# Unraveling the Dynamics of Wolbachia-based Mosquito Control: Early Warning Signals and Optimal Interventions

Contributed Talk

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Wolbachia-induced cytoplasmic incompatibility (CI) is a promising biological tool for controlling mosquito populations and reducing mosquito-borne diseases. This study introduces an entomological model to describe mosquito population dynamics in the presence of Wolbachia-infected (WI) mosquitoes, exploring the transmission dynamics required to establish Wolbachia infection within wild-type (WT) mosquito populations. Using a single-species, age-structured mathematical model incorporating the Allee effect, we find that the coexistence equilibrium is always unstable, while the stability of nontrivial boundary equilibria depends on specific parameter conditions. Our analysis highlights the complex interplay among mosquito life-history traits, the immigration of WT mosquitoes, and the stability of mosquito populations at Wolbachia-free and WI steady states. The findings reveal that factors such as a stronger Allee effect, high intraspecific competition during the juvenile stage, delayed juvenile maturation, low survival fitness of WI mosquitoes, and increased immigration of WT mosquitoes can trigger a regime shift from a WI steady state to one dominated by WT mosquitoes. To address this potential population replacement, we apply the concept of basin stability to develop an early warning system capable of predicting impending tipping points. We demonstrate that introducing additional WI mosquitoes could serve as an effective intervention strategy when such warnings arise. Furthermore, we explore dynamic optimization