Mathematical Methods and Models in Biosciences
June 15–20, 2025, Sofia, Bulgaria
https://biomath.math.bas.bg/biomath/index.php/bmcs

Modelling vectorial capacity and optimising vector control across reservoir and dead-end hosts

Emma L. Fairbanks[1], Matthew Baylis[2], Janet M. Daly[3], Mike J. Tildesley[1]

[1]The Zeeman Institute for Systems Biology & Infectious Disease Epidemiology Research, Mathematics Institute and School of Life Sciences, University of Warwick, UK
emma-louise.fairbanks@warwick.ac.uk

[2]Institute of Infection, Veterinary and Ecological Sciences, Faculty of Health and Life Sciences, University of Liverpool, UK

[3]One Virology – Wolfson Centre for Global Virus Research, School of Veterinary Medicine and Science, University of Nottingham, UK

Vector-borne disease transmission involves complex interactions between vectors, reservoir hosts and dead-end hosts. Our research extends existing mathematical models of vectorial capacity [1] by incorporating multiple host types and their interactions, focusing specifically on West Nile Virus transmission by *Culex pipiens* mosquitoes. We demonstrate how vector control interventions targeting one host type can significantly impact transmission dynamics across all host populations. Our model integrates climate-dependent parameters affecting vector biology with vector control interventions to predict transmission potential under various scenarios. By examining the effects of different vector control tool modes of action (repellency, preprandial killing, disarming and postprandial killing), we develop target product profiles that minimise unintended consequences of vector control. Notably, we identify the optimal intervention characteristics needed to prevent repellency on dead-end hosts from inadvertently increasing transmission among reservoir hosts. This research provides valuable insights for public health officials designing targeted vector control strategies and offers a flexible modelling framework that can be adapted to other vector-borne diseases with complex host dynamics.

Keywords: arbovirus, medical entomology, epidemiology, target product profiles

References

[1] E. L. Fairbanks, J. M. Daly, M. J. Tildesley, Modelling the Influence of Climate and Vector Control Interventions on Arbovirus Transmission, *Viruses*, 16:1221, 2024.