Economic tools ≠ policy actions. Why benefit cost analyses are not a policy panacea for weedy but commercially valuable plant species

Stephen B. Johnson
New South Wales Department of Primary Industries, Locked Bag 21, Orange NSW 2800
(stephen.johnson@dpi.nsw.gov.au)

Summary Both governments and industry have highlighted the need to accurately identify and prioritise the positive and negative impacts of plants that are both weedy and commercially valuable. The introduction and subsequent naturalisation of such species results in conflict between members of the community: between those who derive benefits or positive impacts from the plant; and those who pay for the negative impacts that the plant may cause. Even when such impacts can be accurately identified, the prioritisation of conflicting impacts is mired by competing and conflicting values.

A range of economic tools have been proposed as one panacea to this policy conundrum. Foremost among these are benefit cost analyses. This paper examines the reasons why this economic tool fundamentally fails to address this situation.

While society is familiar with pricing economic benefits and loss, and increasingly the benefit of positive ecosystem services such as nitrogen fixation, it is often nearly impossible to identify and cost both direct negative environmental impacts such as the loss to biodiversity and indirect positive environmental impacts such as human well-being. While research can provide guidance as to what many of these values may be, it is both economically and temporally costly. Even if the positive and negative impacts are properly researched or intelligently assigned/assumed, what the outcome means in a policy (and political) context is far less clear, giving little real guidance about how best to manage these plants.

It is proposed that a fundamentally different process or system of evaluation is needed, one that can deliver robust answers based on available evidence, that highlights information deficiencies and that is clearly linked to weed management policy tools. Post-border Weed Risk Management (WRM) systems already address these issues when they examine the negative impacts of weeds on economic, environmental and social values. This paper proposes combining elements of a system that assesses positive impacts or utility (Walton unpublished) with WRM systems resulting in a decision support model to guide policy and management of weedy but commercially valuable plant species.

Keywords Weed risk management, utility, negative impact, positive impact, conflict, commercial, contentious.

INTRODUCTION

Economic decisions underpin the intentional introduction and use of species by humans (Bennett and Virtue 2004). Benefits from the use of these commercially valuable species are expected, e.g. Ferdinands *et al.* (2011). In some cases, commercially valuable species ‘jump the fence’ and become weedy. Conflict results if these species cause significant negative impacts outside planted areas. These species are variously known as contentious, commercial or conflict species.

The conflict that surrounds these species is not easily resolved. While there are tools to assess the negative impacts a weedy plant causes, for example post-border Weed Risk Management (WRM) systems (Anon. 2006, Auld *et al.* 2012), and the economic benefit that can be derived from a plant’s cultivation (also known as positive impacts/utility), there are comparatively few means of balancing these impacts (Johnson 2010). This is particularly the case where the positive and negative impacts are experienced by different sectors, for example primary producers and consumers often benefit or experience positive impacts from the introduction of a new plant species but, upon naturalisation and spread, the negative impacts of a weedy plant are borne by the environment and custodians for its care (Anon. 2006).

There are at least 18 general categories as to why plants are introduced into areas where they are not native, including for: human foods; the production of edible oils; herbal and medicinal purposes; and animal forage/food (Johnson unpublished). Examining just two of these categories, that is human foods and edible oils, well over 100 species used for these purposes are known to have naturalised in New South Wales (Royal Botanic Gardens and Domain Trust 2012, Johnson unpublished). Many of these food and oil species have minor nuisance (negative) impacts at best and the benefit of cultivating these species is assumed to outweigh the costs of managing any naturalised plants. Having said this, a subset of these food and oil species [including European olive (*Olea europaea* L. subsp.

europaea), some blackberry (*Rubus* L.) species and strawberry guava (*Psidium cattleyanum* var. *cattleyanum* Sabine) which is a particular problem on Lord Howe Island], have significant negative impacts. Others such as the passionfruit (*Passiflora* L.) species and taro (*Colocasia esculenta* (L.) Schott) may be weeds of the future (Johnson unpublished). Weighing the potential benefits and costs produced by a potentially large number of conflict species is not easy. This has led to calls for a range of economic tools including benefit cost analysis (BCA) to be applied as a panacea to this policy conundrum.

