

may include weed management plans, and contract arrangements with Parks Victoria for on-ground management of parks. These plans are strategic in nature and don't really get down to the operational requirements for dealing with weeds.

Flora and Fauna Guarantee Act 1988

This Act provides for the conservation of Victoria's flora and fauna, using various mechanisms for the conservation, management and control of flora and fauna and potentially threatening processes.

'Invasion of native vegetation by environmental weeds' is listed as a potentially threatening process. Some Action Statements for threatened species include measures to control weed invasion.

Enforcement

Under the Catchment and Land Protection Act 1994 the Department of Natural Resources and Environment conducts a substantial enforcement or compliance program. This is directed to priority species in each area and provides support to community groups which are undertaking planned, co-ordinated action. Although the major focus is on protecting the productive value of private land, a number of environmental weeds are targeted in each region. For example boxthorn and furze (gorse) are targeted in the north-west, serrated tussock and furze in the south-west, blackberry, St. John's wort and English broom in the north-east and blackberry, furze and English broom are targets in Gippsland.

Achievements of the Compliance Program in 1998-99 were:

- 87% compliance rate for landowners dealing with priority weeds,
- 13 771 properties covering over 1 million hectares were inspected,
- over 10 000 landowners were contacted,
- 344 Land Management Notices and 1119 Directions were served on landowners requiring action to be taken,
- 11 landowners were prosecuted for failing to undertake the required weed control.

A commitment has been made to continue and expand the Enforcement Program in the 1999-2000 financial year.

A Weedwatch project has just commenced under the Weeds Initiative and will develop co-operative mechanisms to stop the spread of weeds through the nursery, aquatic and seed trades.

Preventing the introduction of potential new weeds to Australia

Paul Pheloung, Australian Quarantine Inspection Service, GPO Box 858, Canberra, ACT 2601, Australia.

Introduction

New species and varieties of plants have been brought into Australia continuously since European colonization. While a proportion of these are beneficial and contribute to the quality of Australian life, a similar proportion have naturalized and become weeds of production or the natural environment. The demand to import new plants continues; in a global environment of free trade and easier access to novel plants, this demand is likely to continue to grow.

Eradication of weeds can be very expensive and is unlikely to succeed unless the infestation is detected at a very early stage. Containment and control are also costly and the cost persists indefinitely. The costs involved in identifying potential new weeds and denying their entry to Australia are very small by comparison.

The National Weeds Strategy (NWS; ARMCANZ 1997), which was formally implemented in 1997, identified the development and introduction of measures to exclude new weed introductions as a primary goal. A review of Australian quarantine (Nairn *et al.* 1996) made similar recommendations. In recognition of this, and with funding support from the NWS, the Australian Quarantine and Inspection Service (AQIS) has implemented a process to screen plant introductions for potential weeds.

Barrier agencies

Barrier agencies include customs, immigration and quarantine. The Australian Customs Service is the primary custodian of the international barrier, recording and regulating trade, imposing tariffs and policing contraband such as drugs, firearms and protected wildlife.

The role of quarantine is to regulate international trade and movement of people with the object of preventing the introduction, establishment or spread of diseases or pests affecting people, animals, or plants. AQIS is the Commonwealth provider of this function.

AQIS aims to achieve two outcomes through the services it provides. They are:

- improved market access opportunities for Australian food and other agricultural products; and
- protection of Australia's animal, plant and human health and the environment.

The role of AQIS is further described in the current Corporate Plan (www.aqis.gov.au). Although AQIS traditionally has focused on protection of plant health in production systems, the second outcome clearly identifies protection of the environment as part of the overall scope.

Trade vs. risk

Quarantine risk can only be eliminated by eliminating all trade, tourism and other

movements across Australia's international borders. As Australia is largely dependent on trade and tourism for the quality of life Australians enjoy, AQIS imposes conditions on imported commodities to manage the quarantine risk and achieve an appropriate level of protection for animal, plant and human health and the environment. Appropriate level of protection refers to the need for consistency, net benefits over costs associated with a trade activity and the diminishing returns of additional measures to further reduce risk.

As a member of the World Trade Organization (WTO), Australia is committed to an open international trading environment. AQIS applies a conservative approach to the management of quarantine risks, but must justify the conditions and restrictions the Commonwealth imposes on the grounds of sound quarantine risk or be accused of erecting economic barriers to the detriment of traders seeking to buy or provide a cheaper or novel product.

Determining the quarantine risk of new plants requires scientific knowledge that may not be available. The precautionary principle in essence states that, in the absence of scientific information necessary to assess risk, the risk should be avoided, that is, the import should not be allowed.

The Sanitary and Phytosanitary (SPS) agreement between WTO members (WTO, 1994) allows for restrictions on trade where such trade can lead to adverse effects on plant health. The agreement requires a sound and clear technical basis for such restrictions. While the precautionary principle requires scientific data to justify trade, the SPS agreement requires such data to justify restrictions on trade.

AQIS must find an appropriate balance to achieving these principles and has implemented the Weed Risk Assessment system to do this.

