Detecting species without species-specific guides

A new, trait-based model of detectability

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Imperfect detectability of plants and animals during ecological surveys is a major issue. Get it wrong and you run the risk of endangered species being lost when development is permitted but the species was still present. Or, on the other hand, you risk an invasive species breaking out when control efforts are stopped too soon because the invading organism was thought to be not there. Imperfect detectability can lead to biased estimates of abundance or occupancy, impaired ability to detect change or response to management action and ultimately leads to poorly informed management decisions.

These days the problem of imperfect detectability is widely recognised, and considerable research has been done in this area by the Environmental Decisions Group.

A range of methods exist for estimating detectability, including distance sampling, mark-recapture, N-mixture models, zero-inflated occupancy models and time-to-detection models. Each of these models has its own set of assumptions, data requirements and applications. Often, the data requirements of these models are heavy; data, including abundance counts, presence-absence observations and times-to-detection, are variously required from multiple sites and multiple observers. What that adds up to is that, at this time, estimates of detection probability are available for relatively few species.

If you don’t have a species-specific model to guide how much effort you need to expend to detect a species that is present (with confidence), what can you do? Maybe you could focus on some character trait of that species as a generic guide? For example, if you were aware that it took a certain amount of effort to detect a weed species with red flowers, maybe that knowledge could help you decide how much effort would be required to find an unrelated species that also had red flowers. We asked whether we can learn about the influence of species traits on detectability, and used trait-based models to predict the detectability of species for which no species-specific model exists.

Using a time-to-detection model (see Garrard et al. 2008 and the box ‘Have we looked hard enough?’), we investigated the influence of a range of species traits on the detectability of grassland plant species. Examples of the traits investigated were local abundance, height, likelihood of flowering at the time of survey, flower colour, leaf area, number of similar grassland species and whether the species grows in clumps.

We found that local abundance has a clear influence on detectability, with species that occur in higher numbers having lower detection times (higher detection rates) than those occurring in small numbers (Figure 1). Species are also more likely to be detected if they are unique or in their peak flowering month at the time of survey, although these results are less definitive.

Our results also show that flower colour may have a large effect on detectability, with pink and red flowered species potentially more easily detected than those with inconspicuous or yellow flowers. This makes sense in native grasslands, where there are many yellow flowers and few pink or red flowers. The influence of flower colour is still very uncertain. We used only coarse categories and it will be interesting...

Figure 1: The relative size of the influence of traits on detection rate (mean and 95% credible intervals).

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to see whether more objective measures of flower colour can help resolve this uncertainty.

Using trait-based detectability models, we were able to predict average times-to-detection reasonably well for new species (Figure 2). I'm probably biased, but I think trait-based detectability models are an exciting development in the field of detectability research and have enormous potential to improve our environmental decision making. With more than 1300 nationally-listed threatened plant species and another 400 animal species in Australia alone, it's impossible to consider constructing a species-specific detectability model for every threatened species. Consider the effort expended on developing guidelines for the detection of the spiny rice flower (see box 'Have we looked hard enough?).

While they may not perfectly predict individual species' detection probabilities, trait-based models should provide sensible bounded estimates of detectability on which to base survey design and effort requirements. 

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Reference


Figure 2: Comparison of ln(ave detection time) estimates for eight species withheld from the model-fitting data set, as predicted by the trait-based (x-axis) and single-species (y-axis) models. Filled diamonds are predictions for expert observers and open circles are predictions for intermediate observers. Error bars are 95% credible intervals.