LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Larval Source Management

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What is Larval Source Management (LSM)?

Habitat modification

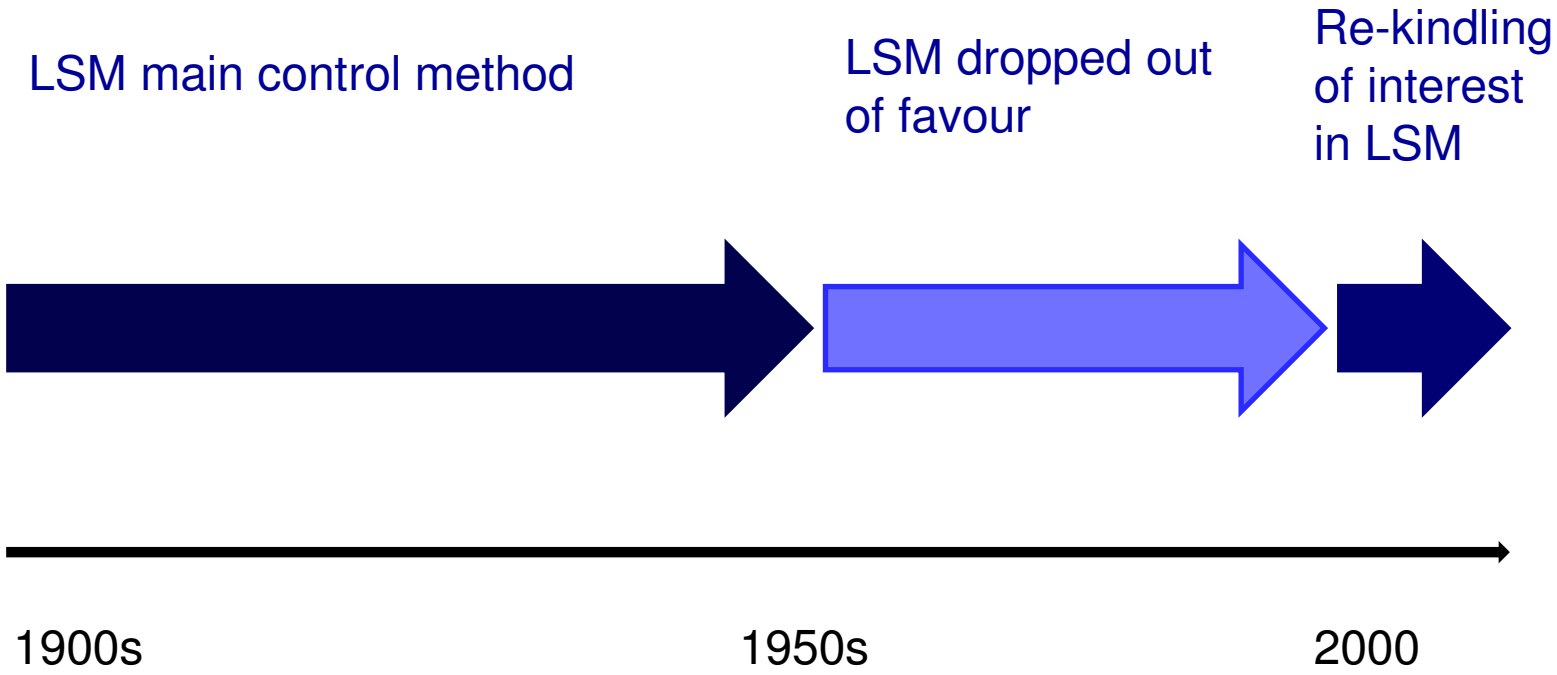
- **habitat modification** (permanent change) e.g. drainage
- **habitat manipulation** (recurrent activity) e.g. flushing
- **biological control** e.g. fish
- **larviciding**, either chemical or microbial

Historical successes

Larviciding in Brazil

- Eradication of *An. gambiae* from Brazil;
- Eradication of *An. gambiae* from Upper Egypt;
- Eradication of malaria from Sardinia;
- Essential component of the Onchocerciasis Control Programme.