This paper discusses why this economic tool fundamentally fails to address this situation. Since little guidance is produced from BCA on how to manage conflict species, this paper proposes a rather different system of evaluation, which is a decision support system that can: deliver assessments for a wide range of species and situations; produce robust answers based on available evidence; highlight information deficiencies; and be clearly linked to weed management and policy decisions. It is partly based on the impact assessments found in post-border WRM systems.

IDENTIFICATION AND ASSESSMENT OF WEED RISKS (NEGATIVE IMPACTS)

Post-border WRM systems have been designed to facilitate 'evidence-based and defensible decision making' about the prioritisation and management of plant species that pose negative impacts (Ferdinands *et al.* 2010). They use general questions to assess the negative impacts of assessed plants on the: reduction in the establishment of, and yield/amount of desirable plants (and animals dependent on these); reduction in the quality of products, diversity or services then available; restriction of physical movement of people, animals, vehicles, machinery and/or water; potential to negatively affect human and/or animal health; and impact on a range of environmental health indicators such as soil salinity, stability and altered nutrient status (Champion and Clayton 2001, Virtue 2005, Johnson 2009, Virtue 2010, Victoria Department of Primary Industries 2011). In addition to these, specific questions on the alteration of fire behaviour and regime (Stone *et al.* 2008, Setterfield *et al.* 2010), or cultivation history/naturalisation (Champion *et al.* 2008) are included.

The positive impacts of plant species that are both weedy and commercially valuable are not assessed by these systems, excepting the ecosystem services evaluated as part of the environmental health impact question (Virtue 2005, Stone *et al.* 2008, Johnson 2009) or the volume of trade question evaluated in the Australian aquatic weed risk assessment model (Champion *et al.* 2008). Aside from limited research, for example Johnson (2010) and Ferdinands *et al.* (2010), there are relatively few published attempts to weigh the positive and negative impacts of conflict species so that policy and management responses can be formulated (excepting Clarkson *et al.* 2010, Friedel *et al.* 2010, Grice *et al.* 2010).

ECONOMIC TOOLS TO ASSESS BENEFITS AND COSTS

After extensive reviews, various authors including Hughey *et al.* (2003) and Heikkila (2010) concluded that "invasive species are fundamentally an economic problem in terms of their causes, effects and remedies" Ferdinands *et al.* (2010). Economic decisions underpin many of the decisions related to the introduction and use of conflict species.

Building on this conclusion, Ferdinands *et al.* (2010) examined a range of economic tools available for risk assessing conflict species. They suggested that BCA was, for some species, the most appropriate economic tool to assess both the costs (negative impacts) and benefits (positive impacts) of conflict species. Their study focused on a partial BCA, an analysis that does not explicitly cover all benefits and costs across economic, environmental and social parameters, rather those that can be readily quantified. Their superordinate research is the first real attempt by researchers not only to balance the benefits and costs of a conflict species (gamba grass, *Andropogon gayanus* Kunth), but to use this information to inform its management (Drucker and Setterfield 2008, Ferdinands *et al.* 2010, Department of Natural Resources Environment the Arts and Sport 2010). It was informed by over 10 years of research costing at least $1 million (K. Ferdinands pers. comm.). As such, even though it was a partial BCA, it was temporally and economically expensive. It is postulated that this is one reason why calls for BCA analysis, particularly for national BCA frameworks for conflict species (e.g. Miles *et al.* 2009) are so rarely implemented.

There are other issues with using BCAs. Firstly, while gamba grass has specific, quantifiable economic impacts making it well suited to the partial BCA approach outlined above, in many cases negative impacts are either partly (de Wit *et al.* 2001) or mostly unmeasured or unknown (Hughey *et al.* 2003, Heikkila 2010). This introduces significant uncertainty into the analyses, the subject of some important recent theoretical modeling research (Yokomizo *et al.* 2012).

Secondly, it is important to remember that conflict species have significant negative impacts not only on economic values (often quantified), but also on environmental and societal values (often not quantified).

The estimates or assumptions used to address these unquantified information gaps, while usually well informed, are often contentious.

Thirdly, there are a large number of conflict species with significant negative impacts that potentially require BCA, and there are likely to be further species in future. Even if 'type' or 'case study' BCAs are conducted (Miles *et al.* 2009), the uncertainty around the negative and positive impacts associated with any particular species are unlikely to stand scientific scrutiny, far less the significant lobbying and political pressure by advocates of certain species.

