PREDICTING THE WEED POTENTIAL OF PLANT INTRODUCTIONS

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Summary Plant species not yet present in Australia continue to be imported as potential new crops, ornamentals or as novelties. Many of these species have the potential to become weeds and there is a need to assess this risk before allowing entry. An assessment system was developed to measure the weed potential of a plant on the basis of available information on the current weed status in other parts of the world, climate preferences and biological attributes.

The system was tested by analysis of its performance for 370 plant species, representing weeds from agricultural, environmental and other sectors, and useful plants. The system was judged on its ability to correctly reject weeds, accept non-weeds and generate a low proportion of species which could not be decisively categorized. More than 70% of the species were rejected or accepted. All serious weeds, and most minor weeds, were rejected or required further evaluation while only 7% of non-weeds were rejected.

INTRODUCTION

In response to an initiative of the National Weeds Strategy, the Australian Weeds Committee (AWC) commissioned a workshop (Panetta *et al.* 1994). The purpose of the workshop was:

> *To review and agree on transparent administrative procedures for plant species' introductions aimed to minimize the introduction of plants that will, on balance, be detrimental to Australia.*

Guidelines were given for a three tiered plant screening process, to be applied progressively as required:

1. Identification of the species and its Australian distribution, with reference to current lists of prohibited and permitted species.
2. If the species is not listed and is not established in Australia, apply a pre-entry assessment procedure to determine the risk of the species becoming a weed in Australia: the possible recommendations are accept, reject or evaluate. Rejected or accepted species are then added to the prohibited or permitted list.
3. If an accept or reject recommendation cannot be obtained from the second tier, and the importer wishes to proceed, subject the species to post-entry evaluation so that, ultimately, the species can be placed on a prohibited or permitted list.

These guidelines are to be used by the Commonwealth agencies responsible for the regulation of plant imports in determining their controls: Australian Quarantine Inspection Service (AQIS) and Australian Nature Conservation Agency (ANCA). A computer based system was devised to deal specifically with the second tier. This system was built on the principles embodied in systems described by Panetta (1993) and Hazard (1988) and is referred to as the Weed Risk Assessment system (WRA).

An acceptable WRA system should satisfy a number of requirements:

1. The system should be calibrated and validated against a large number of species, already present in Australia, representing the full spectrum of species likely to be encountered as imports.
2. It must be shown that the screening procedure is reasonably effective at discriminating between weeds and non-weeds.
3. The dataset resulting from this process should be used to adjust the scoring system such that the majority of weeds are not accepted, non-weeds are not rejected and the proportion requiring evaluation is kept to a minimum.
4. International trade agreements require that prohibited species should fit the definition of a quarantine pest before they can be excluded by quarantine regulations (Walton and Parnell 1996, Anon. 1995). The assessment procedure should be fully transparent and based on sound scientific principles so that Australia cannot be accused of applying unjustified non-tariff trade barriers.
5. Resources needed to operate the system should be realistic—the cost in time and money to the importer and the administering body should be as low as possible.
6. The system should be capable of identifying environmental weeds and identifying them as such so that responsibility for control can be established (AQIS or ANCA).
7. The system should provide significant improvement over others currently in use.

MATERIALS AND METHODS

In the WRA system, answers are sought for questions on historical, biogeographical and biological/ecological details of the candidate. The system is described in detail by Pheloung (1995) and the report and software are available from the author on request. These answers are almost entirely in the form of yes, no or do not know, and are used to produce a score related to weediness. The questions are designed to generate a result from one day or less of research using published information on the species.

The score generated by the procedure is used to determine which of three recommendations, reject, evaluate or accept will result. The three possible recommendations are determined by two critical score settings. The lower critical score separates acceptable species from those requiring evaluation and the higher critical score separates species requiring evaluation from those that should be rejected.

Weed risk assessments The WRA system was circulated to a number of professional scientists in the fields of ecology, botany and agronomy, six of whom responded. They were asked to use the system to assess the weed potential of species they were familiar with, ranging from non-weedy beneficial species to serious weeds. In addition, all species that have a noxious status in Australia were assessed using the information provided in Parsons and Cuthbertson (1992).

