The role of diversity amplification for personal protection control strategies in vector-borne disease models

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Personal protection measures, such as bed nets and repellents, are important tools for the suppression of vector-borne diseases like malaria, and the ability of health agencies to distribute protection and encourage its use plays an important role in the efficacy of community-wide disease management strategies. Modelling studies have previously shown that a counterintuitive diversity-driven amplification in community-wide disease levels can result from a population's partial adoption of personal protection measures, potentially to the detriment of disease management efforts. This finding, however, may overestimate the negative impact of partial personal protection as a result of implicit model assumptions regarding host compliance, access to, and longevity of protection measures. We establish a new modelling methodology for incorporating community-wide personal protection distribution programs in vector-borne disease systems which flexibly accounts for compliance, access, longevity and control strategies by way of a flow between protected and unprotected populations. Our methodology yields large reductions in the severity and occurrence of amplification effects as compared to previous models.