Whakatipu Mahia Possum Eradication Modelling

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1 Introduction

Whakatipu Mahia – Predator Free Mahia plans to eradicate possums over 14,616 ha by 2020, and to suppress mustelids and feral cats. Control is planned in 10 blocks of approximately 1,500 ha each (Figure 1).

We used trap simulation to estimate the expected level of success of various trapping regimes (including trap spacings and length of deployment). The results of this simulation exercise can be used to help guide managers as to the most appropriate trapping regime and provide a level of confidence that the trap regime will meet the eradication goals.

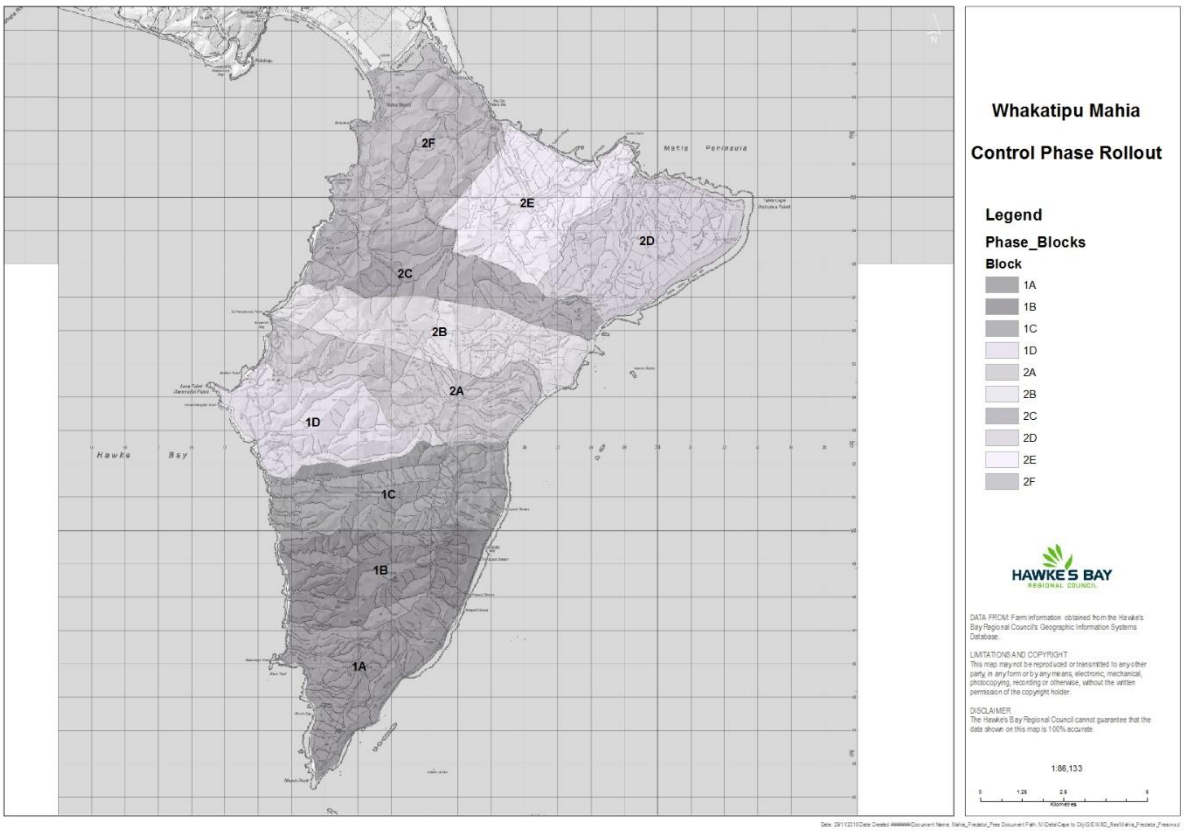

Figure 1. Whakatipu Mahia control phase roll-out.

2 Methods

Simulation modelling was carried out using TrapSim[1], an online 'ready-reckoner' that can be used to simulate the effect of a trapping regime on a pest population. The user specifies the density of the target species, as well as parameters related to home range and trappability,

[1] https://landcare.shinyapps.io/TrapSim

and can then investigate various trapping regimes by altering the trap spacing, trapping interval and likely by-catch.

Based on discussions with staff at Hawke's Bay Regional Council (HBRC)[2], we agreed on a number of parameter values and trapping scenarios.

