# Modelling the future trend of the citrus gall wasp population in southern Australia

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**Abstract:** A modified Nicholson-Bailey model with density-dependence was developed for the citrus gall wasp and its primary parasitoid species to investigate future population trends of the gall wasp after its first arrival in an orchard. Without any human interventions, the model predicted an initial phase of exponential growth of the gall wasp population followed by a period of high-level oscillations. Afterwards, the population was predicted to continue oscillating at high levels, drop to a lower level and then quickly stabilise, drop to a lower level and then undulate before stabilising, or fluctuate between very low and very high levels, depending on the degree of aggregation in the distribution of parasitising attempts by the parasitoid.

Since its first detection in the early 2000s, the citrus gall wasp (CGW), *Bruchophagus fellis*, has spread rapidly throughout the southern citrus-producing regions. In some places, the infestation level appears to be steadily rising, with no signs of easing. Will the CGW population continue to rise, or will it come down after some time? To answer the question, I developed a preliminary model for the populations of CGW and its primary parasitoid species, *Megastigmus brevivalvus*. Both CGW and the parasitoid have a single generation per year. The parasitoid lays its eggs inside the CGW eggs. Unparasitised eggs develop into CGW adults and parasitised eggs develop into adult parasitoid.

The model is a variation of the Nicholson-Bailey model with the inclusion of density-dependence in the growth of the CGW population. It assumes that (1) growth of the CGW population follows the logistic function, (2) the total number of parasitising attempts by a parasitoid is governed by the Holling's type II equation, and (3) the number of parasitising attempts per host follows the negative binomial distribution (NBD). A combination of unpublished and published data was used to estimate the fecundity, sex ratio, and stage specific mortalities of the two species.

Without any human intervention, the model predicted an initial phase of exponential growth of the gall wasp population followed by a period of high-level oscillations. Afterwards, the population was predicted to continue oscillating at high levels, drop to a lower level and then quickly stabilise, drop to a lower level and then undulate before stabilising, or fluctuate between very low and very high levels, depending on the value of the aggregation parameter *k* of the NBD (Figure 1). The size of the stable population decreased with decreasing degree of aggregation (larger *k* values). According to the model predictions, CGW populations in many orchards in the southern citrus-producing regions are still inside the initial growth phase.

A PhD study is underway to refine some of the model parameters and estimate the aggregation parameter for the parasitoid. The updated model can be used to compare the efficiency of different CGW control strategies including releases of parasitic wasps, pruning, applications of systemic and foliar insecticides, and control thresholds.

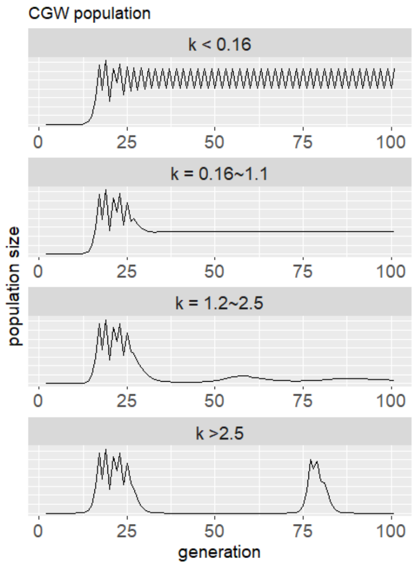


**Figure 1.** Predicted population trends for the citrus gall wasp assuming different aggregation levels for its parasitoid.

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