LSM timeline



Present successes

Bti application by helicopter

- Larval control routinely carried out on the River Rhine
- Larval control used for mosquito abatement in large parts of the USA

Larval control studies in Africa

Gambia River

Western Highlands

Dar es Salaam City

Microbial larvicides for malaria control

Microbial larvicide application

- *Bacillus thuringiensis* var. *Israelensis* or *B. sphaericus*
- Safe to humans
- Only kills mosquito larvae
- Developed by WHO

Larval control in Western Highlands, Kenya

Entomology

Valley	Late instars (larvae/dip)	Adult vector abundance (adults/ house)	Entomological inoculation rate
Baseline period (no intervention)			
No larviciding group	0.19	3.69	12.0
Larviciding group	0.26	3.49	10.3
Intervention period			
No larviciding group	0.21	0.60	1.7
Larviciding group	0.02	0.08	0.4
% reduction	**90%***	**87%***	**76%***

*P <0.001

Fillinger *et al.* (2009) *Bull. WHO* **87,** 655-665.

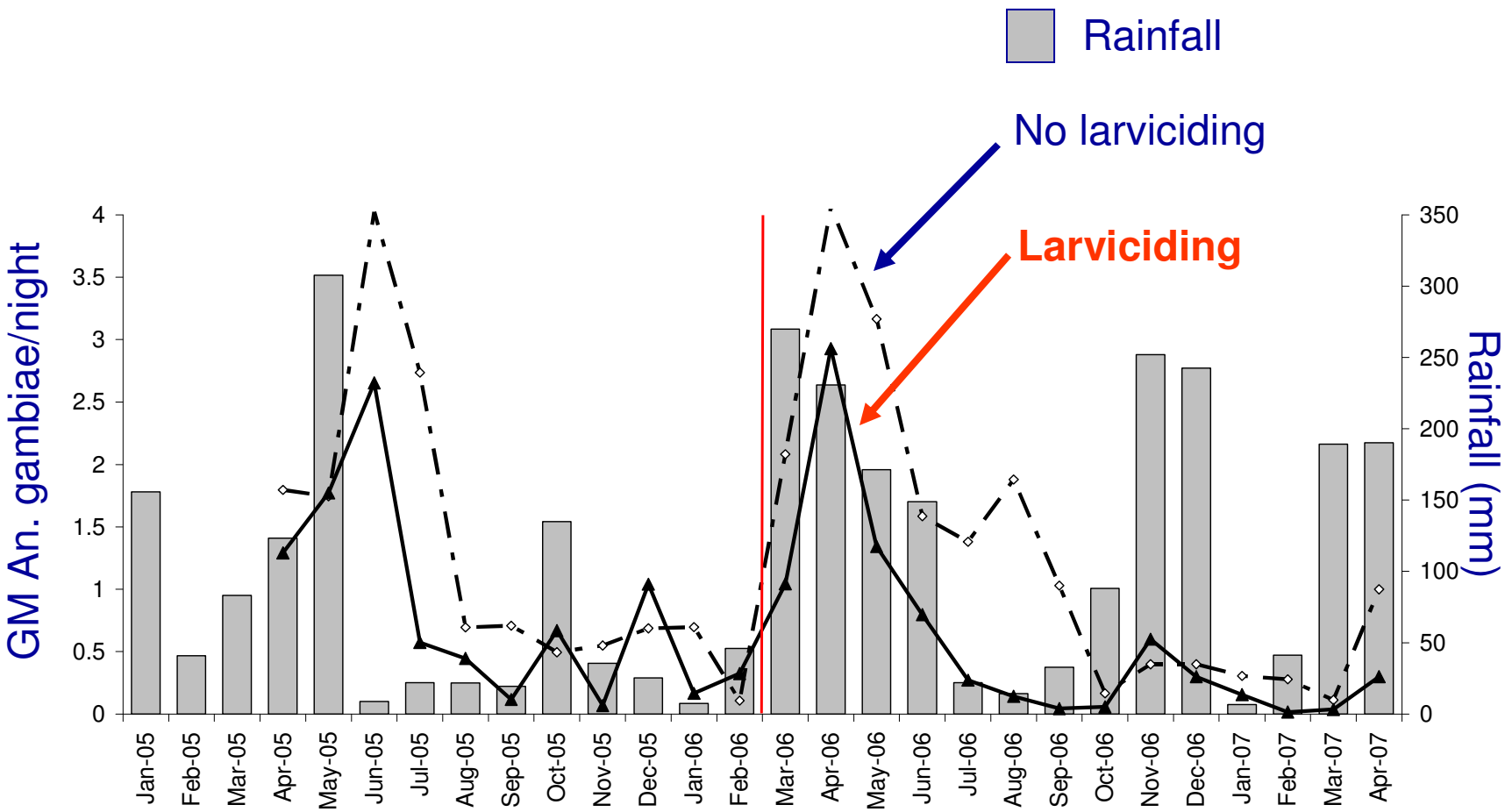
Incidence of new parasite infections in children