- The size of the area was set at approximately 1,500 ha.
- A nightly trap check carried out in order to simulate leg-hold traps.
- Length of simulation was set at 50 nights to correspond to the proposed trapping period of 4–6 weeks.
- Five levels of trap spacing were simulated:
  - 100 × 50 m
  - 100 × 100 m
  - 100 × 200 m
  - 150 × 150 m
  - 200 × 250 m.
- Simulations were run with possums, starting at densities of 0.5 and 1 possum per hectare, equivalent to *n* = 750 and 1,500 possums, respectively. Note the current estimate of population density is 0.8% RTC, equivalent to <0.2 possums per hectare.
- Carrying capacity was set at 10 possums per hectare.
- For the purpose of this exercise we assumed a closed system; that is, no population growth, whether *in situ* or via immigration.
- The nightly probability of by-catch was set to 0.1; this accounts for by-catch of non-target animals (e.g. hedgehogs) as well as traps that are sprung but nothing caught.
- The two key animal parameters for simulation modelling are g_0 (the nightly probability of capture for a trap set in the middle of an individual's home range) and σ (the standard deviation of the bivariate normal home range, where 2.45 × σ = the radius of the home range). We carried out simulations at three levels of g_0 and σ (Table 1). These correspond to the potential range of values from various studies (Glen & Byrom 2014).

Table 1. Combination of animal parameter values for the simulations

Trappability g_0	Home range scale (m) σ	Equivalent home range (ha)
0.05	90	15
0.05	170	55
0.13	90	15

[2] 28 November 2018

3 Results

Trapping scenarios with the smallest trap spacings (100 × 50, 100 × 100 and 100 × 200) rapidly reduced possum populations, with the greatest proportional change occurring in the first 10 days of trapping (Figure 2). Eradication was achieved in >90 % of simulations within 50 days for all modelled 50 × 100 m trap spacing scenarios (Table 2).

When trap spacing increased to 100 × 100 m, eradication was achieved in >90 % of simulation runs for realistic trapping parameters (g_0 = 0.05: σ = 170 m, and g_0 = 0.13: σ = 90 m), but was unsuccessful in the conservative worst-case scenario with low trappability (g_0 = 0.05) and small home range (σ = 90 m) (Table 2). Trap spacings coarser than 100 × 100 m had mixed eradication success and were dependent on both trapping parameters (trappability and home range size) and starting possum densities (Figure 3, Figure 4, and Table 2).

Table 2. Proportion of total simulation runs (1,000) where possum populations were eradicated after trapping for 50 days. Scenarios where eradication was achieved in >95% of model runs are shown in bold

Initial possum density	g_0	σ	Trap spacing 100 × 50	100 × 100	100 × 200	150 × 150	200 × 250
0.50	0.05	170	**1.00**	**1.00**	**0.96**	0.69	0.02
0.50	0.13	90	**1.00**	**0.96**	0.46	0.01	0.00
0.50	0.05	90	**0.96**	0.33	0.00	0.00	0.00
1.00	0.05	170	**1.00**	**1.00**	0.92	0.47	0.00
1.00	0.13	90	**1.00**	0.94	0.21	0.00	0.00
1.00	0.05	90	0.91	0.11	0.00	0.00	0.00

