Management recommendations for invasive Scotch broom (*Cytisus scoparius* L.) in Australia and USA depend on invasion stage, demographic targets and management cost

Natalie Z. Kerr[1,2], Peter W.J. Baxter[3] and Yvonne M. Buckley[1,2]
[1] School of Biological Sciences, The University of Queensland, St Lucia, QLD 4072
[2] CSIRO Ecosystem Sciences, Ecosciences Precinct, Dutton Park, QLD 4102, Australia
[3] Centre for Applications in Natural Resource Mathematics, School of Mathematics and Physics, The University of Queensland, St Lucia, QLD 4072, Australia
(natalie.kerr@uqconnect.edu.au), (y.buckley@uq.edu.au)

Summary A common approach for improving the efficacy of weed management has focused on better understanding demography in order to identify vital rates or life history stages that result in the greatest reduction in population growth rate. For Scotch broom (*Cytisus scoparius* L.), the traditional demographic analyses recommend targeting the survival of seedlings and juveniles for low-density infestations of Scotch broom (Parker 2000, Stokes *et al*. 2006) and extra-large adults at high-density to have the greatest impact on population growth rates. However, demographic models ignore both economic considerations of different management strategies and the feasibility of different management options. Consequently, the strategy resulting in the greatest reduction in population growth rate per dollar spent may not coincide with the recommendations from demographic models alone.

We used an economic sensitivity analysis devised in Baxter *et al*. (2006), which integrates both management cost and efficacy with the traditional sensitivity analysis. This analysis allows us to assess the cost-efficiency, or 'marginal efficiency' of different management strategies, which is the reduction in population growth rate per dollar spent on management. We used existing matrix population models of low-density populations of broom along the Shoalhaven River in New South Wales, Australia (Stokes *et al*. 2006) as well as across three invasion stages – edge, intermediate and centre – in prairie fields and city parks of Washington, USA (Parker 2000). We collected data on management cost, life stages affected and efficacy of control methods used at these study sites in order to calculate their marginal efficiency.

We found that prescribed fire and hand pulling were the most cost-efficient methods used in prairie fields and city parks of Washington. However, all control methods used at these sites affected the survival of similar life stages. In this case, the marginal efficiencies of control methods across all study sites corresponded with the traditional analysis of population matrix models, whereby control methods targeting life stages that contribute the most towards the asymptotic λ were also the most cost-efficient. Because of the lack of variation in demographic targets for prairie fields and city parks, the economic sensitivity analysis was highly driven by management cost. Along the Shoalhaven River in Australia, cut stump was the most cost-efficient method. Despite spot spraying being three times more expensive, it was only slightly less cost-efficient than the cut stump method because of its broader demographic targets. Therefore, this case shows that both demography and cost are the key drivers of the economic sensitivity analysis when there is high variation in demographic targets across control methods.

We also found that managing Scotch broom in prairie fields of Washington was the most cost-efficient, while management in Australia was the least so. Also, the cost-efficiency of management decreased with increasing density and invasion stage for both prairie fields and city parks.

Our study highlights the importance of considering demographic targets, invasion stage and management cost to make sound decisions for Scotch Broom management.

Keywords Economic sensitivity analysis, *Cytisus scoparius*, Scotch broom, demography, management, efficacy, marginal efficiency.

ACKNOWLEGDMENTS

Special thanks to Inger Gruhn, Todd Zuchowski, Mary Chramiec, Casey Dennehy, Rick Johnson, Eric Coombs and Rory Denovan from agencies in Washington and Matthew Dickinson and Geoffrey James from agencies in NSW for their help with data compilation. We would also like to thank CSIRO Ecosystem Sciences and the Australian Research Council for financial support.

REFERENCES

Baxter, P.W.J., McCarthy, M.A., Possingham, H.P., Menkhorst, P.W. and McLean, N. (2006). Accounting for management costs in sensitivity analyses of matrix population models. *Conservation Biology* 20, 893-905.

Parker, I. (2000). Invasion dynamics of *Cytisus scoparius*: A matrix model approach. *Ecological Applications* 10, 726-743.

Stokes, K., Buckley, Y.M. and Sheppard, A. (2006). A modelling approach to estimate the effect of exotic pollinators on exotic weed population dynamics: bumblebees and broom in Australia. *Diversity and Distributions* 12, 593-600.