A decision tool to assist in ranking the declared plants of Western Australia

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Summary A decision tool was developed to demonstrate the likely agricultural and environmental impacts of the large number of declared plants present in Western Australia (WA). The purpose of developing the tool was to provide a rigorous and objective method for prioritising government actions associated with declared plants in WA. Conducting a full benefit cost analysis (BCA) on each species would be time consuming and inefficient, given that expert knowledge can easily and reliably determine those declared plants that are known to have relatively little impact on agricultural or environmental resources. The BCA was conducted in two stages. The first stage (reported here) was an initial impact assessment of all declared plants, performed using the expert panel approach. The second stage will involve a full benefit cost analysis conducted on selected species that are given a high ranking by the initial impact assessment. The processes involved in conducting these stages, and some impact assessment results, are described in this paper.

Keywords Prioritisation, ranking, declared plants, impact assessment, benefit cost analysis, expert panel.

INTRODUCTION

In Western Australia (WA) the *Biosecurity and Agriculture Management Act 2007* (BAM Act) and subsidiary legislation require landholders to control declared pests (plants and animals) if present on the land they manage. Because plants can spread across property and jurisdictional boundaries, effective control of declared plants may at times be difficult and costly for individual land managers to achieve (economists term the spread of declared plants as an *externality* and their control as a *public good*).

Governments also face costs associated with ensuring that land managers comply with control requirements for declared plants. Before engaging with land managers over the control of declared plants, it is appropriate for government to first assess whether the benefits of enforcing the control of a particular declared plant species outweigh the costs, i.e. whether government intervention is cost-effective. For those declared plants that are cost-effective to control, governments must also identify which species will provide the biggest benefits per dollar, given government budget constraints and alternative uses of public funding. Both aspects require governments to prioritise the target species and the measures directed at them.

The benefits of declared plant control are greatest in the earlier stages of plant invasion. The generalised invasion curve (Anon. 2009) shows that the benefits of control are greatest to the left of the curve where the area of habitat occupied is low, and where prevention or eradication is most cost-effective. Prevention or eradication is generally not economically or technically feasible to the right of the curve, and the associated costs are significantly higher. The role of government when dealing with an invasive species to the right of the curve is often limited to providing information and capacity building to enable industry and the wider community to manage the species, usually by protecting assets from impacts.

Processes for prioritising declared plants and other significant weeds in Australia have been documented for WA (Passeretto and Powell 2012), South Australia (Virtue 2010) and Victoria (Weiss and McLaren 2002, Weiss *et al*. 2002).

This paper outlines the methodology developed by the Department of Agriculture and Food, Western Australia (DAFWA) to rank the impacts of declared plants, and provides some initial results.

MATERIALS AND METHODS

The decision tool developed to provide rankings in WA was based on benefit cost analysis (BCA) (e.g. Campbell and Brown 2003, Pannell *et al.* 2012), conducted in two stages. The first stage involved an initial impact assessment on all declared plants[1] present in WA. The second will involve conducting a full BCA on those species that received high rankings in the impact assessment.

[1] The weeds subjected to ranking comprised all declared plants established in WA, together with several Weeds of National Significance present but not yet declared; in this paper they are referred to collectively as **declared plants**.

Because there is a large number of declared plants present in WA (96 at the time of developing the decision tool), the list of declared plants was first ranked based on impact assessment. The impact assessment was conducted using the expert panel approach, which is a variant of the Delphi Method where highly technical and complex knowledge is synthesised from experts and combined in order to achieve an optimal decision (see Dufour *et al*. 2011, Pulkkinen and Simola 2000, Slocum 2005). The initial rankings provided by the impact assessment identified priority declared plants for which a full BCA will be conducted.

The list of 96 declared plants was reduced to the more manageable total of 73 by assessing each of the following congeneric groups of weeds as a single 'species': blackberry (*Rubus* spp.), prickly pear (*Opuntia* spp.), thornapple (*Datura* spp.), weedy asparagus (*Asparagus* spp.), and willow (*Salix* spp.).

Impact assessment The impact assessment employed the expert panel approach. A panel of ten experts who were familiar with the impacts of declared plants in WA scored each declared plant according to their knowledge of the benefits of controlling the plant. Agricultural and environmental benefits were scored separately, and both private (landholder) and public (government and the wider community) benefits were considered.

The scores ranged from 1 (i.e. the uncontrolled plant has very little impact on profit or the environment) to 5 (uncontrolled plant has significant impact). The costs of control were also scored, but were not eventually considered in the impact assessment, because they were more complex in nature and the expert knowledge of these costs was more limited than knowledge of the benefits of control.

The term *impact* in this assessment had two dimensions: (1) the capacity of a species to change its surroundings, and (2) species invasiveness (ability to spread). A species with an impact score of 1 had both low 'capacity to change' and 'invasiveness', whereas a high rating for both gave a score of 5.

Each expert panel member provided impact scores for each declared plant. Where there was little variation in scores, the average score was used. Variation was measured as the difference between the maximum and minimum impact scores. Where this difference was 0, 1 or 2 (i.e. the scores were within the range of 1–3, 2–4 or 3–5), variation was considered to be minor; however, where this difference was 3 or 4 points, the variation was viewed as significant and was investigated.

For those declared plants with wide variation in scores, outliers were removed if observed. Of the 73 species and groups of declared plants considered by the expert panel, 52 agricultural impact scores and 54 environmental impact scores had low variability, and the overall scores for these were determined by averaging the scores from each panel member.

Because variation was still significant in some species after outliers had been removed, a workshop of panel members was conducted to discuss the sources of variation and the impacts of the particular declared plants, and to form a consensus on the impact score for those species.