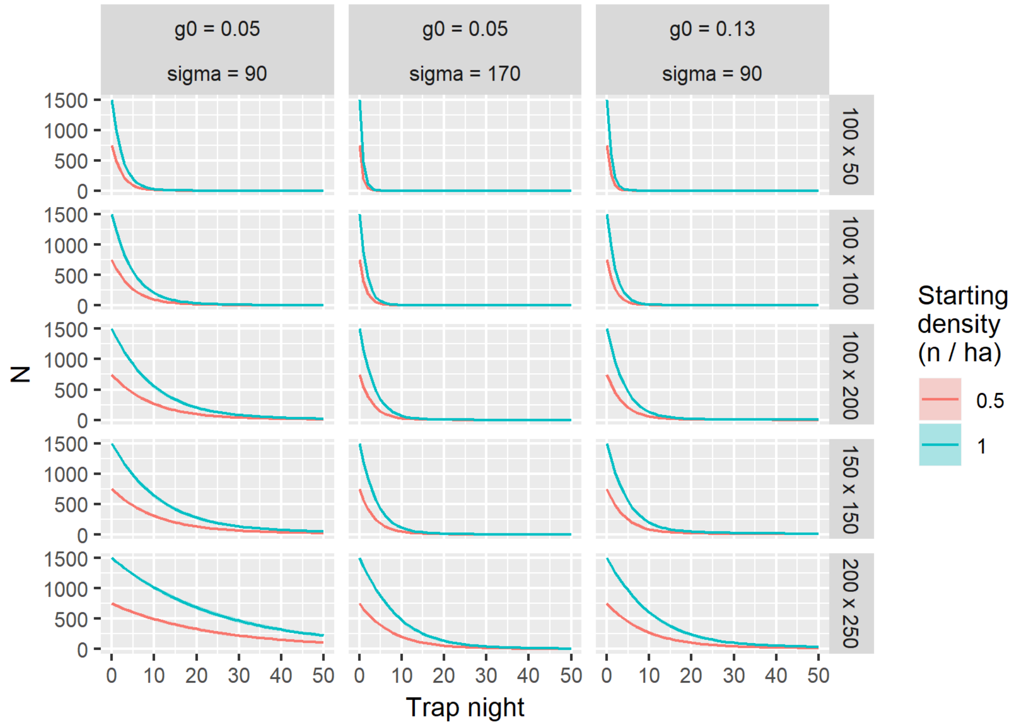

Figure 2. Possum population size over time for modelled scenarios. Panels are shown for each trap spacing (rows) and trapping parameter (columns) combination, and for each starting possum density (blue and red lines).

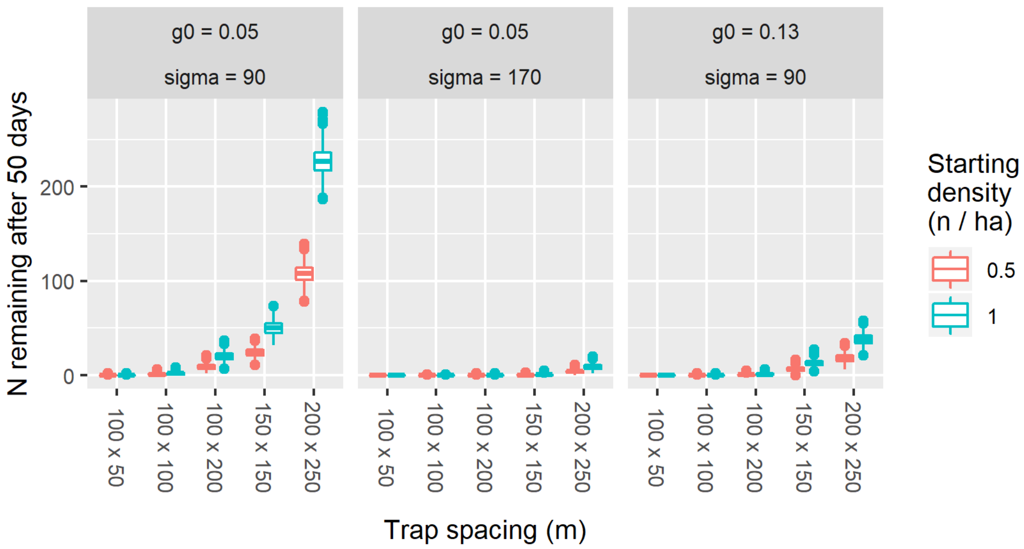

Figure 3. Possum population size (N) after 50 days of trapping for combinations of trap spacing (x axis), trapping parameters (columns) and starting possum densities (blue and red box-and-whisker plots: the 'box' shows the 25th and 75th percentiles, the horizontal line indicates the median value, and the vertical 'whisker' line indicates the range of values). Each scenario comprises 1,000 model runs. Model runs where eradication is achieved have zero population size after 50 days.

