

# Evaluating agreement between counting methods: Documentation of Winbugs code TRAPMETH.ODC\* applied to the calibration of different trapping methods for mosquitoes

**Tom Smith**

Swiss Tropical Institute Department of Public Health & Epidemiology

Socinstrasse 57 Tel +41-61-284 8273

P.O . Box Fax +41-61-271 7951

CH-4002 Basel Telex 962508

Switzerland

email: Thomas-A.Smith@unibas.ch

<http://www.sti.unibas.ch/biomet.htm>

## Introduction

In general, the problem of evaluating agreement between different measurement techniques can be addressed using plots of differences between pairs of measurements against averages of the two methods (Altman & Bland, 1983). This approach has been applied to logarithmically transformed mosquito collection data (Lines *et al*, 1991, Mbogo *et al.*, 1993, Davis *et al*, 1995), but must be modified if it is to allow for zero counts of mosquitoes. The simple expedient of adding one to each count can be misleading (Smith, 1995), and we therefore propose a regression based method.

This method has been used to examine the relationships between light trap catches and landing catches in Papua New Guinea (Hii *et al*, 2000). It makes use of software written in *Winbugs* and provided in the accompanying file TRAPMETH.ODC. The present document describes this method. It does not aim to provide any assistance with running *Winbugs*, which is a free software package available from the MRC Biostatistics Unit, Cambridge, UK (<http://www.mrc-bsu.cam.ac.uk/bugs/>).

## Statistical Models

Random sampling of a homogeneous population of mosquitoes would give a Poisson distribution of counts (in which the variance is equal to the mean). In addition to this random sampling variation, however, mosquito counts vary considerably as a result of differences in underlying densities and therefore the observed variance in recorded mosquito numbers typically greater than the mean (overdispersion). One modelling approach is therefore to assume the counts to be distributed according to a negative binomial distribution. Negative binomial distributions have been extensively used to model densities of insects. The negative binomial can be parameterised as a gamma mixture of Poisson distributions and we use this idea of a mixture of Poissons to model agreement between sampling methods.

We assume that at each sampling point,  $i$ , there is a single replicate of measurements made with the first method, giving a count,  $x_i$  and multiple replicates of measurements made with the second method  $y_{ij}$  ( $j=1,2,3,\dots$ ).

The values of  $x_i$  are assumed to be generated from an underlying distribution of densities (gamma or log normal), taking a distinct value,  $E(x_i)$ , for each matched set,  $i$ . i.e:

$$E(x_i) \sim \text{Gamma}(a_0, a_1) \quad \text{or} \quad \log(E(x_i)) \sim \text{Normal}(\mu, s^2) \quad (1)$$

where  $a_0$ ,  $a_1$ ,  $\mu$ , and  $s^2$  are unknown parameters of the distributions of  $E(x_i)$ .

We further propose that the sampling variation about  $E(x_i)$  was Poisson, i.e:

$$x_i \sim \text{Poisson}(E(x_i)) \quad (2)$$

Where  $E(x_i)$  was taken to be gamma, the counts are thus modelled as negative binomial. The assumption of a log normal distribution generally gives very similar values of  $E(x_i)$ . In both cases the model handles zero counts naturally, with  $x_i=0$  arising with probability  $\exp(-E(x_i))$ .

We propose two distinct models for  $y_{ij}$ , the numbers of mosquitoes caught in the light traps corresponding to landing catch  $i$ :

(i) **A model assuming proportionality**, i.e.

$$E(y_i) = \beta_0 E(x_i) \quad (3)$$

(ii) **A model allowing for a curvilinear relationship** between the number of mosquitoes caught using the different methods.

$$E(y_i) = \beta_1 E(x_i)^{\beta_2} \quad (4)$$

In both cases, we assume:

$$y_{ij} \sim \text{Poisson}(E(y_i)) \quad (5)$$

Agreement between the different sampling methods can be assessed by

- (i) Calculation of Deviance statistics to examine the fit of the models. The deviance should be approximately equal to the residual degrees of freedom if the fit of the lines is good and the sampling error is approximately Poisson, as assumed. The deviance can be monitored by entering the word 'deviance' in the *samples* dialog of the Winbugs program. Note that this will give a slightly different result to the approximate formula given by Hii *et al* (2000).
- (ii) by comparing the two different regression lines to see if the proportionality assumption holds. If the different methods are sampling the same fraction of the mosquito population then the fitted line for model (ii) should be close to that for model (i). Equivalently, the 95% credible intervals (Bayesian equivalent of confidence intervals) for  $\beta_2$  should overlap with unity.

## References

- Altman, D.G. & Bland, J.M. (1983) Measurement in medicine: the analysis of method comparison studies. *The Statistician* **32**: 307-317.
- Davis, J.R., Hall, T., Chee, E.M., Majala, A., Minjas, J. & Shiff, C.J. (1995) Comparison of sampling anopheline mosquitoes by light-trap and human-bait collections indoors at Bagamoyo, Tanzania. *Medical and Veterinary Entomology* **9**, 249-255.
- Hii JLK, Smith T, Mai A, Ibam E, Alpers MP. (2000) Comparison between anopheline mosquitoes (Diptera: Culicidae) caught using different methods in a malaria endemic area of Papua New Guinea. *Bull Ent Res.* **90**: 211-219..
- Lines, J.D., Curtis, C.F., Wilkes, T.J. & Njunwa, K.J. (1991) Monitoring human-biting mosquitoes (Diptera: Culicidae) in Tanzania with light-traps hung beside mosquito nets. *Bulletin of Entomological Research* **81**, 77-84.
- Mbogo, C.N.M., Glass, G.E., Forster, D., Kabiru, E.W., Githure, J.I., Ouma, J.H. & Beier, J.C. (1993) Evaluation of light-traps for sampling anopheline mosquitoes in Kilifi, Kenya. *Journal of American Mosquito Control Association* **9**, 260-263.
- Nedelman, J.A. (1983). A negative binomial model for sampling mosquitoes in a malaria survey. *Biometrics* **39**: 1009-1020.
- Smith, T. (1995) Proportionality between light trap catches and biting densities of malaria vectors. *Journal of American Mosquito Control Association* **11**: 377-378.

## Disclaimer

\*Users of these programs should note that the software downloads made available on this site are provided "as is" without any warranty of any kind, either expressed or implied, including but not limited to implied warranties of merchantability and fitness for a particular purpose. In no event shall the Swiss Tropical Insitute or its employees be liable for loss of profit, business interruption, loss of business information, or other pecuniary loss, including but not limited to special incidental consequential or other damages. Users of the software will not hold the Swiss Tropical Insitute or its employees or agents responsible for any consequences arising from use of the programs. Users will hold harmless the Swiss Tropical Insitute for any losses or damages of whatsoever nature arising from use of the software.