Weed risk assessment of the DEH Alert List and other non-native plant species

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Summary Environmental weeds pose a significant threat to natural ecosystems in Australia. The risk posed to the environment by 51 non-native naturalised plant species, which include the Australian Government's Department of Environment and Heritage Alert List as well as an additional 23 species, were assessed in this project. Weed risk assessment processes investigating the invasiveness, impact and potential distribution of these species were developed and applied for this purpose. Weed risk for terrestrial and aquatic species was determined separately. Data for the weed risk assessment process was obtained from literature, Internet resources, herbaria (national and international) and questionnaires sent to experts in weed related fields. The potential distribution of these species in Australia was calculated using the climate modelling program CLIMEX and analysed using ArcGIS.

The weed risk assessment process revealed that the 10 non-native terrestrial plant species that pose the greatest risk to natural ecosystems are, in order from most to less risk, *Retama raetam*, *Acacia catechu*, *Nassella hyalina*, *Acacia karroo*, *Asystasia gangetica*, *Cytisus multiflorus*, *Nassella leucotricha*, *Barleria prionitis*, *Chromolaena odorata* and *Equisetum arvense*. The top two aquatic species are *Gymnocoronis spilanthoides* and *Lagarosiphon major*. Several recommendations are made highlighting potential areas of action for the future.

Keywords Weed risk assessment, alert list, environmental weeds.

INTRODUCTION

The number of naturalised non-native plant species in Australia is approximately 2810 with the number increasing each year (Groves *et al.* 2003). These plants are introduced intentionally for ornamental or agricultural purposes or unintentionally (Werren 2001, Groves *et al.* 2003). Naturalised non-native plants cause varying degrees of damage to natural ecosystems. The extent of this damage depends upon their ability to alter ecosystem properties such as fire regimes (Richardson *et al.* 2000).

Weed Risk Assessment (WRA) processes are used to determine the risk posed to natural ecosystems and agriculture by non-native plant species. Results are used to determine which species warrant exclusion, containment or eradication. WRA processes usually investigate the invasiveness, impact and potential distribution of the plant undergoing assessment (Pheloung *et al.* 1999, Virtue and Melland 2003).

WRA processes should form part of a wider weed management procedure in order to allow for the most effective use of results. Virtue *et al.* (2006) have recently proposed a systematic procedure for weed risk management. This procedure consists of the following six steps:

1. Establish the weed management context;
2. Identify the weed risk candidates;
3. Assess the weed risks;
4. Assess the feasibility of coordinated control;
5. Determine the weed management actions; and
6. Implement weed management actions.

This project focuses on step 3 above, occurs within the context of Australia-wide natural ecosystems and investigates 51 non-native plant species already present in Australia. The aim of this project was to gather information, write a review on all 51 species and perform a weed risk assessment on each species.

MATERIALS AND METHODS

Species The plant species investigated for this project consist of the 28 naturalised non-native species on the Department of Environment and Heritage (DEH) Alert List plus an additional 23 species. The latter group was made up from the group recommended for containment or eradication by Groves *et al.* (2003) (minus the species already on the Alert List; 15 species in all) plus another eight species known to have a direct impact on rare or threatened native plant species, but with relatively restricted distributions in Australia (Table 5 in Groves *et al.* 2003) (Table 1).

Data collection Several data collection methods were used to gather information on each species for use in report writing and for the WRA process. These included literature databases, Internet searches and online overseas herbarium sites, as well as all Australian state and territory herbariums, which were used to collect location and biological information on each species. Questionnaires were also used and designed in a way that allowed answers to be directly fed into the WRA process. These questionnaires were emailed to weed

scientists and managers, botanists and ecologists in Australia, as well as overseas. Observational fieldwork was also carried out on a number of the species, with the results directly applied to the WRA process.

Weed Risk Assessment process

Two WRA processes**,** aquatic and terrestrial, were developed for use in this project. The processes were partly based on pre-existing WRA systems such as those of Pheloung *et al.* (1999), Champion and Clayton (2001), Werren (2001), Williams *et al.* (2002) and Virtue and Melland (2003). These two WRA processes were extensively peer reviewed, with comments aiding in the design of the final WRA process.

