Analysis of a Generalized Discrete Periodic Model for the Spread of Wolbachia in a Mosquito Population

Alexandra Fedrigo, Dr. Shangbing Ai, Department of Mathematical Sciences

Overview and Impact

Wolbachia bacteria in mosquitoes keeps them from spreading certain harmful diseases and sterilizes males. The spread of Wolbachia has been widely studied, and here we performed analysis of a generalized discrete model (below) for Wolbachia spread, with the intention of making the model useable by researchers seeking to perform field releases of Wolbachia infected mosquitoes. We sought conditions to guarantee the existence of periodic solutions to the model: \( x_{n+1} = F_n(x_n) \). These solutions are the attractors for the model; they determine the global dynamics.

\[
F_n(x_n) = \frac{(1 - \mu)(1 - s_f)(1 + m_n)(x_n + f_n)}{s_h x_n^2 - (s_f + s_h + m_n(s_f - s_h)) x_n + 1 + (1 - s_f) f_n + (1 - s_h)m_n + (1 - s_f)f_n m_n}
\]

Methods

- Guarantee at least one periodic solution by common interval (Fig 1)
- Guarantee maximum number of periodic solutions by conditions (Fig 2)
- Results were obtained from model, and verified numerically

Results

We were able to find conditions to guarantee a minimum of one periodic solution, and conditions to guarantee the maximum number of periodic solutions. The latter also provide an interval on which the solution exists, assuming the conditions are met.

References


Acknowledgements

Special thanks to David Cook and Dr. Bernhard Vogler for their administration of the Summer Community of Scholars. Thanks also to the UAH Office of the President, Office of the Provost, Office of the Vice President for Research and Economic Development, The Dean of the College of Science, the Dean of the College of Engineering, the Alabama Louis Stokes Alliances for Minority Participation, and the Alabama Space Grant Consortium for their support.