Factor	n	Odds ratio (95% CIs)	*P*
ITN use			
No	4773	1.00	
Yes	1592	0.69 (0.48-0.99)	0.047
Larviciding			
No	4890	1.00	
Yes	1475	0.44 (0.23-0.82)	0.010

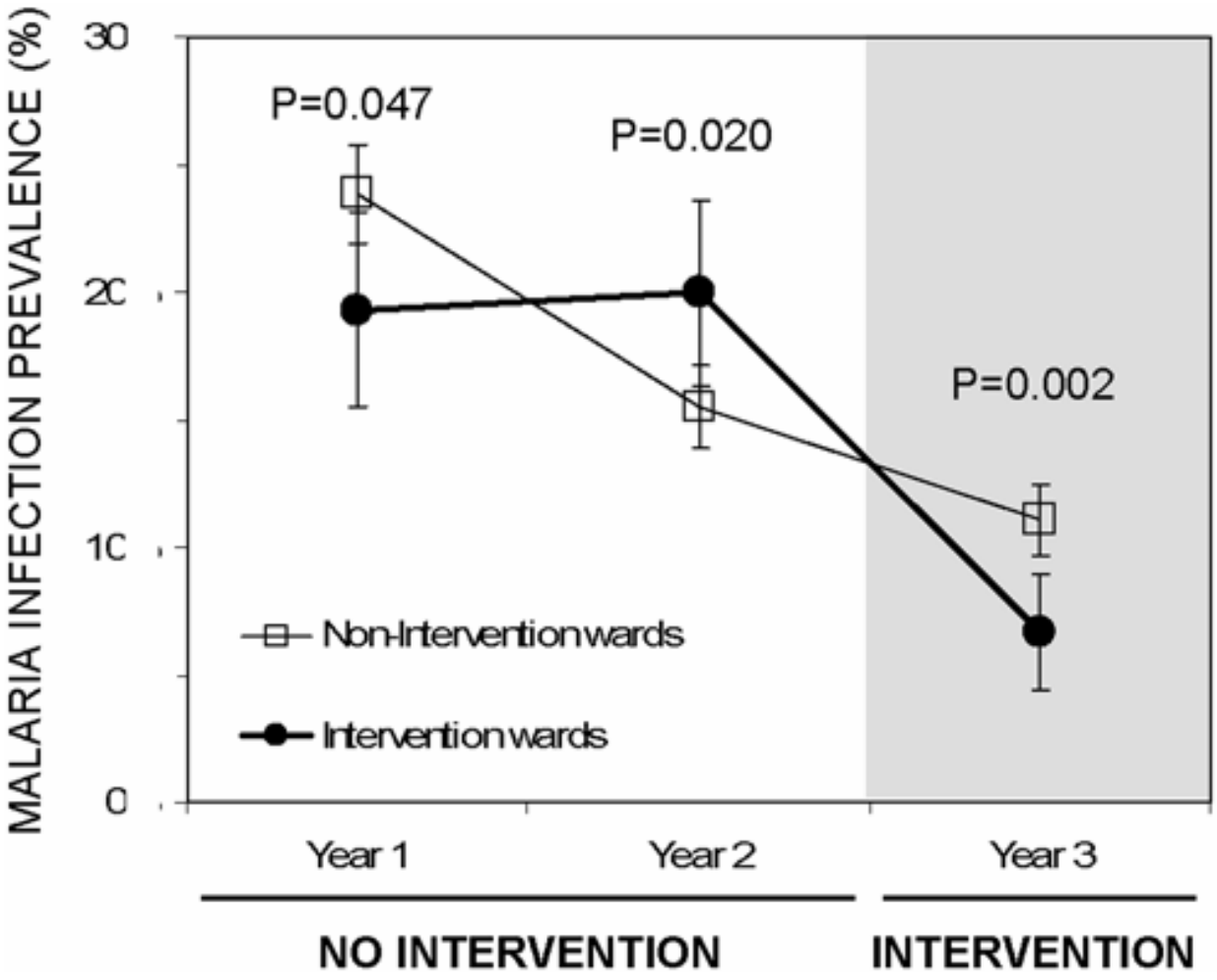
Fillinger *et al.* (2009) *Bull. WHO* **87,** 655-665.

