Supplementary Information for Magori, K., Legros, M., Puente, M.E., Focks, D.A., Scott, T.W., Lloyd, A.L. & Gould, F. (2009). Skeeter Buster: a stochastic, spatially-explicit modeling tool for studying *Aedes aegypti* population replacement and population suppression strategies. PLoS Neglected Tropical Diseases **3**(9): e508. doi:10.1371/journal.pntd.0000508

Text S1: Verification of C++ CIMSiM against the original CIMSiM

We chose to rewrite a clone (named C++ CIMSiM) of the existing CIMSiM model [1] as a starting point for the development of Skeeter Buster. This rewriting allowed us to identify a number of inconsistencies between the original CIMSiM model as coded and the algorithms presented in the corresponding paper [1]. We list these here, along with the corrections made when these were imported into C++ CIMSiM and Skeeter Buster.

- In CIMSiM, the weight of dead pupae for the next day is erroneously inflated by multiplying the overall survival of pupae with survival at eclosion even for pupal cohorts not emerging. This error is not present in C++ CIMSiM or Skeeter Buster.
- In CIMSiM, the weight of dead pupae that died during eclosion is not included into the cadaver weight for the next day. In C++ CIMSiM and Skeeter Buster, it is included.
- In CIMSiM, 26 ºC is converted to Kelvin as 299 K. In C++ CIMSiM and Skeeter Buster, 26 ºC is converted to the more accurate 299.15 K. Although this seems like a small difference, due to the sensitivity of larval maturation and growth rates on temperature, it can cause the larvae to pupate a day earlier in C++ CIMSiM and Skeeter Buster than in CIMSiM.
- In CIMSiM, prefasting lipid reserve can be negative at very small larval weights according to Equation 9 in [1]. In C++ CIMSiM and Skeeter Buster, this is corrected by setting it to zero in such instances.
- In CIMSiM, the developmental rate at the developmental threshold of 13.4ºC is inaccurately fixed at 0.00146 hr^{-1}. In C++ CIMSiM and Skeeter Buster, it is accurately calculated as 0.0347 hr^{-1}.
- In CIMSiM, half as many eggs are laid as should have been when no females emerge for five days and outdoor containers are used (fecundity calculation is different in outdoors and indoor containers). The same happens on any day when there are no female nulliparous adults. This does not happen in C++ CIMSiM or Skeeter Buster.

Verification of a version of C++ CIMSiM (in which the above six imprecisions were deliberately left uncorrected) to the original CIMSiM revealed persisting differences between the output of these two models. Only deliberate manipulation of specific cohorts on specific dates in the source code of C++ CIMSiM allowed us to get rid of these mismatches. Here we present the details and the rationale for these manipulations.

We compare the number of larvae in C++ CIMSiM in the absence of these manipulations to the number of larvae based on the original CIMSiM executable (Figure S1). The number of larvae matches exactly until day 158 with the specific parameters used (Iquitos, Peru 1978 weather data, 1 gallon buckets). At day 158, there are 18.3 more larvae according to C++ CIMSiM relative to the output of the original program (Figure S2), while all other life stages are identical. We argue that this difference is due to the 'disappearance' of a cohort of freshly hatched larvae in the original program. This is based on the evidence that this difference is identical to the size of a specific egg cohort that hatches on this day in C++ CIMSiM, according to the algorithms (see main text Figure 2) that should also apply to the original program. Moreover, when we artificially remove this specific egg cohort in C++ CIMSiM, numbers of larvae are identical between the two programs up until day 232 when a similar discrepancy occurs. When we perform the same manipulation on day 232, we get perfect correspondence between the outputs of the two programs over the entire one-year simulation period (see main text Figure 5).

We considered alternative hypotheses to explain this presence of surplus larvae in C++ CIMSiM relative to the original program. This excess of larvae could be due to an increase of eggs hatching or a decrease of larvae pupating on that specific day in C++ CIMSiM. However, numbers of both eggs and pupae are identical between C++ CIMSiM and the original CIMSiM for that specific day (Figure S2). It is also possible that larval mortality would be decreased in C++ CIMSiM on the specific day. One consequence of such a decrease would be a decrease in the amount of larval food in the containers. Since the amount of larval food in the containers is equal in C++ CIMSiM and the original program, we reject this hypothesis. Finally, the surplus larvae in C++ CIMSiM could be the result of an unknown error or a duplication. However, we can identify the unique egg cohort on the preceding day from which the excess larvae hatch, exactly following the algorithms in Figure 3. Unfortunately, the original CIMSiM output does not allow us to examine the development of single cohorts as C++ CIMSiM does. However, in light of the above indirect evidence, we are confident that the observed differences can only be explained by a malfunction of the original CIMSiM executable. (Potential causes could include a memory allocation error in the code or a bug in the compiler used to generate the executable.)

