Quantification of local bovine tuberculosis (bTB) transmission in badgers and cattle with and without vaccination of badgers (Meles meles) in the Republic of Ireland (RoI)

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In the Republic of Ireland (RoI), bovine Tuberculosis (bTB) in cattle continues to circulate despite considerable efforts placed on controlling the infection. The European badger (*Meles meles*) is considered by most scientist to be implicit in the transmission and maintenance of bTB in cattle. Badger culling has been linked to a reduction in bTB incidence in cattle, however, continued persecution of badger populations is not sustainable long-term. As an alternative badger intra-muscular Bacille Calmette-Guérin (BCG) vaccination is now being rolled out across the country on a phased basis. Although vaccination was associated with a reduction in badger-to-badger transmission in a field trial, it remains unclear whether vaccination will sufficiently reduce transmission across the badger-cattle system everywhere in the RoI when combined with current control measures in cattle. The objective of this study is to assess the efficacy of the vaccination programme on the multi-host system at a local level. We propose to quantify the spatio-temporal heterogeneity of bTB transmission in a multi-host system (badgers and cattle) across areas with vaccinated and unvaccinated badger populations. We aim to identify any factors that could be involved in limiting the success of badger vaccination so as these limitations may be quickly and adequately addressed by policy decision-makers. Transmission kernels, as a function of distance between epidemiological units (both farms and setts), will be generated for each pairwise unit interaction and these kernels will inform a Next Generation Matrix (NGM) applied to each Quartile (1.5X2km^2 grid cells) in the RoI. This will generate a risk map of local (Quartile level) reproduction ratios (R-map). Clusters, hotspots and outliers can be identified via the R-map, informing decision makers about areas which require further intervention, where infection cannot be maintained and where the vaccination is proving effective or ineffective. A large body of existing national data will be utilized for the analysis. Further data will be collected in vaccinated regions to monitor the infection status of badger setts over time to inform the transmission kernels, assessing whether or not any reduction in badger transmission of bTB due to vaccination can be accurately attributed to vaccination (or not). The results of this study will provide insights to the policy-makers, i.e. mainly the veterinary services, and by improving the eradication will benefit animal welfare, human health and the profitability of cattle farming.