Larval control in Dar es Salaam City,Tanzania

Anopheles adults



Prevalence of malaria infection in children



Geissbühler *et al* (2009) *PLoS ONE* **49,** e5107

Summary

- EIR reduced by 32%
- Peak reduction in EIR 65%
- Larviciding reduced malaria infection by 72%
- Insecticide-treated nets reduced infection by 24%
- Larviciding & nets together will reduce malaria even more

...and now the cautionary note.

Larval control in The Gambia

Entomological findings

- **92% reduction in anopheline larvae**

(Odds ratio = 0.08, 95% CIs = 0.06-0.10, p <0.001);

- **91% reduction in late stage larvae**

(OR = 0.09, 0.05-0.16, p<0.001);

- **28% reduction in adult vectors**

(OR = 0.72, 0.56-0.91, p = 0.005);

- Larviciding in areas of extensive flooded habitats had a small impact on adult mosquito densities and had little, if any, impact on malaria transmission

Majambere et al. (2010) *AJTMH* **82,** 176-184

Clinical findings

- No reduction in clinical malaria or anaemia

Summary

Site	Habitat	Anopheline larvae	Anopheline adults	Parasite prevalence
Mbita, Kenya	Rural town	**99% ↓**	**93% ↓**	Not done
Eritrea	Semi-arid	**73% ↓**	**>50% ↓**	Not done
Mwea, Kenya	Rice paddies	↓ unpublished	Not known	Not done
The Gambia	River floodplains	**88% ↓**	32-52% ↓	No reduction
W. Highlands Kenya	Highlands	**90% ↓**	**75% ↓**	**50%↓**
Dar es Salaam, Tz.	Urban	**96% ↓**	**>>30% ↓**	**43% ↓**

***P* <0.001**

Conclusions

- Larval control by hand application will not work in areas of extensive flooding e.g. floodplains or large-scale irrigated rice
- Larval control can reduce anopheline larvae by >90%
- It can also reduce transmission by 35-75%
- Findings suggest that prevalence of infection in children can be reduced by ≈ 50%
- NB. ITNs have a protective efficacy against parasite prevalence of just 13% (Lengeler 2007 Cochrane Collaboration, Wiley)
- Great potential to use LSM (larviciding and breeding site reduction) in combination with other anti-vector methods
- Integrated vector management seen as the future

Crucially we will never have the same evidence of efficacy that one would have with an antimalarial or a vaccine since this is an environmental intervention where we randomise by area, not individual.

Here the justification for LSM is based largely on the historical success of interventions – as is the case for IRS

Potential uses of LSM

- Adds improved control when combined with LLINs and/or IRS
- Tool for insecticide resistance management
- Effective for reducing biting by exophilic vectors
- May be particularly beneficial for malaria elimination – for removing 'hot spots'
- Aerial application may be appropriate for elimination in areas with extensive water bodies
- Effective in areas of seasonal transmission, relatively few and well-defined, where habitats are accessible by ground crews, and in cooler parts of Africa where larval development is prolonged

Building the evidence

- Cochrane review on fish – *Tom Burkot*
- Cochrane review on LSM (not fish) – *Thwing, Gimnig, Newman, Fillinger & Lindsay*
- WHO review on global use of LSM
- Updated review on LSM – *Lindsay & Fillinger*

Expansion of LSM – for discussion tomorrow

- Support for NMCPs that are considering or are using LSM
- Monitoring & evaluation of LSM programmes
- Training courses on LSM
- Refinement of where and when to use LSM
- Assessment of different a.i.s & formulations
- Financial support for these activities

Summary

- Historical evidence for LSM success
- Recent evidence confirms success in well-defined habitats
- Need to build momentum & develop the evidence
- Where next? Needs to be discussed