The WRA processes consisted of 22 questions for terrestrial species and 23 questions for aquatic species. For both processes, the questions were divided between three sections: invasiveness; impact; and potential distribution. The scores for each question were added together to give a final score that could be used to assign a relative rank to each species. Potential distributions for each species were calculated using the computer program CLIMEX version 2. Climex models were constructed for 46 species with a further five pre-existing models utilised (see Weber 2006).

RESULTS

The weed risk assessment scores for the terrestrial, non-native naturalised plant species investigated in this project are listed in Table 1. The species with the top 10 scores, posing the highest risk, are *Retama raetam*, *Acacia catechu*, *Nassella hyalina*, *Acacia karroo*, *Asystasia gangetica*, *Cytisus multiflorus*, *Nassella leucotricha*, *Barleria prionitis*, *Chromolaena odorata* and *Equisetum arvense*. The potential distribution score was the main factor that separated out the top 10 species, as the scores for invasiveness and impact were largely similar (Table 2). It should also be noted that there was no clear disjunction in scores

Table 1. Species analysed in the WRA process with subsequent score. DEH species are those on the Alert List, G2 species are those recommended for containment or eradication and G3 species are those that are known to have a direct impact on rare or threatened native plant species, but have relatively restricted distributions (Groves *et al.* 2003).

Species – terrestrial	DEH	G2	G3	Score
Retama raetam (Forsskal) Webb	*	*		41
Acacia catechu Willd.	*	*		39
Nassella hyalina (Nees) Barkworth	*			39
Acacia karroo Hayne	*	*		38
Asystasia gangetica (L.) T.Anderson	*	*		37
Cytisus multiflorus (L'Her.) Sweet	*			36
Nassella leucotricha (Trin. & Rupr.) Pohl			*	36
Barleria prionitis L.	*			35
Chromolaena odorata (L.) King & H.E.Robins		*		35
Equisetum arvense L.	*			35
Dittrichia viscose (L.) W.Greuter	*	*		34
Jarava plumose (Spreng.) S.L.W.Jacobs & J.Everett		*		34
Pereskia aculeate P.Mill	*			34
Senecio glastifolius L.f.	*	*		34
Calluna vulgaris (L.) Hull	*			33
Centaurea maculosa Lam.		*		33
Succowia balearica (L.) Medik.		*		33
Tipuana tipu (Benth.) Kuntze	*	*		33
Thunbergia laurifolia Lindl.	*	*		32
Watsonia meriana (L.) P.Mill			*	32
Hieracium aurantiacum L.	*			31
Oenanthe pimpinelloides L.		*		30
Bassia scoparia (L.) Scott	*	*		29
Gliricidia sepium (Jacq.) Kunth ex Walp.		*		29
Lachenalia reflexa Thunb.	*	*		29
Pelargonium alchemilloides (L.) L'Hér.	*	*		29
Koelreuteria elegans (Seem.) A.C.Sm.	*	*		28
Moraea lewisiae (Goldblatt) Goldblatt			*	28
Gladiolus caryophyllaceus (Burm.f.) Poir.			*	27
Orobanche ramosa L.		*		27
Piptochaetium montevidense (Spreng.) Parodi	*	*		27
Praxelis clematidea (Griseb.) R.M.King & H.Rob.	*			27
Stachys sylvatica L.		*		27
Annona reticulate L.		*		26
Crataegus azarolus L.		*		26
Cyperus teneristolon Mattf. & Kuk.	*	*		26
Nassella charruana (Arechav.) Barkworth	*	*		26
Coffea arabica L.			*	25
Ornithogalum longibracteatum Jacq.		*		25
Panicum racemosum (P. Beauv.) Spreng.		*		25
Romulea rosea (L.) Eckl.			*	25
Iva axillaries Pursh		*		22
Trianoptiles solitaria (C.B.Clarke) Levyns	*	*		22
Cynoglossum creticum Mill.	*			20
Centaurea eriophora L.		*		18
Reseda phyteuma L.		*		18
Species – aquatic	**DEH**	**G2**	**G3**	**Score**
Gymnocoronis spilanthoides DC.	*			47
Lagarosiphon major (Ridley) Moss	*			41
Hygrophila costata Nees			*	35
Schoenoplectus californicus (C.A.Mey.) Sojak		*		33
Juncus subnodulosus Schrank		*		29

Table 2. Top ten scoring terrestrial and all aquatic species analysed in this project. Invasiveness (Inv.), impact (Imp.), potential distribution (PD) and total score listed.