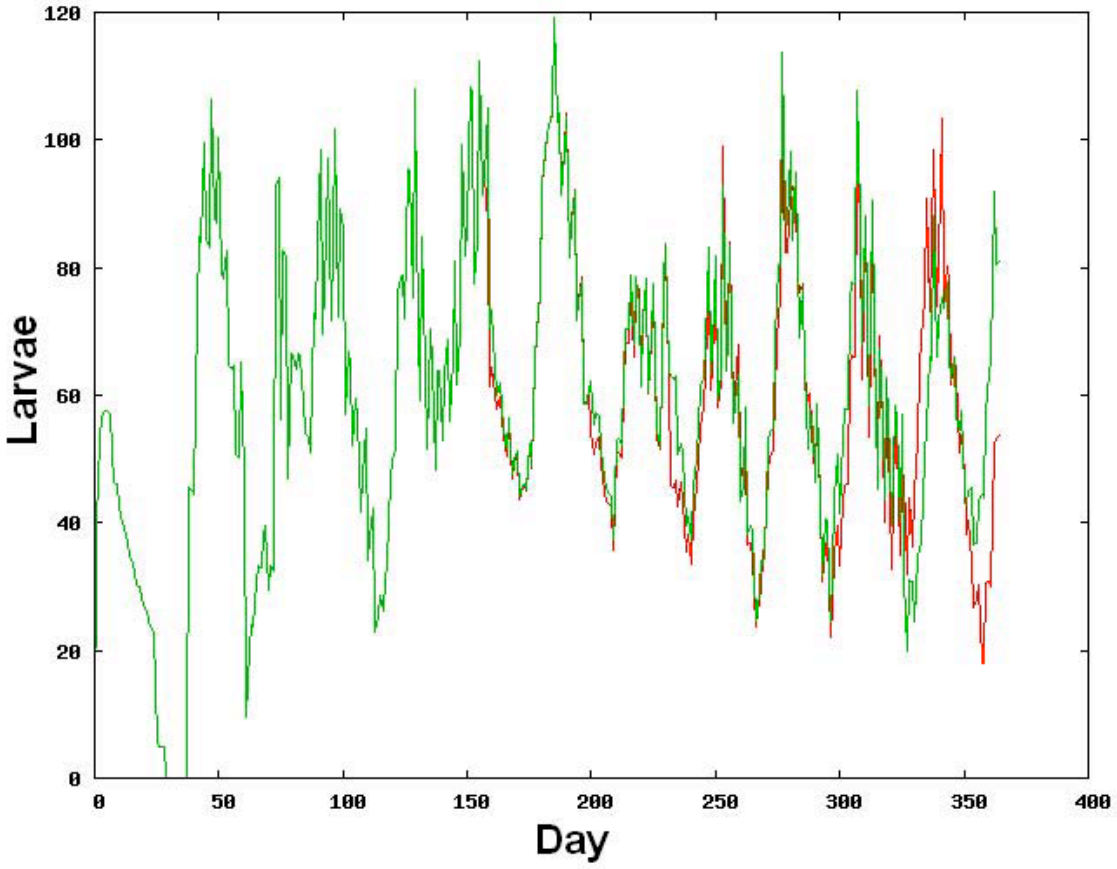

Figure S1. Discrepancies between uncorrected C++ CIMSiM and original CIMSiM. Number of larvae for C++ CIMSiM (green) without the corrections detailed in the text and in the absence of manipulations, and for the original CIMSiM (red). Weather data was collected for Iquitos, Peru 1978. Containers used were 1 gallon buckets.

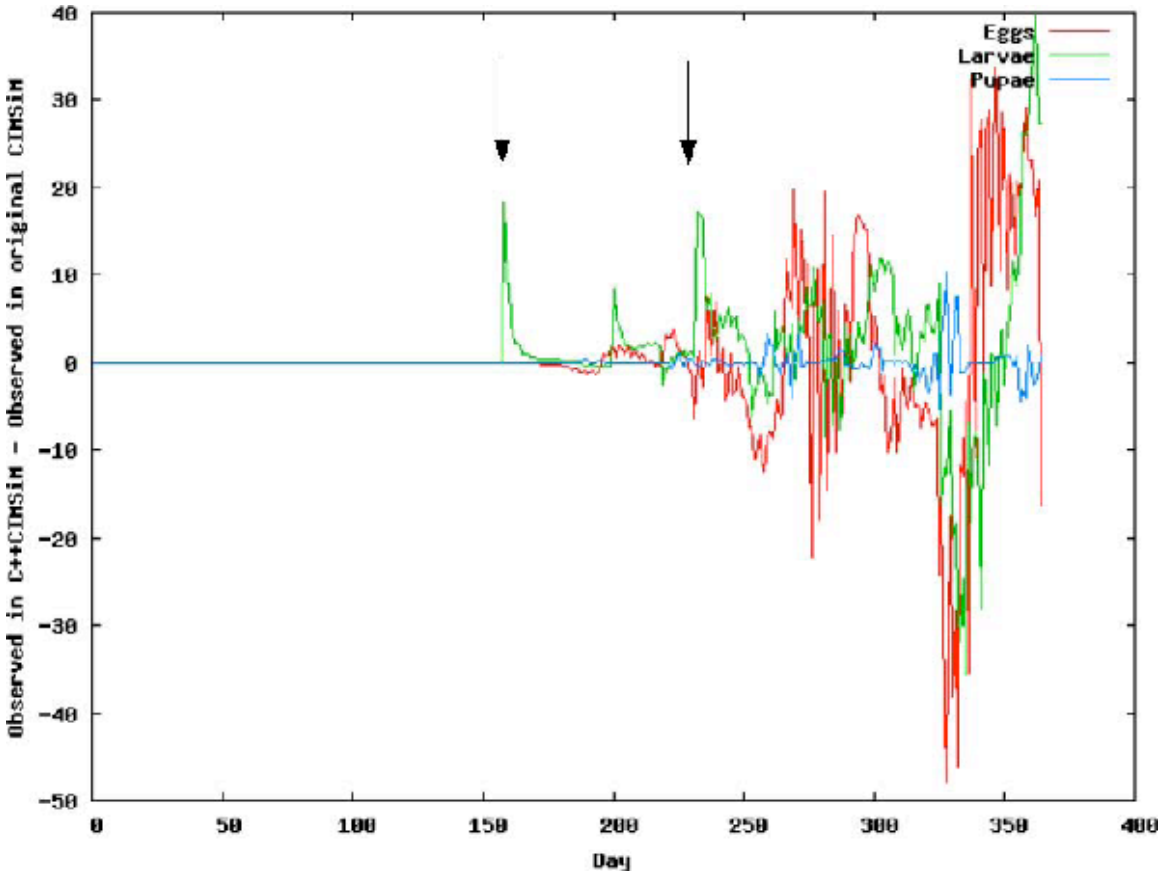

Figure S2. Details of the discrepancies between uncorrected C++ CIMSiM and original CIMSiM and associated cohort manipulations. Differences in the number of eggs (red), larvae (green) and pupae (blue) between uncorrected C++ CIMSiM (in the absence of the cohort manipulations discussed in the text) and the original CIMSiM. Weather data was collected for Iquitos, Peru 1978. Containers used were 1 gallon buckets. Arrows mark days 158 and 232 at which malfunctions occur in the original CIMSiM.

