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## **The Use of a Geographical Model in Setting Directions for Future Control Methods**

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### ***Introduction***

The structure of the geographical simulation model PossPOP was described in Pfeiffer *et al* (1995). One of the objectives the model development has been to allow evaluation of different control strategies currently available or to be developed in the future. Given the substantial investments required to develop new methods for tuberculosis control it is desirable to have available a technique which allows identifying control methods which are most likely to be effective.

### ***Methods for Control of Possum Tuberculosis***

The objectives of possum tuberculosis control are to decrease local possum tuberculosis prevalence and to limit/prevent the probability of spatial spread of infection. Maximizing the probability of achieving one of the two objectives may require the use of a less than optimal control strategy for the other one.

An effect on local possum tuberculosis infection prevalence or spatial spread of infection can be achieved either through influencing possum population dynamics, transmission mechanisms of *Mycobacterium bovis* infection or susceptibility of possums to infection. Any of the possible control methods to be considered have to be applied in a spatial context. This means that a decision has to be made where to apply control, how often and how effective it has to be at the individual animal level in order

to have the desired effect at the population level. For each control option in consideration the simulation model can be used to identify target values with regard to required aerial coverage, frequency of application and effectiveness at the individual animal level in order to maximize the probability of success. Alternative control methods can be ranked according to the probability of success. Combinations of control strategies can be evaluated and optimised.

### ***Evaluation of Future Control Methods Using PossPOP***

The geographical model PossPOP allows simulation exercises for any geographical location in New Zealand. Within each simulation area control can be applied to specific parts such as bush/pasture margins, specific types of habitat or specific farm paddocks. The effect of possum population control through removal can be simulated at pre-determined times, intervals and effectiveness. Possum population fertility control and the effect of vaccination against *Mycobacterium bovis* infection can be evaluated through modifying the respective probabilities for individual animals which were present within the specified control area at the time of control application.

Before a model can be used for evaluation of control strategies it has be investigated if it produces a valid representation of reality. For this purpose the geographical simulation model PossPOP was used validated against data from the Castlepoint longitudinal study. Sensitivity analyses were conducted to evaluate the importance of specific parameters for the mechanisms represented in the model. After these simulations without control another set of simulations was conducted to experiment with some possible control options.

### ***Simulation without Control***

A series of initial simulation runs was conducted to calibrate model parameters using data from a longitudinal field study of bovine tuberculosis infection in a wild possum

population (Pfeiffer and Morris 1991). The comparison was based mainly on population size, infection prevalence and incidence. It was necessary to calibrate the parameters for survival and infection probabilities to achieve satisfactory agreement between field data and simulation output.

Given the current parameter settings it was possible to maintain endemic disease within the population in the presence of infection in immigrating possums. Simulation runs produced spatial clustering of the disease which was relatively stable in time. This is an emergent property of the model and agrees with findings from field data. Survival analysis showed that survival of simulated possums with clinical tuberculosis compared reasonably well with the field data. Using time-series analysis it was not possible to detect long-term cycling patterns of the disease in an infected population. Spectral analysis was used to further investigate the time series patterns of tuberculosis prevalence and incidence. Prevalence of subclinically and clinically tuberculous animals did show a seasonal pattern. Incidence of infection was not strongly seasonal.

The results of sensitivity analysis of the different transmission mechanisms show that given the current parameter settings transmission through spatial proximity has a strong influence on the infection dynamics in a simulation run. Taking into account recent evidence from field data the importance of mating is underrepresented in the model. Further studies are required to obtain quantitative estimates of the parameters controlling transmission during mating.

### ***Simulation with Control***

A number of options for controlling the disease using reduction of possum population density were evaluated. The success of initial reductions by 75% depended largely on the amount of residual infection remaining in the population after control which was subject to stochastic variation. In 20% of 20 simulation runs the disease did not

become extinct using a single initial reduction in population size. Amongst the control options evaluated only reduction by 75% at three yearly intervals was able to eliminate endemic infection in the presence of infection in immigrants at 5% prevalence.

### **Conclusions**

Simulation models are useful for comparing existing control strategies as well as for designing and setting target requirements for new ones. Combinations of control strategies can be evaluated. It is likely that different control strategies may have to be used in different geographic locations. A model which takes account of geographic information can fulfill this objective. A basic requirement for any such exercise is that the model has been validated against existing data.

### **References**

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