It is for these reasons that many have concluded that BCA, even partial BCA, may not be possible for many weed species (K. Ferdinands pers. comm.). For these species, alternative ways of incorporating economic analyses into management decisions for such weeds may be required.

AN ALTERNATE PLANT UTILITY (POSTIVE IMPACT) ASSESSMENT

A decision support model or ranking system to jointly assess the negative impacts and potential benefits or utility of conflict species is needed (Bennett and Virtue 2004, Anon. 2006). This will, necessarily, be external to current post-border WRM systems (see Auld 2012, and Auld *et al.* 2012 for further examination of this issue).

It is proposed that elements from post-border WRM systems assessing negative impacts be combined with parts of a proposed Queensland pest prioritisation system (Walton unpublished). That system used general questions to assess the benefits or utility arising from economic (revenue; diversification; gardens; land stabilisation; display; animal fodder), environmental (alternate food or shelter for native species; amelioration or repair of ecosystem functions or water quality; carbon sequestration) and social (medicinal; traditional food; cultural; recreational; aesthetic) plant uses.

As is the case with the examination of negative impacts in current WRM systems, general questions would be used to facilitate evidence-based and defensible decisions. Once scored, the relative positive impact (benefit or utility) could be compared with the negative impact of the plant and policy and management responses determined using a decision support matrix (Johnson 2010). Other benefits of this approach include that: a large number of species could be easily and specifically assessed using this semi-quantitative framework; accurate data, while important, is not crucial given the scoring based system of evaluation; assumptions made can be recorded and revised if/when new information comes to light; and with a minimum of training, assessments can be made on a range of scales, for example see Johnson and Charlton (2010). Translation of these ideas into a functional peer-reviewed system awaits development.

ACKNOWLEDGMENTS

Information, comments and ideas from members of the Australian Weed Risk Management forum and NSW state and local government staff is gratefully acknowledged. Particular thanks are extended to Dr Keith Ferdinands, Associate Professor Samantha Setterfield, Dr John Virtue, Mr Steve Csurhes, Ms Jackie Steel, Adjunct Professor Bruce Auld and Dr Paul Champion.

REFERENCES

Anon. (2006). 'HB 294:2006 National post-border weed risk management protocol'. (Standards Australia/Standards New Zealand/Co-operative Research Centre for Australian Weeds).

Auld, B. (2012). An overview of pre-border weed risk assessment and post-border weed risk management protocols. *Plant Protection Quarterly* 27, (*in press*)

Auld, B., Johnson, S., Ainsworth, N., Brunel, S., Csurhes, S., Downey, P., Ferdinands, K., Hannan-Jones, M., Hennecke, B., Keese, P., Kriticos, D., Low, D., Munday, C., Panetta, F. D., Robold, A., Setterfield, S., Steel, J., Stewart, K. and Virtue, J. (2012). Further development of the national weed risk management protocol. Proceedings of the 18th Australian Weeds Conference, *this volume* (Weed Society of Victoria, Melbourne).

Bennett, S.J. and Virtue, J.G. (2004). Salinity mitigation versus weed risks – can conflicts of interest in introducing new plants be resolved? *Australian Journal of Experimental Agriculture* 44, 1141-56.

Champion, P.D., Burnett, D.A. and Petroeschevsky, A. (2008). 'Risk assessment of tradeable aquatic plant species in Australia'. (National Institute of Water and Atmospheric Research, Australia. O'Connor, Western Australia).

Champion, P.D. and Clayton, J.S. (2001). 'A weed risk assessment model for aquatic plants in New Zealand.' In, *Weed Risk Assessment*. Eds. R.H. Groves, F.D. Panetta and J.G. Virtue, pp. 194-202 (CSIRO Publishing, Collingwood, Victoria).

Clarkson, J.R., Grice, A.C., Friedel, M.H., Setterfield, S.A. and Ferdinands, K.B. (2010). The role of legislation and policy in dealing with contentious plants. In, Proceedings of the 17th Australasian Weeds Conference, (ed.) S.M. Zydenbos, pp. 474-7. (New Zealand Plant Protection Society, Christchurch).

de Wit, M.P., Crookes, D.J. and van Wilgen, B.W. (2001). Conflicts of interest in environmental management; estimating the costs and benefits of a tree invasion. *Biological Invasions* 3, 167-78.