Reference:

1. Focks DA, Haile DG, Daniels E, Mount GA (1993) Dynamic life table model of *Aedes aegypti* (Diptera: Culicidae) - Analysis of the literature and model development. J Med Entomol 30: 1003-1017.

Text S2 : Details of CIMSiM elements used in Skeeter Buster, together with modifications adopted

S2.1. The amount and temperature of water in the containers

Water temperature is a critical determinant of immature mosquito developmental and survival rates. Skeeter Buster, following CIMSiM, assumes that water temperature fluctuations depend on air temperatures, solar exposure and container characteristics. The dependence of water temperature and evaporative loss on these factors was estimated by D.A. Focks in an unpublished study undertaken in Gainesville, FL, USA. In this study, water levels and temperatures of 12 containers were monitored for 76 days, and regressed against meteorological data from an adjacent weather station, giving the following relationships:

$$WaterTemp_{\max} = 15.03 + 0.27\,AirTemp_{\min} + 0.01\,AirTemp_{\max}^2 + 7.69\,SunExp^2$$
$$WaterTemp_{\min} = 5.02 - 1.36\,SunExp + 0.81\,AirTemp_{\min} + 0.001\,AirTemp_{\max}^2$$

SunExp represents the solar exposure of the container, expressed as a proportion between 0 = complete shadow and 1 = maximal sunlight. $AirTemp_{\min}$ and $AirTemp_{\max}$ are daily minimal and maximal temperatures, respectively. For containers whose volume is larger than 5 litres, moving averages of the daily values of both $WaterTemp_{\min}$ and $WaterTemp_{\max}$ are used to mimic the attenuated temperature fluctuations due to thermal inertia. The length of this moving average is increasing for increasing volume of the containers (4 days for >500l, 3 days for 100-500 l and 2 days for 50-100l). $WaterTemp_{\min}$ and $WaterTemp_{\max}$ are used in calculating survival probabilities as a function of temperature extremes; their average is used in thermal development calculations.

Daily evaporative loss (in cm) for uncovered containers is given by:

$$EvaporativeLoss = 0.93 + 0.28\,SunExp - 0.01\,RH$$

where *RH* is the atmospheric relative humidity (in percentage). Evaporative loss in covered containers is reduced compared to this by a user-specified amount. In the case of manual drawdown, total loss includes both evaporative

loss and drawdown. Daily water gains in rain-filled containers are the product of rainfall and the watershed ratio of the container. Watershed ratio reflects the surface actually receiving rainfall relative to the actual area of the container – containers associated with an active rain collection system have a watershed ratio >1, while containers like bottles with a narrow opening have a ratio <1. Manually-filled containers are assumed to retain a constant water level.

S2.2. The calculation of temperature-dependent developmental rates

Skeeter Buster, following CIMSiM, determines the developmental rates of mosquitoes based on an existing enzyme kinetics model [1]. This model assumes that the rate of development is determined by a single rate-controlling enzyme which is reversibly denaturated at high and low temperatures. Skeeter Buster (and CIMSiM) uses a simplified version of this model [2] which assumes inactivation only at high temperatures. The developmental rate is calculated by:

$$r(T_t) = \frac{\rho_{(25^\circ \mathrm{C})} \frac{T_t}{298} e^{\frac{\Delta H_\mathrm{A}^{\neq}}{R}\left(\frac{1}{298} - \frac{1}{T_t}\right)}}{1 + e^{\frac{\Delta H_\mathrm{H}}{R}\left(\frac{1}{T_{1/2\mathrm{H}}} - \frac{1}{T_t}\right)}},$$

where $r(T_t)$ is the developmental rate (hr^{-1}) at temperature T (K) on day t, T_t is the mean of the moving average of $WaterTemp_{\min}$ and $WaterTemp_{\max}$ for all immature stages, while it is the average of $AirTemp_{\min}$ and $AirTemp_{\max}$ for the gonotrophic development of adult female mosquitoes. Parameter estimates are obtained by comparison to observed data, using non-linear regression, and finding the best estimates through an iterative process with initial estimates taken from [3].The definitions of all other parameters, as well as their estimated values for each lifestage[4], are given in Table S1.

Table S1. Parameters of the temperature-dependent enzyme-kinetics developmental rate model

Parameter	*Definition*	*Eggs*	*Larvae*	*Pupae*	*Gonotrophic cycle*
$\rho_{(25^{\circ}C)}$	Development rate per hour at 25ºC assuming no temperature inactivation of the critical enzyme (hr^{-1})	0.01066	0.00873	0.01610	0.00898
$\Delta H_A^{\neq}$	Enthalpy of activation of the reaction catalyzed by the enzyme (cal/mol)	10,798.18	26,018.51	14,931.94	15,725.23
ΔH_H	Enthalpy change associated with high temperature inactivation of the enzyme (cal/mol)	100,000	55,990.75	-472,379	1,756,481.07
$T_{1/2H}$	Temperature at which 50% of the enzyme is inactivated from high temperature	14184.5	304.58	148.45	447.17

For a given cohort of age n at time t, the cumulative physiological development CD_t is then given by:

$$CD_t = \sum_{\tau=t-n}^{t} r(T_\tau)$$

Developmental rates accumulate up to the point when the physiological development is considered completed.

S2.3. Variation in development time in Skeeter Buster

In CIMSiM, larval and pupal cohorts reach complete physiological development, and are marked as "developed", when their cumulative physiological development (CD_t) exceeds 0.95. In Skeeter Buster, we relax this assumption, and allow some individuals to become developed with $CD_t < 0.95$ while others have to reach a higher value to become developed.

More precisely, no larva becomes developed when $CD_t < 0.89$. All larvae become developed if $CD_t > 1.17$. If $0.89 < CD_t < 1.17$, a proportion of a given cohort becomes developed. The cumulative proportion y_t of a cohort reaching development based on the value of CD_t is given by the following function [5]:

$$y_t = (1 - z_t)^{2.0126 z_t^2},$$

where

$$z_t = \frac{1.17 - CD_t}{1.17 - 0.89}.$$

The shape of this function is shown in Figure S3. The proportion of larvae becoming developed at time t is then given by $(y_t - y_{t-1})/(1-y_{t-1})$ (assuming $y_t = 0$ if $CD_t < 0.89$ and $y_t = 1$ if $CD_t > 1.17$). In Skeeter Buster, the actual number of larvae becoming developed is calculated according to a binomial distribution with a probability equal to $(y_t - y_{t-1})/(1-y_{t-1})$.