Assessors were asked to treat each species as if it had not yet arrived in Australia. Species that are serious weeds in Australia, for example, were to be assessed purely on their weed status outside Australia.

Responses were checked for obvious errors and corrected if necessary.

Weed survey In a followup survey, 12 scientists were supplied with a list of the assessed species and asked to define the weed status and usefulness of those they were familiar with. The species were given a rank from 0 to 2, which was used to classify them as non-weeds, minor weeds and serious weeds, respectively. At least two respondents supplied information for 370 of the species and the collective opinion was used to assess the performance of the WRA system.

The performance of the system was also compared to that of two simpler systems (Hazard 1988, Panetta 1993).

RESULTS

The results of the survey were partitioned to assess the sectors represented. Although the majority of species (81%) are perceived as weeds in some context, less than half are considered serious weeds. A good sample of non-weeds (19%) and useful species (21%), some of which

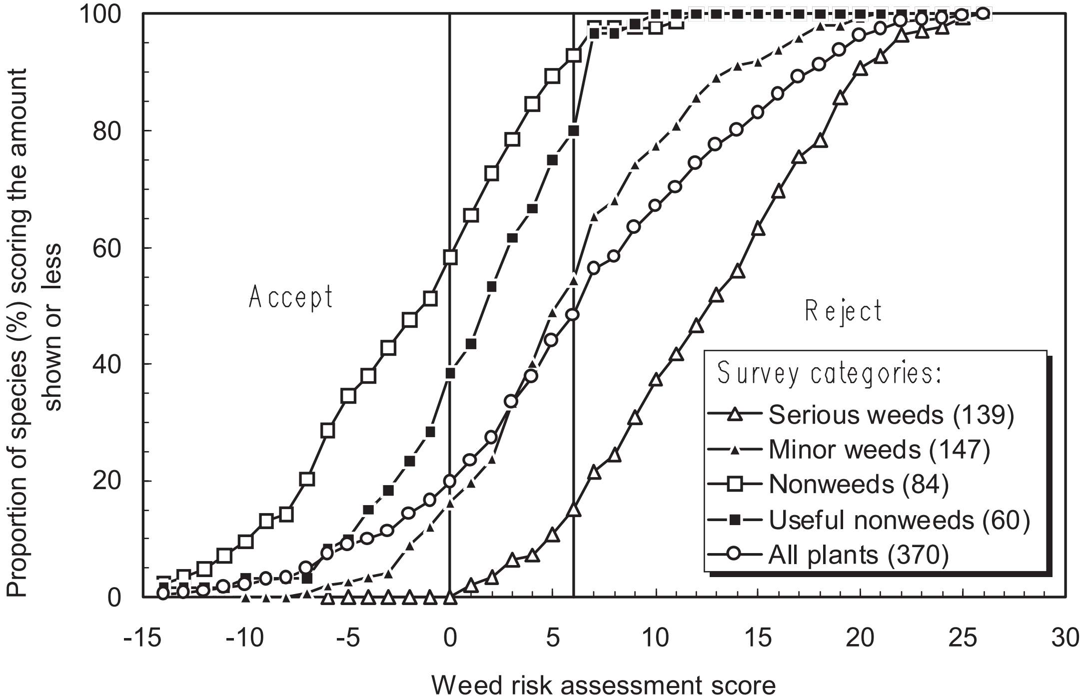

Figure 1. Cumulative frequency of species receiving a given WRA score or less for each of the survey classifications. Serious weeds are those which scored 2 in the survey, minor weeds scored 1 and non-weeds scored 0.

are also considered to be weeds (45%), were included. Weeds from all sectors (agriculture, environment, horticulture, garden and service areas) were well represented.

In the optimized WRA system, all serious weeds, and most minor weeds, were rejected or required evaluation while only 7% of non-weeds were rejected. Less than 30% of the species required evaluation.

The cumulative frequency distributions of WRA scores for each of the survey classifications are shown in Figure 1. These data were used to investigate the effect of different pairs of critical scores on the distribution of WRA recommendations.

