Jonathan Greenman
University of Stirling, UK
e-mail: j.v.greenman@stir.ac.uk
Virginia Pasour
US Army Research Office

Pathogen exclusion in eco-epidemiological models

It is well known that external forcing (whether periodic or stochastic) can alter the conditions under which a population is excluded from or can establish itself within an ecological system. This phenomenon is largely understood when the forcing only has one component but less so when there are multiple components, especially when some are environmental while others are controls imposed by management to achieve its objectives. The problem of how to exercise these controls is of importance in eco-epidemiological systems where the pathogen is to be excluded, particularly so in wildlife systems that impinge on human health and livelihood. Much of the work in this area has focused on the dynamics of the underlying unforced and unmanaged system but progress has also been made on the effect of specific controls (e.g. culling, vaccination) in systems with periodic environmental forcing (e.g. on birth rate, infection transmission). In this paper we wish to add to the literature by taking an algebraic approach based on a quadratic approximation in the forcing strength, linking directly to the pathogen exclusion threshold through the rare invader approximation. This approach generates explicit formulae for the distortion in the pathogen threshold when the forcing is of moderate strength. We can then efficiently explore the behaviour of specific eco-epidemiological models and to make general statements about their behaviour. The algebraic analysis provides a sound basis to extend the analysis to large strength forcing by numerical simulation, of importance when the pathogen threshold reflects resonance in the resident subsystem and the subharmonics and chaos that increased forcing can create. Applications include the effect on threshold behaviour of added structure in epidemiological models and the effect of forcing on coexistence in the presence of apparent competition mediated by pathogen or predator.