Calculations are identical for pupal development.

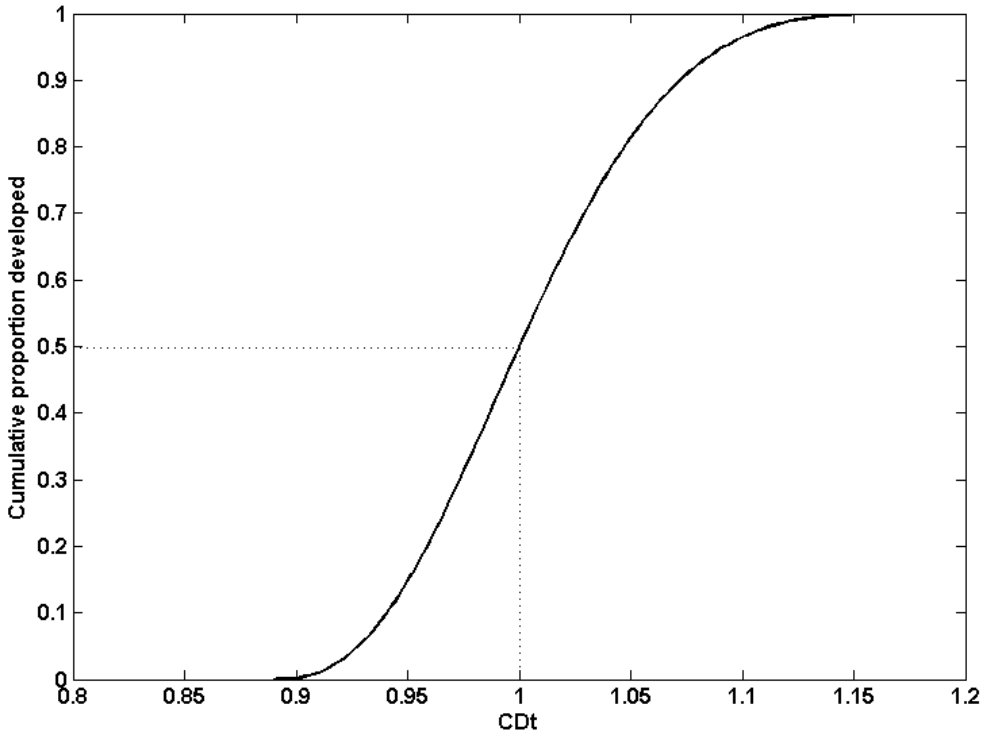

Figure S3. Cumulative proportion of larvae reaching physiological development based on the current physiological status of the cohort. For values of CDt (cumulative physiological development) between 0.89 and 1.17, a certain proportion of larvae within the cohort can become developed. In Skeeter Buster, the actual number of larvae becoming developed is drawn from a binomial distribution (see the calculation of the probability associated to this distribution in the text). Note that 50% of larvae are expected to become mature before the cumulative physiological development reaches 1.0, and 50% after.

S2.4. Larval weight change and fasting

Larval weight change and the associated changes in the amount of food in the container are modeled in parallel according to the following equations [6]:

$$\frac{dW(t)}{dt} = af(T_t)\left(W(t)^b\left(1 - e^{-cF(t)} - d_1 W(t)^{d_2}\right)\right)$$

$$\frac{dF(t)}{dt} = -n(t) f(T_t) W(t)^b \left(1 - e^{-cF(t)}\right),$$

where t is time, $W(t)$ is larval dry weight (mg), $F(t)$ is the amount of food within the container (mg), T_t is the temperature (K) at time t and $n(t)$ is the number of larvae in the cohort. Parameter values and descriptions are detailed in Table S2

Table S2. Parameter description and default values for larval weight and food amount calculations.

Parameter	***Description***	**Value**
A	Conversion rate of consumed food to biomass	0.3
B	Exponent of increase of food exploitation rate with body weight	0.8
C	Change in food exploitation rate with food density (type II functional response)	0.1
d_1	Metabolic weight loss of larvae when food is totally depleted	0.016
d_2		0.667

The original equations were calibrated at 26 ºC. The change in metabolic rate with temperature is described by the function $f(T_t)$, calculated as:

$$f(T_t) = f_T \frac{r(T_t) - r(13.4\,^{\circ}\mathrm{C})}{r(26\,^{\circ}\mathrm{C}) - r(13.4\,^{\circ}\mathrm{C})},$$

where f_T is the value at 26 ºC (f_T = 0.001). $r(T_t)$ is calculated as described above. 13.4 ºC is the lower developmental threshold [7] at which $f(T_t)$ is set to zero.

$W(t)$ and $F(t)$ are calculated each day for each cohort in each container using Euler's method with a resolution of 8 steps per day.

The proportion of lipid for a larva of weight $W(t)$ is modeled by the following equations:

$$L(t) = 0.059\left(\ln W(t) + 6.9\right)$$

$$R(t) = L(t) - L_{min},$$

where $L(t)$ is the total proportion of lipid, $L_{\min}$ (= 0.15) is the proportion of lipid involved in structural components and therefore not available as reserves, and $R(t)$ is the proportion of available lipid reserves. The amount of lipid reserves determines mortality probabilities for fasting larvae as described in the main text (Fig. 4).

S2.5. Pupation

Larvae in a given cohort can pupate if they meet two required conditions: their cumulative physiological development has to exceed a minimal threshold, and their weight has to exceed a minimal threshold. The values of these thresholds are temperature-dependent, and are not independent: at a given temperature, the value of the weight threshold depends on the cumulative physiological development of the cohort.

