambia and (4) India (LSM in Urban MCP). The case-studies could have the following structure:

1. **Background:** topography, climate, urban or rural, primary and secondary vectors, main type of breeding sites, local health system
2. **Description of intervention:** baseline mapping, type of LSM, frequency and duration of application, structure of program, funding, community involvement
3. **Data on co-interventions:** e.g. coverage with LLINs, MDA
4. **Effect of intervention:** baseline and post-intervention data on human clinical and entomological outcomes

Other case studies suggested by the Work Stream were (1) Mauritius, (2) winter larviciding in Swaziland, (3) Niger, (4) dengue in South America, (5) the Amazon, (6) Angola, (7) Nigeria, (8) Cape Verde, (9) Oman.

### ***LSM in Khartoum, Sudan – Mr Hmooda Toto Kafy (NMCP)***

Hmooda Toto Kafy gave a presentation on the LSM program in Khartoum, Sudan, the aim of which is to reduce parasite prevalence in the city (population 6m) to less than 0.1%. The LSM program has significant community participation and political support and an annual budget of US\$600,000. It relies on the repair of broken water pipes, removal of water basins by law, environmental management, biological control with *Gambusia* fish, use of intermittent irrigation and clearance of irrigation canals. It has had a significant impact and parasite prevalence declined from 7.8% to 0.4% between 1995 and 2008, alongside a reduction in the incidence of reported malaria.

### ***Discussion***

It was suggested that in the programme described, nuisance biting by *Culex* mosquitoes may be driving community involvement.

A participant noted the similarities with the Chagas elimination program in South America

It was pointed out that if the target population is 6m, and the annual cost is US\$600,000, then the program has a low annual cost per person (US\$1).

Participants were informed that amongst the responses to the position statement, it was interesting to see that of those in favour of LSM, some thought community support was important while others thought the community cannot be relied upon to target LSM in the right place.

A proposal to post a YouTube video of the Khartoum presentation was made.

### Operational Manual

Shiva Murugasampillay presented a draft outline of the operational manual, which will be a complete toolkit for program managers, detailing what is required for LSM. The distinction was made between policy (what should be done and why) and operational guidance (how LSM should be conducted and to what coverage and standard). Since LSM is already being conducted on a large scale, this operational manual will help ensure that it is done efficiently and of the right coverage and quality.

The purpose of the manual is to provide step-by-step operational guidance on the overall management of an LSM programme, together with practical guidance on larvicide application and environmental manipulation and modification, to enable national programmes to:

- develop or refine strategies and operational tactics;
- develop or update training materials;
- conduct LSM programmes;
- review coverage, quality and impact of LSM programmes.

The manual will have the following chapters:

- i. Introduction
- ii. Chapter 1 (POLICY): objectives, indicators, outcomes and impact (policy, strategy and standards) - for national policy makers and programme managers.
- iii. Chapter 2 (MANAGEMENT): LSM program planning, organization and management, including stewardship and safe use of larvicides - for both national programme managers and district LSM coordinators.
- iv. Chapter 3 (IMPLEMENTATION): application guidelines - mainly for district LSM coordinators, supervisors and field team leaders.

The suggested content for the chapters was as follows:

#### Introduction

(1) Malaria control and elimination, (2) vector control for malaria control, (3) vector control for other vector borne diseases, (4) vector control for mosquito control, (5) integrated vector management, (6) urban malaria control, (7) larval source management for malaria control & elimination, other vector borne diseases and mosquito control .

It would be logical to use previous WHO manuals on environmental management to avoid replicating work [e.g. WHO (1982) Manual on Environmental Management for Mosquito Control; Lindsay, S. W. et al (2004) Environmental management for malaria control in the East Asia and Pacific (EAP) Region]. Old documents on insecticide resistance could also be added as annexes.

It was noted that a fundamental issue is whether or not this manual will focus on 'mosquito abatement' or 'anopheline mosquito control' and it was pointed out that in urban settings it is not possible to conduct anopheline control alone. It is necessary to target culicines also, since the local population will not understand the difference between species. It was also suggested that the manual

should not focus on general mosquito abatement or the reduction of nuisance biting, but simply highlight these as issues.

Participants suggested the following for inclusion / reflection in the manual: a Programmatic Environmental Assessment of larvicides; importance of political support; importance of monitoring; importance of community compliance, especially when water treatment, for example, is involved; some discussion of environmental regulations; the role of LSM in managing insecticide resistance; more detail on different vector species.

It was suggested that the order of the three main chapters could be reversed and monitoring methods added to the end of each.

A question was raised as to why LSM in rural areas is not included. In response, it was noted that the evidence for the efficacy of LSM is questionable in rural areas; however, there are some examples of LSM being appropriate in rural areas. It is sensible to begin LSM programs only where they will be most effective i.e. urban areas. The manual could have a chapter on rural LSM.

#### Chapter 1 - Policy

(1) definitions of LSM, (2) mosquito life cycle and morphological features of target larvae, (3) goals and objectives of LSM, (4) performance framework with indicators on input, process, output, outcome, (5) evidence base for integration of LSM (vector ecology, malaria transmission ecology, physical environment, demographics, economics, health system and national program capacity), (6) decision making for LSM (why, where, when, operational synergies with other interventions such as IRS and LLIN, role in urban areas).

