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The Perturbation Effect in wildlife diseases: An emergent behaviour of simple models

Population reduction is often used as a disease control strategy when dealing with wildlife hosts; however, in some systems it has been associated with an increase in disease (including bovine tuberculosis in badgers and classical swine fever virus in wild boar). This increase in disease following population reduction is often referred to as the perturbation effect. Several possible reasons for the perturbation effect have been suggested, including increased movement and contact rates, and compensatory reproduction following population reduction.

We use mathematical epidemiological SI models containing key processes, to investigate properties of the perturbation effect and study how it arises as an emergent property of the underlying population and disease dynamic.

In a non-spatial context, we investigate how a change in host behaviour (as a consequence of population reduction) leading to an increase in horizontal disease transmission, can give rise to the perturbation effect. We also investigate how characteristics of demography and disease affect the magnitude of this increase.

In a stochastic spatial context, we investigate the role of density dependent movement between multiple sub populations, and how the horizontal disease transmission between groups can affect the increase. Finally we investigate how different population reduction strategies can maximise the perturbation effect.

We find that the perturbation effect is most likely to occur in disease systems with low disease prevalence, where populations are close to the carrying capacity and the disease is spatially heterogeneous in nature.