In Skeeter Buster, as in CIMSiM, this interaction is represented by an L-shaped window (Figure S4) representing the minimal weight ($W_{\min}$) as a function of the cohort's current cumulative physiological development (CD_t). This L-shaped window is described by the following:

- the vertical line on the left represents the minimal cumulative physiological development for any temperature (CD_t = 0.95).
- beyond this value, and up to the maximum possible value of CD_t = 8.0 (above that value, larvae are removed from the population), the weight threshold for pupation decreases linearly with CD_t. The precise

line for a given temperature is defined by two points. First, at $CD_t = 0.95$ the minimal weight W_{min} is a function of water temperature. In CIMSiM, this minimal weight is given by the following equation [5]:

$$W_{\min} = 2.11 - 0.04T_t$$

(where T_t is the temperature at time t). In Skeeter Buster, this equation is modified to introduce an additional level of stochasticity (see below). From this point, the required minimal weight decreases linearly with CD_t (*i.e.* as larvae age physiologically) down to a minimal temperature-independent requirement of 0.1 mg at the maximal value of $CD_t = 8.0$.

The progress of a given larval cohort can then be represented by its trajectory on this graph, reflecting the changes in larval weight and cumulative physiological development (see examples on Figure S4). Pupation occurs when this trajectory crosses the L-shaped window.

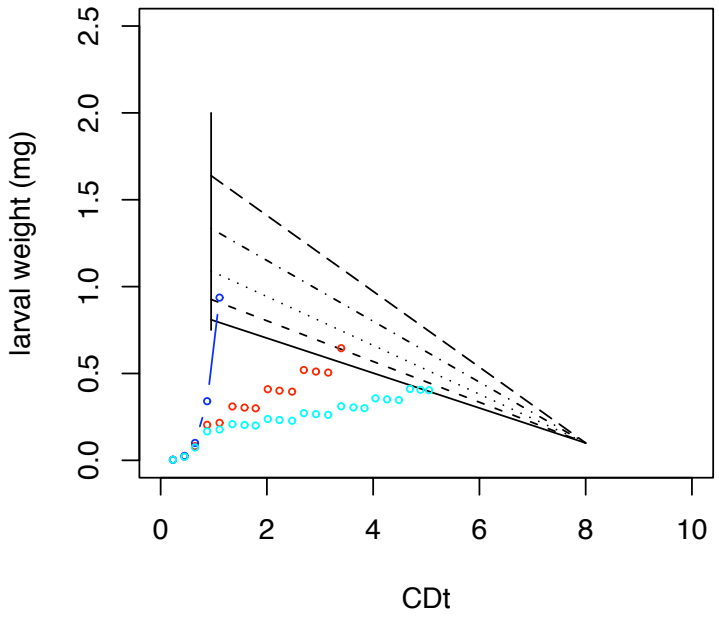

Figure S4. Pupation windows as a function of physiological development status and temperature. Pupation windows define the required minimal larval weight for pupation. Lines correspond, from top to bottom, to temperatures of 15, 20, 25, 30 and 35°C. Symbols represent hypothetical larval trajectories from simulation using weather data from Iquitos, Peru, under different nutritional conditions (dark blue: high food; red: medium; light blue: low food) and show the progress of these cohorts in terms of weight gain and cumulative physiological development (CDt). Pupation of these larvae occurs when their trajectory crosses the pupation window.

Skeeter Buster introduces additional detail in the calculation of this window. First, specific windows are calculated for male and female larvae, with a lower minimal weight for pupation of males.

Moreover, an additional level of stochasticity is introduced in the definition of this L-shaped window. Instead of defining a single window for a given temperature, 4 windows are defined, corresponding to cumulative pupation probabilities of 25%, 50%, 75% and 100% when the trajectories cross the successive windows. These 4 windows are defined by the calculation of the upper-left point, defining the value of W_{min} at $CD_t = 0.95$. These calculations are presented in Table S3. 50% female and male pupation weight thresholds are estimated from [8]. 25%, 75%, 100% pupation weight thresholds are estimated from [9].

Table S3. Calculation of weight thresholds (W_{min}) at $CD_t = 0.95$, as a function of temperature (T_t) and pupation probability in Skeeter Buster

	Female larvae	**Male larvae**
25%	$W_{min} = 1.5411 - 0.0389\ T_t$	$W_{min} = 1.2275 - 0.0389\ T_t$
50%	$W_{min} = 1.7994 - 0.0389\ T_t$	$W_{min} = 1.4494 - 0.0389\ T_t$
75%	$W_{min} = 2.3270 - 0.0389\ T_t$	$W_{min} = 1.9665 - 0.0389\ T_t$
100%	$W_{min} = 2.8545 - 0.0389\ T_t$	$W_{min} = 2.4836 - 0.0389\ T_t$

S2.6. Nominal daily survival rates

CIMSIM and Skeeter Buster assume that survival at all stages is independent of age and density (except for indirect larval fasting effects). Nominal daily survival probabilities are given in Table S4.

Table S4. Stage-specific nominal daily survival probabilities.

	Eggs	***Larvae***	***Pupae***	***Adults***
Nominal daily survival	0.99	0.99	0.99	0.89 (females) 0.77 (males)

These survival probabilities can be modified by the multiplication of factors reflecting additional sources of mortality, as described in subsections II.7 and II.8.

S2.7. Temperature-dependent survival probabilities

For all stages, daily survival probability is multiplied by an additional factor s_T reflecting temperature effects on survival. The value of this factor depends on the daily extreme temperatures T_{min} and T_{max}, and on 4 stage-specific threshold temperatures. We can write:

$$s_T = s_{T\min} * s_{T\max}$$

where:

- if $T_{min} < T_0$ then $s_{T\min} = 0.05$
- if $T_0 < T_{min} < T_1$ then $s_{T\min} = 0.05 + 0.95(T_{min}-T_0)/(T_1-T_0)$ (in other words, survival increases linearly with T_{min} from 0.05 at T_0 to 1.0 at T_1)
- otherwise, $s_{T\min} = 1.0$ (no effect of minimum temperature on survival)

and:

- if $T_2 < T_{max} < T_3$ then $s_{T\max} = 1 - 0.95(T_{max}-T_2)/(T_3-T_2)$ (in other words, survival decreases linearly with T_{max} from 1.0 at T_2 to 0.05 at T_3)
- if $T_{max} > T_3$ then $s_{T\max} = 0.05$
- otherwise, $s_{T\max} = 1.0$ (no effect of maximum temperature on survival)

Values of the threshold temperatures for these four temperature-dependent survival factors are given in Table S5. Note that the temperatures used in the calculation of these factors are water temperatures for eggs, larvae and pupae, and air temperatures for adults.