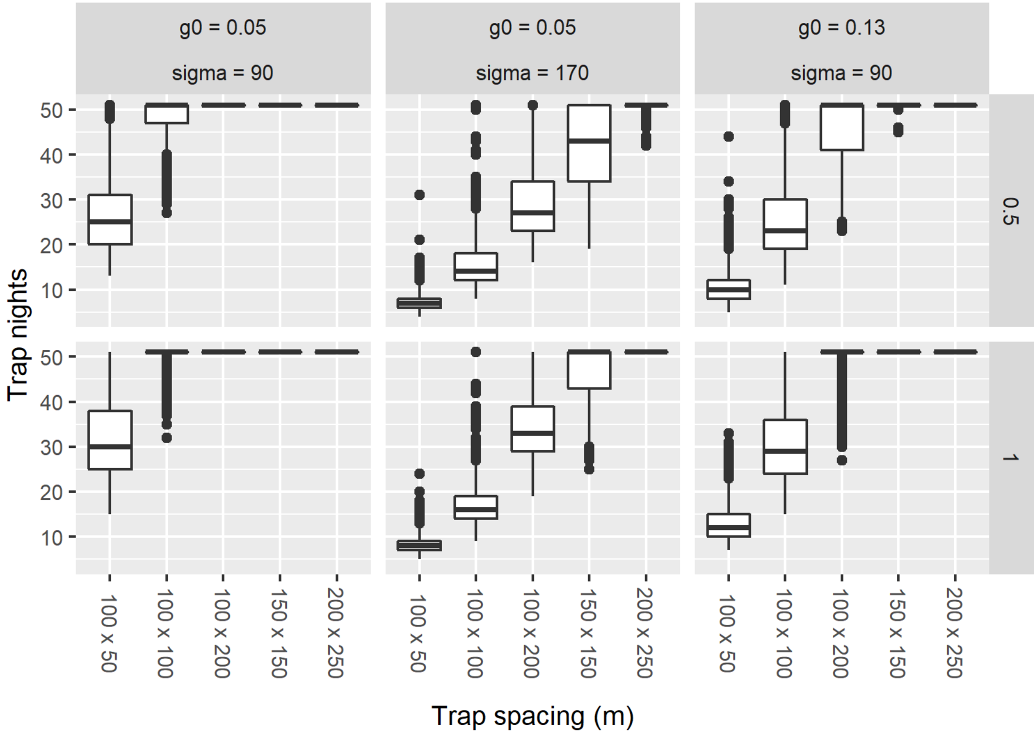

Figure 4. Time to eradication for combinations of trap spacing (x axis), trapping parameters (columns) and starting possum densities (rows). Each scenario comprises 1,000 model runs: the 'box' shows the 25th and 75th percentiles, the horizontal line indicates the median value, and the vertical 'whisker' line indicates the range of values. Time to eradication is calculated for each model run as the night where the modelled possum population was reduced to zero. Values at Trap-nights = 50 indicate that eradication was not achieved within the 50-nights simulation period.

4 Discussion

The results from the simulation suggest that possum eradication could be achieved with a trapping regime using trap spacings of 100 × 100 m. This spacing achieved eradication in >90% of simulation runs for scenarios that modelled realistic trappability and home range size values. In the most conservative (worst-case) scenario with low trappability (g_0 = 0.05) and small home range size (σ = 90 m), eradication is unlikely to be achieved within the time frame for trap spacings wider than 50 × 100 m.

Where eradication was not successful for the proposed trap spacing of 100 × 100 m, the number of remaining animals was low (i.e. <10). Survivors were possibly an artefact of the high starting densities: the densities of 0.5 and 1 possum per hectare are conservatively high, given the current estimates of TCI (Trap Catch Index) = c. 0.8%, which equates to a density of <0.2 possums per hectare (Ramsey et al. 2005).

The initial possum density influenced eradication success, with higher starting possum densities having an increased time to eradication. However, as previously stated, the starting possum densities modelled are highly conservative compared to densities suggested by the TCI estimates.

The results of the trapping simulations are based on the specified parameter inputs, expressed as averages. In reality these are likely to vary among individual possums, which will affect the results. For example, the TrapSim model currently assumes that all individuals have the same level of trappability, however there may be sub-sets of the population that are much harder to capture, thereby making the goal of eradication more difficult. Such variable trappability (especially the last survivors having very low trappability) could result in a significant difference between the simulation predictions and reality. Research on the reasons and consequences related to variable trappability of small mammal populations is currently occurring and will probably become an important addition to TrapSim.

In addition, the current modelling exercise assumed a 'closed population' and does not therefore include immigration from neighbouring areas, which if present compromises the effectiveness of any eradication programme. These features would need to be accounted for in subsequent modelling work.

TrapSim was developed to enable managers to quickly make more informed decisions about the potential relative effectiveness of various trapping networks. It is not an 'oracle' and should not be relied on to make absolute predictions. Rather, it is recommended that when a trapping programme is implemented, data are collected on trapping outcomes to enable comparison with the model predictions and there is flexibility to adapt the trapping network if required.

5 References

Glen A, Byrom A 2014. Implications of landholder buy-in for the success of regional-scale predator control: Part 1: Review of predator movements. Landcare Research Contract Report LC1956, prepared for Hawke's Bay Regional Council.

Ramsey D, Efford M, Ball S, Nugent G 2005. The evaluation of indices of animal abundance using spatial simulation of animal trapping. Wildlife Research 32: 229–237.