Department of Natural Resources Environment, The Arts and Sport. (2010). 'Weed management plan for *Andropogon gayanus* (gamba grass) URL http://www.nretas.nt.gov.au/__data/assets/pdf_file/0011/13115/FINAL_WMP_GAMBA_GRASS.pdf

Drucker, A.G. and Setterfield, S.A. (2008). 'Gamba grass benefit-cost analysis'. (Charles Darwin University, Darwin).

Ferdinands, K.B., Setterfield, S.A., Clarkson, J.R., Grice, A.C. and Friedel, M.H. (2010). Embedding economics in weed risk management to assess contentious plants. In, Proceedings of the 17th Australasian Weeds Conference, (ed.) S.M. Zydenbos, pp. 482-5. (New Zealand Plant Protection Society, Christchurch).

Ferdinands, K., Virtue, J., Johnson, S.B. and Setterfield, S.A. (2011). 'Bio-insecurities': managing demand for potentially invasive plants in the bioeconomy. *Current Opinion in Environmental Sustainability* 3, 43-9.

Friedel, M.H., Grice, A.C., Clarkson, J.R., Ferdinands, K. and Setterfield, S.A. (2010). How well are we currently dealing with contentious plants? In, Proceedings of the 17th Australasian Weeds Conference, (ed.) S.M. Zydenbos, pp. 470-3. (New Zealand Plant Protection Society, Christchurch).

Grice, A.C., Clarkson, J.R., Friedel, M.H., Ferdinands, K. and Setterfield, S. (2010). Containment as a strategy for tackling contentious plants. In, Proceedings of the 17th Australasian Weeds Conference, (ed.) S.M. Zydenbos, pp. 486-9. (New Zealand Plant Protection Society, Christchurch).

Heikkila, J. (2010). Economics of biosecurity across levels of decision-making: a review. *Agronomy for Sustainable Development* 31, 119-38.

Hughey, K.F.D., Cullen, R. and Moran, E. (2003). Integrating economics into priority setting and evaluation in conservation management. *Conservation Biology* 17, 93-103.

Johnson, S.B. (2009). 'New South Wales Weed Risk Management System. Instruction Book'. (Industry and Investment New South Wales, Orange).

Johnson, S.B. (2010). A way to weigh dread weeds – a policy framework to estimate the costs and benefits of commercially valuable invasive species. In, Proceedings of the Global Biosecurity Conference, pp. 122-3.

Johnson, S.B. (unpublished). The A to Z of conflict species that have jumped the fence in New South Wales.

Johnson, S.B. and Charlton, S.A. (2010). Evolution, not revolution. Getting stakeholders on board with the roll out of the national post-border weed risk management protocols in New South Wales. In, Proceedings of the 17th Australasian Weeds Conference, (ed.) S.M. Zydenbos, pp. 493-6. (New Zealand Plant Protection Society, Christchurch).

Miles, R.L., Kinnear, S., Friedel, M., Grice, A.C., van Klinken, R.D., Setterfield, S. and Herpich, M. (2009). 'Policy, institutional and managerial considerations in managing weeds with a commercial value'. (Land and Water Australia, Canberra).

Royal Botanic Gardens and Domain Trust (2012). PlantNET - The Plant Information Network System of The Royal Botanic Gardens and Domain Trust, Sydney, Australia. http://plantnet.rbgsyd.nsw.gov.au.

Setterfield, S.A., Ferdinands, K., Rossiter-Rachor, N. and Douglas, M.M. (2010). The Northern Territory's Weed Risk Management System: an application of the National Post-Border WRM Protocol. *Plant Protection Quarterly* 25, 71-4.

Stone, L.M., Byrne, M. and Virtue, J.G. (2008). An environmental weed risk assessment model for Australian forage improvement programs. *Australian Journal of Experimental Agriculture* 48, 568-74.

Victoria Department of Primary Industries (2011). Pest plants. URL http://www.dpi.vic.gov.au/vro/weeds

Virtue, J.G. (2005). South Australian weed risk management system. (Department of Water, Land and Biodiversity Conservation, South Australia).

Virtue, J.G. (2010). South Australia's Weed Risk Management System. *Plant Protection Quarterly* 25, 90-4.

Walton, C. (unpublished). Prioritisation of pests in Queensland.

Yokomizo, H., Possingham, H.P., Hulme, P.E., Grice, A.C. and Buckley, Y.M. (2012). Cost-benefit analysis for intentional plant introductions under uncertainty. *Biological Invasions* 14, 839-49.