Benefit cost analysis (BCA) based on Pannell *et al.* (2012) will be conducted on species that received high rankings in the initial impact assessment. The full BCA will involve calculation of a Benefit Cost Ratio (BCR), derived from the Net Present Value (NPV) of the *benefits* of declared plant control divided by the NPV of the *costs* of control. Using this approach, a BCR >1 indicates that the benefits of declared plant control are greater than the costs and, therefore, control of that declared plant is cost-effective. Conversely, a BCR <1 implies that the benefits of declared plant control are less than the costs, and control of that declared plant would not be cost-effective; thus, the larger the BCR, the more cost-effective the control effort. Declared plants with a relatively high BCR will have higher priority for intervention than those with relatively low BCRs.

RESULTS

Results are for the initial impact assessment only, because full BCAs had not been completed at the time of writing this paper.

The top 15 declared plants ranked on their agricultural impact are presented in Table 1.

The declared plants with low agricultural and environmental impact scores (where both scores were less than 2.0) are presented in Table 2.

DISCUSSION

This section discusses the methodology and initial results of the impact assessment process used to rank WA's agricultural declared plants.

The ranking and prioritisation approaches described by Passeretto and Powell (2012), Virtue (2010), Weiss and McLaren (2002) and Weiss *et al*. (2002) are generally more detailed and complex than the decision tool outlined here, and all used different approaches; for example, none employed the expert panel approach. Passeretto and Powell (2012) described a non-numerical scoring system for ranking environmental weeds in WA. The process described in Virtue (2010) used numerical assessment of a species to generate scores for weed risk and feasibility of

Table 1. Top 15 declared plants ranked on their agricultural impact scores.

Name	Agricultural impact score (rank)
Gamba grass *Andropogon gayanus* Kunth	4.5 (1)
Three-horned bedstraw *Galium tricornutum* Dandy	4.2 (2)
Mesquite *Prosopis glandulosa* Torr. × *velutina* Woot.	4.2 (3)
Skeleton weed *Chondrilla juncea* L.	4.0 (4=)
Hoary cress *Lepidium draba* L.	4.0 (4=)
Mesquites *Prosopis glandulosa* Torr., *P. pallida* (Willd.) Kunth	4.0 (4=)
Mimosa *Mimosa pigra* L.	3.7 (8)
Rubber vine *Cryptostegia grandiflora* R.Br.	3.6 (9=)
Cylindropuntia cacti (3 species) *Cylindropuntia* spp.	3.6 (9=)
Prickly pear *Opuntia* spp.	3.6 (9=)
Prickly acacia *Acacia nilotica* (L.) Delile	3.6 (14)
Two-leaf Cape tulip *Moraea miniata* Andrews	3.5 (15)

Table 2. Declared plants with agricultural and environmental impact scores below 2.0.

Name	Agricultural (and Environmental) impact scores
Golden dodder *Cuscuta campestris* Yunck.	2.0 (2.0)
St John's wort *Hypericum perforatum* L.	2.0 (1.8)
Stemless thistle *Onopordum acaulon* L.	2.0 (1.5)
Silverleaf nightshade *Solanum elaeagnifolium* Cav.	2.0 (1.2)
Thornapple *Datura* spp.	1.8 (1.7)
Mintweed *Salvia reflexa* Hornem.	1.7 (1.5)
Horehound *Marrubium vulgare* L.	1.7 (1.0)
Mexican poppy *Argemone ochroleuca* Sweet	1.6 (2.0)
Field bindweed *Convolvulus arvensis* L.	1.6 (1.2)
Sicklepod, javabean *Senna obtusifolia* (L.) H.S.Irwin & Barneby	1.6 (2.0)
Madeira vine *Anredera cordifolia* (Ten.) Steenis	1.3 (1.0)
Sida *Sida acuta* Burm.f., *S. cordifolia* L.	1.3 (1.6, 1.0)
Glaucous star thistle *Carthamus leucocaulos* Sm.	1.0 (1.6)
Lesser jack *Emex spinosa* (L.) Campd.	1.0 (1.3)

control, from which a Comparative Weed Risk score was derived: this score then formed the basis for ranking the species. Weiss and McLaren (2002) and Weiss *et al*. (2002) described a two tier process similar to ours, involving, first, a detailed analytical expert system to generate an invasiveness score for a weed, allowing its invasiveness to be ranked, after which a detailed BCA could be done (Weiss *et al*. 2002).

The prioritisation process described here can be used to determine which high ranked declared plants should be considered for DAFWA's compliance and control activities. Most of these high-priority declared plants are those already targeted for eradication from the State, depending on long-term government funding for regulatory and compliance activities.

The initial results of the impact analysis have led to the following recommendations for DAFWA:

1. That full BCAs be conducted for at least the top 15 declared plants that impact on agriculture, as shown in Table 1.
2. That further consideration be given to conducting full BCAs for declared plants with low to moderate agricultural impact scores, and where eradication should be relatively easy and inexpensive.
3. That management or strategic plans be developed for those declared plants that can be targeted for prevention or eradication, and which have the highest Benefit Cost Ratios.
4. Engage with community-based biosecurity groups to ensure that landholders control widespread declared plants targeted for containment or management, giving priority to those declared plants with relatively high Benefit Cost Ratios (e.g. >2, as determined by BCA).
5. That basic BCAs be conducted on those declared plants with low agricultural and environmental impact scores (see Table 2).

It is unlikely that long-term government funding will be available to ensure that land managers comply with control requirements for low-priority declared plants. For these species, government involvement is likely to be limited to capacity building activities with community-based biosecurity groups to facilitate containment and management activities.

Low ranked declared plants that are not controlled by land managers through biosecurity group arrangements could be considered for a change in their declaration status from a declared pest to an unregulated permitted organism, as defined in the BAM Act.

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