Table S5. Thresholds for temperature-dependent survival calculations (ºC)

	Eggs	***Larvae/Pupae***	**Adults**
T_0	-14	5	0
T_1	-6	10	4
T_2	30	39	40
T_3	47	44	50

S2.8. Survival to desiccation

Desiccation can be an additional source of mortality for eggs when a container is dried out. In that case, survival probability is multiplied by an additional factor s_H. This factor depends on two quantities, the sun exposure *SunExp* of the container, and the atmospheric saturation deficit *SD* (in mBars) (reflecting both humidity and temperature).

For containers with *SunExp*>0.85, $s_H = 0.95$.

For containers with *SunExp*<0.85:

- if $SD < 10$, $s_H = 0.99$
- if $10 < SD < 30$, $s_H = 0.99 - 0.04*(SD-10)/(30-10)$ (in other words, survival decreases linearly with *SD* from 0.99 at *SD*=10 to 0.95 at *SD*=30)
- if $SD > 30$, $s_H = 0.95$

Desiccation also affects adult survival when $SD > 10$ mBars. A similar survival factor s_H multiplies daily adult survival in this case, and is calculated as follows:

- if $10 < SD < 30$, $s_H = 1 - 0.4*(SD-10)/(30-10)$ (in other words, survival decreases linearly with *SD* from 1.0 at *SD*=10 to 0.6 at *SD*=30)
- if $SD > 30$, $s_H = 0.6$

References:

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3. McHugh CP, Olson JK (1982) The effect of temperature on the development, growth and survival of *Psorophora columbiae*. Mosq News 42: 608-613.
4. Focks DA, Haile DG, Daniels E, Mount GA (1993) Dynamic life table model of *Aedes aegypti* (Diptera: Culicidae) - Analysis of the literature and model development. J Med Entomol 30: 1003-1017.

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Text S3: Analyses of periodicities in the time series

The periodicity of the stage-specific time series appears to differ between C++CIMSiM and Skeeter Buster (see Figure 6D, main text). In this section we present analyses of the periodicities of these time series for various initial setups of the models, by plotting periodograms obtained through a discrete Fourier transformation of these time series.

According to a periodogram of female adult density for both models (Figure S5), the dominant period of female adult density fluctuations is about 2 days shorter in Skeeter Buster than it is in C++CIMSiM (approx. 28 days vs. 30 days).

We investigate how the periodicity is related to nutritional conditions and intraspecific competition within containers. We analyzed the periodicity of female adult density (Figure S6, left column) for three different nutritional conditions (defined as daily food gain per container in the model). It appears that the period of female adult density fluctuations is linked to the food availability in the containers (period of 24, 28 and 38 days for high, medium, and low food availability, respectively), although the dominant period is not clearly identifiable when the nutritional conditions are harsh.

Finally, the periodicity of female adult density at an individual property is strongly reduced when spatial structure is included, except when food levels are high (Figure S6, right column). In the latter case, the level of variation in development time among properties is greatly reduced, and fluctuations at the population level reflect those at the level of individual properties.