The range of scores for non-weeds overlaps the range for serious weeds so it is impossible to define any set of critical scores that reject all serious weeds while accepting all non-weeds. However, it is possible to ensure that none of the serious weeds are accepted by setting the accept score at 0 or less. Similarly, less than 10% of non-weeds will be rejected if the reject score is greater than 6. This would mean that 29% of the species assessed in this study would fall between these extremes and require evaluation. Lowering the minimum reject score to 6 would reduce this proportion to 22% but increase the proportion of rejected non-weeds to 15%, which is less desirable, since some of these are regarded as useful (Figure 1). Consequently, the critical scores, of 0 and 6, were used convert the WRA scores into the recommendations, accept, evaluate and reject.

Table 1. Distribution of recommendations for the WRA system and two simpler systems, H (Hazard 1988) and P (Panetta 1993).

	System		
	H	P	WRA
% of all species (*n=370*)			
Serious weeds not accepted	99	100	100
Minor weeds not accepted	95	93	84
Non-weeds not rejected	89	74	93
Useful species not rejected	73	45	74
Species to be evaluated	39	20	29

Table 2. Correlations of the WRA score, its components, and the survey classifications.

	Survey	Biogeography
Biogeography	0.62	
Undesirable attributes	0.44	0.28
Biology/ecology	0.50	0.46
All components	0.69	0.80

Table 3. Correlations of the WRA score with the survey categories.

WRA	Survey	
	Agricultural	Environmental
Agricultural	0.58	0.41
Environmental	0.44	0.51
Total	0.53	0.52

The two simpler systems were equally effective at rejecting serious weeds (Table 1). The Panetta system was particularly severe in rejecting non-weeds, while the system published by Hazard tended to require further evaluation for a large proportion of the species. The WRA system was least severe on non-weeds and useful species but accepted more minor weeds.

Correlations of the WRA score components and the survey classifications were examined (Table 2). The biological/ecological attributes (reproduction, dispersal and persistence) do show some relationship to documented behaviour of the plant elsewhere in the world (biogeography). Overall, the WRA system is well correlated to the survey classifications, and all components make significant contributions.

The WRA system has some capacity to detect environmental weeds and identify them as such.

The weeds were partitioned into the two main categories, agricultural and environmental weeds. Of the species classified as weeds in the survey, 31% were regarded as both environmental and agricultural weeds, 35% were environmental weeds only and 15% were agricultural weeds only. The remaining 19% were weeds in other categories.

The WRA score could be partitioned into agricultural and environmental components (Pheloung 1995). Each score partition was best correlated to the corresponding survey category (Table 3).

DISCUSSION

The success rate of the WRA system in predicting weed potential, using the survey classifications as a guide, was good (r=0.69***). No serious weeds were accepted and the majority of minor weeds were also not accepted. Less than 10% of non-weeds were rejected but some of these were considered useful species. Improved performance in excluding weeds can be achieved by manipulating the critical scores, but at the expense of excluding more non-weeds. The same applies to the Hazard system which also recommends on the basis of critical scores.

The biogeography component of the WRA system deals with climatic suitability and the documented weed status of the plant. This component was most closely correlated to weed status in Australia which is consistent with other studies (Panetta 1993, Scott and Panetta 1993).

The WRA system performed best overall although, in many respects, the Hazard system performed similarly. However, the Hazard system has the disadvantage of making no provision for lack of information pertaining to the questions, which meant that in many cases a recommendation to accept could not be made. The Panetta system was the most severe, largely due to the more rigorous treatment of the weed elsewhere question. Panetta was reluctant to relax the rigour of this question because of the precautionary principle and the reasonable expectation that widely naturalized species, newly introduced to Australia, could become weedy.

There were no obvious differences in the performance of the systems in screening for weeds of agriculture or the environment (data not shown), although there was some evidence that the WRA system was able to categorize species on this basis. In other words, the WRA system could be made to identify species that are likely to be of concern in one sector only.

The WRA evaluate recommendation identifies plants which are likely to impose an economic cost if they become established, including the cost of environmental damage. Where possible, quantitative cost/benefit analysis, using risk analysis techniques, could be used to decide if the risk is acceptable.

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