

Simulating the spread of *Miconia calvescens* in Queensland's Wet Tropics

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To date, there have been few attempts to model the dispersal of invasive weeds in rainforests to create predictive simulation models for their management. This may be partly due to the difficulty of describing the movement of vertebrate seed dispersers which are responsible for dispersal of most rainforest plant species, and partly due to a lack of baseline data on invasive species.

We address these issues by constructing a single species, individual based and spatially explicit simulation model. The model is based on an expert understanding of the ecological processes driving dispersal and invasion by fleshy-fruited species in Wet Tropics rainforests (north Queensland), and allows us to examine how these small-scale processes create population-level patterns and rates of spread across a landscape. This is an extremely useful tool for:

- 1) predicting the spread of invasive species like *Miconia calvescens* (Melastomataceae) in rainforest landscapes;
- 2) understanding which ecological processes dominate and drive the spread of weeds; and
- 3) supporting management decisions about efficient allocation of resources in eradication efforts.

The generalised modelling framework can be used to examine any vertebrate dispersed plant, but for the purposes of this study we parameterised the model using detailed and empirically derived dispersal and survivorship curves based upon extensive field data for native plants with similar characteristics (Dennis and Westcott 2007) to *Miconia calvescens*, a class one invasive weed in Queensland. We incorporated estimates of seed dispersal patterns by rainforest frugivores, and plant mortality rates due to age and population densities at two scales, as well as maturation rate and fecundity.

We used this model to investigate rates and patterns of spread around areas currently under active eradication efforts as part of Biosecurity Queensland's 'Four Tropical Weeds' program (Murphy *et al.* in press). Early model predictions overestimated rates of spread and population size compared to observed and historical data. However, refinements to the model mechanics, including the implementation of habitat suitability metrics and anisotropic dispersal processes

significantly improved the correlation between modelled and observed invasive populations.

The modelling framework has also allowed us to investigate key driving processes of invasion ecology. In particular, we have examined how the accumulation of specialised enemies over the time-series of an invasion alters the rate and pattern of spread of an invasive plant species.

Finally, we have investigated how human management and eradication efforts affect the containment or spread of an invasive over time. Incorporating Agent Based Modelling techniques into the broader simulation model has allowed us to begin estimating the effectiveness and resource requirements of different strategic approaches to invasive management and eradication.

The construction of a model based on the dispersal of rainforest weeds by animals provides an excellent tool for both studying the fundamental ecology of rainforest weeds, and predicting the spread and effectiveness of management for invasive species such as *Miconia calvescens* in Queensland's Wet Tropics. In addition to providing on-the-ground managers with an easy to use decision support tool, the insights gained provide additional information for policy decisions about invasive management and eradication.

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