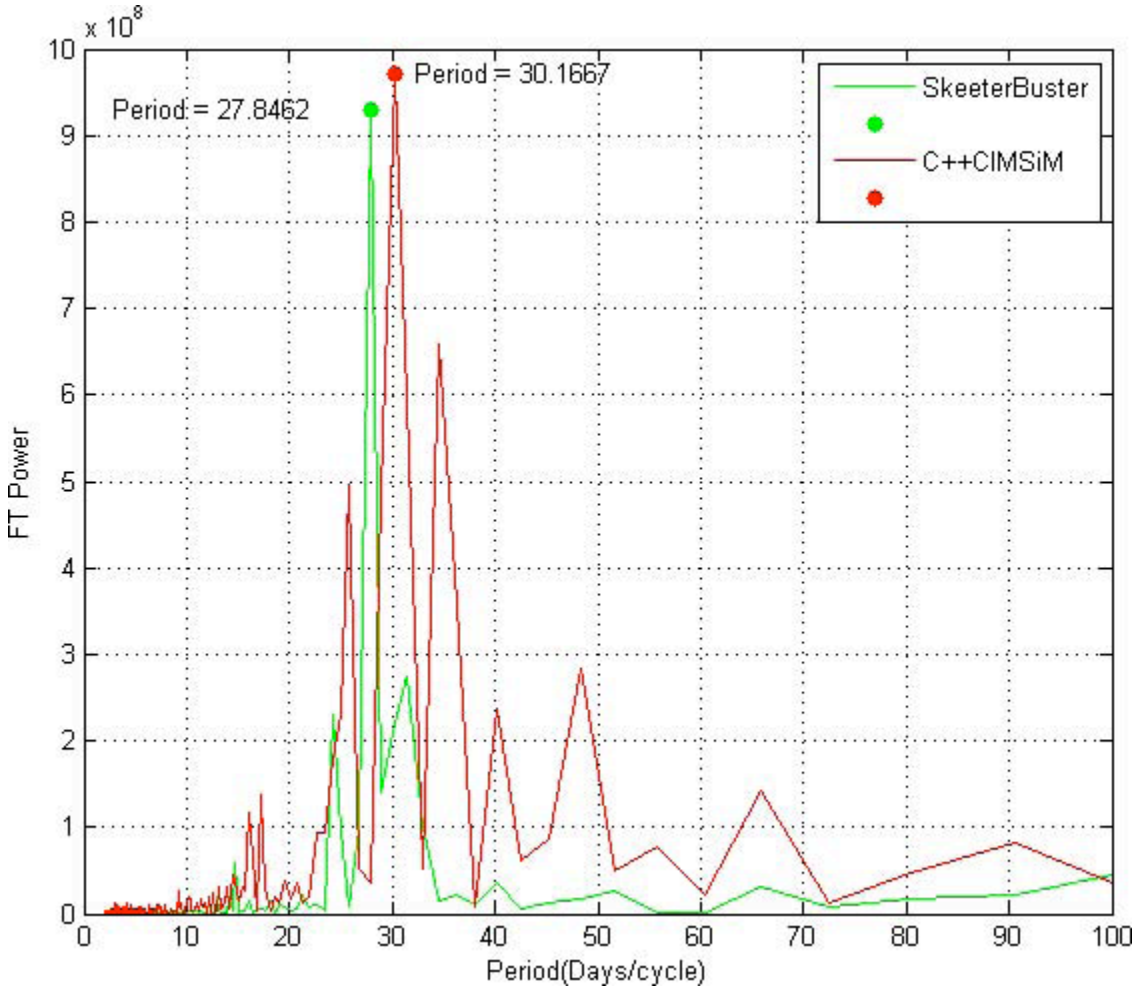
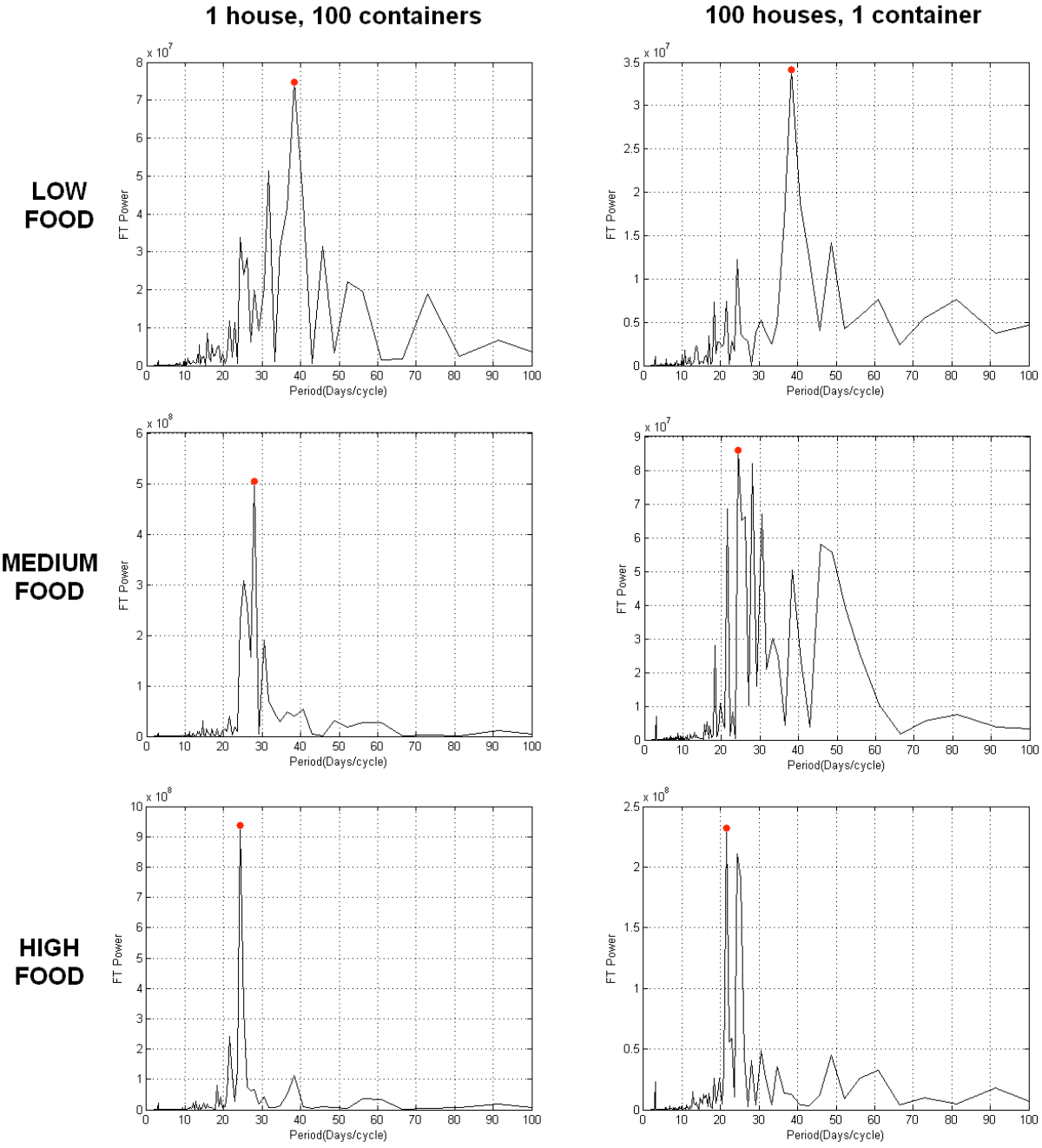


Figure S5. Periodogram of female adult density from C++ CIMSiM and Skeeter Buster. This periodogram is based on a discrete Fourier transformation of the time series presented in the main text (Fig. 6D). The dominant period of the cycles is approximately two days shorter in Skeeter Buster, resulting in approximately 13 density peaks a year, compared to the 12 peaks predicted by C++ CIMSiM.

Figure S6. (On following page) Periodograms of female adult densities for various setups of Skeeter Buster. These periodograms are based on discrete Fourier transformation of time series from the model. All simulations are run using 1-gallon buckets and weather data from Iquitos, Peru, 1978–1980. Simulations are run for three years. To avoid initial cohort effects, only the last two years of each time series is analyzed. Moreover, the population is initialized with cohorts from all life stages, in proportions defined by a run of Skeeter Buster with non-limiting food. The left column represents simulations with no spatial structure, and 100 containers within the same location. The

right column represents simulations with spatial structure, and 100 properties, each containing one single container. In the latter case, only short range dispersal is allowed (there is no long range dispersal). Rows correspond to different food conditions, modeled as daily food gain per container: top row, low food amounts (0.8 mg/day) ; middle row, medium (default) food amount (1.8 mg/day) ; bottom row, high food amount (3.0 mg/day). Note that the y-axes have different scales between panels.



