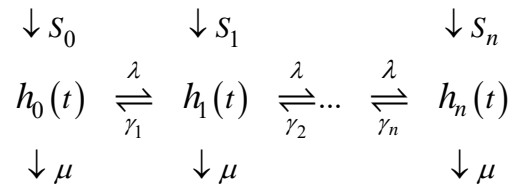


## Appendices

### A. Further details of the SWB system

Host population  $H = \sum_{k=0}^n h_k$  is divided into burden strata  $\{h_k\}$  by their worm load ( $w = \#$  adult worms):  $k \Delta w \leq w < (k+1) \Delta w$  for  $h_k$ . The partition is determined by worm-step  $\Delta w \geq 1$ , that derives from a hypothetical *mating threshold*. So  $h_0$  are infection-free (no mated couples), while for  $h_k$  ( $k \geq 1$ ), its mated count (expected number of couples) is given by equation (14) of Additional File 2, Appendix B. The transitions among strata



are determined by FOI  $\lambda$  (= rate of worm accumulation), resolution rates  $\gamma_k = k \gamma$  (based on estimated natural worm mortality  $\gamma$ ), and population turnover rate  $\mu$  (human mortality, maturation, migration, etc.). Source terms  $S_k$  represent demographic inputs from related population groups, e.g., for infants  $S_0 = b_H$  (birth rate), while  $S_{k \geq 1} = 0$  (representing the fact that all newborns are infection-free), while adult sources come from maturing childhood strata. Dynamic variables  $\vec{h}(t) = \{h_k(t)\}$  obey a coupled differential system

$$\left\{ \begin{array}{l}
 \frac{dh_0}{dt} = -(\lambda + \mu)h_0 + \gamma_1 h_1 + S_0 \\
 \vdots \\
 \frac{dh_i}{dt} = \lambda h_{i-1} - (\lambda + \gamma_i + \mu)h_i + \gamma_{i+1} h_{i+1} + S_i \\
 \vdots \\
 \frac{dh_n}{dt} = \lambda h_{n-1} - (\gamma_n + \mu)h_n + S_n
 \end{array} \right. \quad (10)$$

We write it using vector notation as

$$\frac{d\vec{h}}{dt} = A(\lambda, \mu, \gamma) \cdot \vec{h} + \vec{S}, \quad (11)$$

with FOI (transition) matrix

$$A(\lambda, \mu, \gamma) = \begin{bmatrix} -(\lambda + \mu) & \gamma_1 & & & & \\ & \lambda & \ddots & & & \\ & & \lambda & -(\lambda + \gamma_i + \mu) & \gamma_{i+1} & \\ & & & \ddots & \ddots & \gamma_n \\ & & & & \lambda & -(\gamma_n + \mu) \end{bmatrix}.$$

Reduced systems, like the MacDonald mean worm burden (MWB) models can be derived as moment equations of system (10) (see [12]).

For age-structured populations (child + adult), each subgroup has its own SWB, with specific FOI -  $\lambda^d$ , turnover  $\mu^d$ , and source  $\vec{S}^d$ . The children's' source  $\vec{S}^C = \{b_c, 0, 0, \dots\}$  comes from newborns ( $b_c =$  per capita birth rate) entering the uninfected  $h_0$ -stratum.

The adult source is contributed by aging children,

$$\vec{S}^A = \{S_k^A\} = \frac{\tau}{\gamma} \frac{H_C}{H_A} \vec{h}^C \quad (12)$$

Here  $\{H_C, H_A\}$  are populations of two groups,  $\tau$  - maturation rate (= 1/maturation age).

Child and adult SWB variables  $\vec{h}^C$ ,  $\vec{h}^A$  are coupled via

$$\begin{cases} \frac{d}{dt} \vec{h}^C = A(\lambda^C, \mu^C, \gamma) \cdot \vec{h}^C + \vec{S}^C \\ \frac{d}{dt} \vec{h}^A = A(\lambda^A, \mu^A, \gamma) \cdot \vec{h}^A + \vec{S}^A \end{cases} \quad (13)$$