Terrestrial species	Inv.	Imp.	PD	Total
	Score			
Retama raetam	9	20	12	41
Acacia catechu	7	19	13	39
Nassella hyalina	10	18	11	39
Acacia karroo	6	19	13	38
Asystasia gangetica	12	14	11	37
Cytisus multiflorus	7	18	11	36
Nassella leucotricha	10	13	13	36
Barleria prionitis	9	20	6	35
Chromolaena odorata	8	20	7	35
Equisetum arvense	10	14	11	35
Aquatic species				
Gymnocoronis spilanthoides	16	18	13	47
Lagarosiphon major	12	18	11	41
Hygrophila costata	15	16	4	35
Schoenoplectus californicus	13	7	13	33
Juncus subnodulosus	11	7	11	29

between the tenth ranking species and those that ranked slightly lower (Table 1).

The impact scores for aquatic species played a more important part in determining the species that pose the greatest risk to the environment. *Gymnocoronis spilanthoides* and *Lagarosiphon major* were the two species that posed the greatest threat to aquatic ecosystems (Table 2).

DISCUSSION

This project employed a peer reviewed WRA process to determine the risk posed to the environment by 51 non-native plant species. The terrestrial species that received the top 10 scores from the WRA process are already considered to be, or thought to have the potential to be, serious weeds (Groves *et al.* 2003). All but one of these species, *Nassella leucotricha*, is on the DEH alert list of environmental weeds. Most of the top scoring species are subject to ongoing control operations, with several being the subject of eradication campaigns. The two *Acacia* species, *A. catechu* and *A. karroo*, are the two species closest to being eradicated from Australia, with only the occasional cultivated specimen found.

An important issue to consider with a nationally-scaled WRA process is the risk of species with relatively high impact scores receiving low overall rankings due to the requirement for specific climatic or environmental conditions not widespread in Australia. This situation results in a low potential distribution score, pushing the overall environmental risk ranking down and can also allow for weeds with a lower environmental impact, yet higher potential distribution score, to receive a higher risk ranking. *Coffea arabica* is one such species that has a higher impact score than one of the top 10 species, but is restricted to warm, high rainfall and frost free areas. This species can form monocultures in rainforests and received a relatively high ranking for a WRA process restricted to the Wet Tropics region of north Queensland (Werren 2001). Therefore, relative weed risk rankings are occasionally influenced by the spatial scale of the analysis. This situation highlights the need for regional WRA processes to be used when developing regional weed management plans. By using regional WRA processes, local habitat importance can be taken into account. Other species assessed in this project that had the same issues associated with them include *Calluna vulgaris*, *Praxelis clematidea*, *Tipuana tipu*, *Gliricidia sepium*, *Nassella charruana* and *Annona reticulata*.

The top three ranked aquatic species are considered to be serious, or potentially serious, weeds in Australia. Impact scores more clearly differentiated the aquatic species than they did the terrestrial species. Of these, *Hygrophila costata* is the most widely distributed species, particularly in north-eastern New South Wales. *Gymnocoronis spilanthoides* has a more restricted distribution than *H. costata*, with the remaining three species found at fewer than 10 sites. Due to the importance of aquatic ecosystems in Australia and the potential impacts of all five aquatic species, action should be taken to at least contain all current infestations of these plants.

Recommendations The following points are recommendations based on the results of this project:

- Create and update Weed Management Guides for all species investigated in this project, except for the five lowest ranking terrestrial plant species;
- Conduct further research into the feasibility of containment or eradication of all the aquatic plant species investigated in this project;
- Conduct further research into the feasibility of containment or eradication of the top 20 ranked terrestrial non-native plant species, excluding those species already subject to such action, and other high impact species, such as *Hieracium aurantiacum*, *Gliricidia sepium*, *Praxelis clematidea*, *Nassella charruana*, *Annona reticulata* and *Coffea arabica*, and;
- Consider the production of best practice manuals for agricultural industries involved with *Coffea arabica*, *Tipuana tipu* and *Gliricidia sepium*.

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