The use of a ratio measure, e.g. population per breeding site (i.e. the more people per breeding site, the more cost-effective LSM will be) would be a useful addition. High population density was important in the success of the rural Kenya study [Fillinger et al 2009. Integrated malaria vector control with microbial larvicides and insecticide-treated nets in western Kenya: a controlled trial. Bull WHO 87:655-665]. However there is not yet a rule of thumb for this. One possible rule of thumb might be that LSM will be most effective in areas of high population density (i.e. urban areas).

The operational strategy for LSM needs to be laid out in this chapter.

#### Chapter 2 - Planning and Management

- Situation analysis and baseline surveys
  - Adult anopheline surveys
  - Larval surveys: identification and mapping of water bodies and larval breeding sites (GPS, GR); larval sampling methods (location, access, size-hectare, number and productivity)
  - Epidemiological survey
  - Mapping population at risk: density and distribution of households and related human activity
  - Establishing a database
- Selection of target areas for LSM (large scale or limited)
- Selection of LSM methods and tools, application equipment
- Planning, organization and delivery of LSM programs
- Inter-sectoral collaboration – links with local government, agriculture department, etc
- IEC and community mobilization (communities & schools)
- Recording, reporting and monitoring and evaluation

The advantages of aerial application could be added to this chapter. The importance of sensitisation of the local community should be emphasised (IEC). Political commitment is also important because it is required for inter-sectoral collaboration.

It was suggested that a short and accessible SOP of 'how to do LSM' is necessary to prevent the manual becoming too long.

### Chapter 3 – Implementation

- Step 1. Finding and recording larval source habitats
- Step 2. Reporting on pre-management larval and adult surveys
- Step 3. Community information, education and mobilization
- Step 4. Prioritizing habitats for modification and manipulation
- Step 5. Treating larval source habitats
- Step 6. Reporting on habitats modified, manipulated or treated
- Step 7. Reporting on post-management larval and adult surveys

### *Discussion*

It was suggested that specific technical details must be documented in this chapter for different larvae species e.g. type of larvicide, frequency of application. It must also be stated that supervisors must check sites post treatment. However, it was also felt that the manual should be fairly general because vector species are so variable. Due to the complexity involved in the selection of control materials and tools, this section needs to be reviewed in great detail. It was noted that a program manager considering buying a product would not seek advice from a long RBM document, but instead would want shorter term, shorter documents on specific products from WHO, and this was suggested as a role for WHOPES; however, it was noted that WHOPES will not recommend specific products for purchase, it will simply test products. It was felt that the manual must still recommend products recommended by WHOPES. The importance of emphasizing data collection and operational reporting in the document was acknowledged; however, it was noted that attempts to collect data from countries using a standardised form on LSM activities in 2011 were not fruitful. This data would be very useful if it could be collected because it is not currently clear what is being done in different countries.

A first draft of the operational manual should be ready by the end of April.

### Bibliography

Cochrane review, WHO documents, country documents, private sector documents, LSM pilots and case studies

### Annexes

Sample larval survey forms, larval treatment forms, LSM supervision check list

The following will be consulted in the drafting of the manual: country programs, WHO teams, research and academic institutions and the private sector.

**The following volunteered or were nominated to contribute to the manual:**

### Introduction

- Lucy Tusting (LSHTM)
- Rose Peter (Arysta Life Science / Nexvet)
- Steve Lindsay (LSHTM)

### Chapter 1 – policy

Charles Mbogo (KEMRI)  
Chioma Amajoh (Ministry of Health, Nigeria)  
Shiva Murugasampillay (WHO)

### Chapter 2 – planning and management

Aramis Martinex Arias (Labiofam)  
Chiomah Amajoh (Ministry of Health, Nigeria)  
Norbert Becker (German Mosquito Control Association)  
Steve Lindsay (LSHTM) (standard operating procedure)  
Ulrike Fillinger (volunteered by Steve Lindsay)  
(Michael Macdonald also suggested partners from US mosquito abatement)

### Chapter 3 – Implementation

Egon Weinmueller (BASF)  
Hmooda Toto Kafy (NMCP, Sudan)  
Jacob Williams (RTI)  
Peter DeChant (VBC)

Steve Lindsay thanked all participants. The date of next meeting is to be decided.

### ***Final Conclusions and Summary – Mr Hmooda Toto Kafy***

#### *Discussions*

- Cochrane review update. Results indicate that LSM can reduce morbidity where breeding sites are fixed, discrete and identifiable
- Update on LSM programme in Khartoum. LSM associated with a reduction in parasite prevalence from 7.8% to 0.4%. Full results to be documented and published

### **Actions and 2012 Work Plan**

1. Booklet to support decision-making on use of LSM for NMCPs and NGOs. Additional contents suggested by work stream members: Selection of methodologies and materials for LSM, integration of LSM into other sectors (e.g. city improvements), role of LSM in targeting hot spots and in managing resistance, importance of community
2. Country case studies on LSM. Proposed: Malindi (Kenya), Dar-es-Salaam (Tanzania), Zambia, India. Additional suggestions from work stream: Mauritius, Swaziland, Cameroon, Niger, Amazon, Cape Verde
3. Operational manual on LSM for programme managers (lead: Shiva Murugasampillay)

## Agenda

13.00-13.15	Welcome	Steve Lindsay
	Main points from 2nd Meeting, ASTMH	
13.15-13.30	Update on Cochrane Review	Lucy Tusting
13.30-13.45	2012 plan of work	Steve Lindsay
	Decision-making framework	
	Country case-studies	
13.45-14.00	Operational manual	Shiva Murugasampillay
14.00-15.00	Discussion	Led by Steve Lindsay

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