Text S4: List of differences in biological procedures between CIMSiM and Skeeter Buster

We recapitulate here modifications made to biological procedures present in CIMSiM when we incorporated them into Skeeter Buster. (All six corrections discussed in Text S1 are also made.)

1. In CIMSiM, the calculation of the fecundity of female adult cohorts (made at the time of their emergence) is based on the moving average weight of the last five emerged female adult cohorts. While this is understandable as a simple solution to avoid keeping track of the weights and fecundities of all female adult cohorts separately, it has several drawbacks. First of all, it averages the weights of small-sized and large-sized adult cohorts, treating them as if they all have the average weight. Weights of nulliparous female adult cohorts are also included in this average. Additionally, this moving average is not weighted by the number of female adult mosquitoes in the different cohorts. In Skeeter Buster, we keep track of the weights and fecundities of all female adults separately.

2. In CIMSiM, all larvae in the same larval cohort pupate at the same time when they exceed their pupation weight threshold for the corresponding physiological percentage (2.11 mg at 26ºC for 0.95 cumulative physiological development). Males and females have the same parameters and pupate at the same time. In Skeeter Buster, four separate pupation windows are calculated with different parameters for male and female larvae (and parameter values are different to those used in the original CIMSiM). The four separate pupation windows (see Text S2.5) specify the weight the larvae have to achieve in order for 25%, 50%, 75% or 100% of them to pupate. (female at 26ºC 0.95 phys. dev. 25%: 1.5411, 50%: 1.79935, 75%: 2.32698, 100%: 2.854526; male at 26ºC 0.95 phys. dev. 25%: 1.2275, 50%: 1.44935, 75%: 1.9664689, 100%: 1.9664689) 50% female and male pupation weight thresholds are estimated from Figure 2 of [1]. 25%, 75%, 100% pupation weight thresholds are estimated from Figure 1 of [2].

3. In CIMSiM, the fecundity of female adult cohorts is independent of the age of the female adult cohort. In Skeeter Buster, fecundity of a female adult cohort is decreasing with age above age 25 with a slope of -0.4366743 eggs/day, based on Figure 3B of [3].

4. In CIMSiM, all larvae mature at the same time, when they reach cumulative physiological development CD_t = 0.95. In Skeeter Buster, some larvae mature earlier and some later, according to [4]. The first larvae start to mature when they reach cumulative physiological development CD_t = 0.89. All of the larvae mature when they reach cumulative physiological development CD_t = 1.17. In between, only a fraction of the larvae mature based on equation 2 in [4]. In this case, a new mature cohort is branched off the original larval cohort with identical characteristics but marked as mature. Note that this cohort is not processed again on the same day.

5. In CIMSiM, all pupae mature at the same time, when they reach cumulative physiological development CD_t = 0.95. In Skeeter Buster, some pupae mature earlier and some later, according to [4]. The first pupae start to mature when they reach cumulative physiological development CD_t = 0.89. All of the pupae mature when they reach cumulative physiological development CD_t =1.17. In between, only a fraction of the pupae mature based on equation 2 in [4]. In this case, a new mature pupal cohort is branched off of the original cohort with identical characteristics but mature. Note that this cohort is not processed again on the same day.

6. In CIMSiM, both male and female pupae obtain their weights from the larval cohort weight on the previous day. In Skeeter Buster, female pupae have a weight that is the average between the female larval weights on the previous day and on the current day. Male pupae inherit the weight of the male larvae on the previous day (to ensure that, even in optimal conditions, male pupae have a lower weight than female pupae).

7. In CIMSiM, females emerging from several different pupal cohorts on the same day are merged into one female adult cohort that is assigned an average weight. In Skeeter Buster, separate cohorts are created for females and males emerging from different pupal cohorts, with their own representative weights.

8. In CIMSiM, there is no variation in the fecundity of females in the same adult cohort. In Skeeter Buster, females emerging from a given pupal cohort are modeled individually, and their fecundity is calculated stochastically from a normal distribution, with an average value based on the weight of the female (see main text), and, based on Table 2 of [5], standard deviation equal to 0.3751946 multiplied by the mean fecundity.

9. In CIMSiM, the nominal daily survival of both male and female adults is 0.91 day^{-1}. In Skeeter Buster, the nominal daily survival of male adults is 0.77 day^{-1}, while the nominal daily survival of female adults is 0.89 day^{-1}[6].

10. In CIMSiM, containers are divided into 2 cm layers for oviposition. In Skeeter Buster, containers are divided into 2 mm layers for oviposition.

11. In CIMSiM, if the water level is at the top layer of the container, eggs are only laid into the top layer. If the water level is lower than that, eggs are distributed evenly at the water level layer and one layer above. In Skeeter Buster, if the water level is at the top layer of the container, eggs are only laid into the top layer. If the water level is lower than that, eggs are distributed evenly into the layers between the water level layer and all the layers up to the top layer of the container, but at most into 19 layers above the water level.

12. In CIMSiM, the pupation weight threshold is calculated at the beginning of the day. In Skeeter Buster, it is calculated at the end of the day, right before pupation.

13. In CIMSiM, adult males are discarded. In Skeeter Buster, male and female adults are both retained and tracked.

14. In CIMSiM, the initial weight of larvae at hatch is 0.0034 mg. In Skeeter Buster, the initial weight of larvae at hatch is 0.001 mg, based on [7]. The minimal weight for larval survival is lowered to 0.0009 mg in Skeeter Buster.

15. In CIMSiM, fasting survival is not recalculated if the larval cohort is about to pupate on the given day, and the fasting survival calculated on the previous day is used. In Skeeter Buster, fasting survival is always recalculated.

16. In CIMSiM, the average lipid reserve of a larval cohort is always reset to its original value when starvation ends, and recalculated when starvation begins. In Skeeter Buster, it is recalculated when starvation begins and do not implement the unnecessary reset.

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