The policy

AQIS has adopted a three tiered *permitted list* approach to managing the risk of proposed new plant introductions becoming weeds in Australia. Details of the system have been described elsewhere (Pheloung 1995, 1996, Steinke and Walton in press) but are outlined here.

The permitted list

In June 1998, the Proclamations to the 1908 Quarantine Act were revised into one document that includes Schedule 5, the list of Permitted Seeds. Seed of plants included on this list may be imported subject to inspection to ensure freedom from soil, insects, contaminant seeds or other material of quarantine concern (other propagating material may have conditions to address the risk of associated pests and disease). This list currently contains 5700 plant taxa.

All plant species not on the permitted list are prohibited entry into Australia, except where AQIS issues a permit to import. AQIS does not issue permits to import for assessed weeds or for unassessed taxa. However, permits are required for many crop species that require growth in quarantine. This includes species that are not necessarily weeds but potential carriers of disease. For example, *Triticum* (wheat) and *Eucalyptus* are not on the permitted list because they have the potential to introduce seed-borne diseases and consequently imports require treatment and growth in quarantine.

The permitted list is added to as proposed new plant introductions are assessed to be of low weed risk.

The Weed Risk Assessment (WRA) system

The WRA system is a scoring system used to determine weed potential based on existing knowledge of proposed new plant introductions (Table 1). The questions relate to knowledge of the status of the plant as a weed outside of Australia, climatic preferences, undesirable attributes, growth, reproductive and dispersal attributes. The system includes consideration of attributes that make a plant less weedy. Not all questions need to be answered in order to generate a result.

An attempt was made to include and identify attributes that contribute to the risk of a plant becoming an environmental weed. This is shown in Table 1 by the letter 'E' in the left hand column. 'A' denotes attributes that have agricultural significance and 'C' denotes attributes relevant to both sectors. The score is partitioned on this basis. In the example shown,

Asparagus asparagoides (bridal creeper) has a much higher environmental score partition, consistent with the fact that this plant is essentially a weed of natural environments.

The system was designed so that the score produced would be a measure of its weed potential. A calibration process using a complete spectrum of 370 weeds, non-weeds and useful plants already present in Australia, was used to convert the score to one of three outcomes, reject, accept or further evaluate (Pheloung 1995). The WRA is reasonably reliable in rejecting weeds while accepting non-weeds, but to minimize the proportion of incorrect outcomes (rejecting non-weeds or accepting weeds), a proportion fell within the intermediate category of 'further evaluate'. From a quarantine standpoint, and in accordance with the precautionary approach, plants falling into this category are not permitted entry unless a more detailed examination of the biology satisfactorily resolves the concern.

AQIS adopted the WRA formally in 1997 as part of the three tiered process to assess new plant introductions.

The three tiered process

AQIS's three tiered system to screen proposed new plant introductions for weed potential is illustrated in Figure 1.

Tier 1 A client wishing to import a plant advises AQIS who determines if the plant is listed on the schedule of permitted seeds or has previously been assessed. The taxonomy is also checked to determine if the name given is correct or is a synonym of a previously dealt with species.

Tier 2 WRA is undertaken on taxa that are not on the permitted list and have not previously been examined by AQIS. Accepted species are added to the permitted list and AQIS keeps a record of species rejected by WRA to prevent repeat assessment. The client is advised of species requiring further evaluation and in some cases may be able to supply additional information that leads to a definitive WRA outcome. Up to this point, AQIS bears the cost of assessment.

Tier 3 Species requiring further evaluation must be assessed in greater detail, at the client's expense. An assessment protocol involving further experimentation either offshore or onshore under quarantine supervision and possible cost benefit analysis is being developed in consultation with stakeholders.

Performance

Over an 18 month period of operation of the three tiered system, AQIS has undertaken WRAs on 478 applications to

import new plants – this just represents those applications that progressed to the second tier. Table 2 shows the outcomes. The majority of species (64%) were accepted and the WRA was unable to reject or accept 15%, which is a marked improvement on the 30% that fell into the 'further evaluate' category during calibration of the system.

Critical factors leading to rejecting a taxon varied from evidence of weedy behaviour in other parts of the world to biological attributes of reproductive capacity and dispersal mechanisms. Because of the uncertainty of prediction, many (possibly all) of these taxa may not, given the opportunity, become significant weeds in Australia. Nevertheless, there is a significant risk that at least some would become important weeds and the combined cost of assessment is negligible in comparison to the costs associated with just one such introduction.

Operational considerations

The three tiered screening system depends on understanding and co-operation from importers of plants.

- Inspectors generally must assume that the material is correctly described because the capacity within Australia to taxonomically identify exotic material, particularly seed, is very limited.
- Seeds are compact and easy to bring into Australia undetected, either deliberately or through ignorance of quarantine requirements. Plants are available via international mail order, through printed catalogues or via the internet. Small parcels may pass through the mail exchange undetected, particularly if the label gives no indication of the contents. The risks from entry through the mail or on a person can only be met by a combination of increase in specific resources, community awareness and penalties. AQIS is currently undertaking an information campaign intended to address community awareness. Additional resources following the Quarantine Review resulted in a substantial increase in interceptions of items in the mail posing a quarantine risk (from 10 000 to 50 000 p.a.). A large proportion of these are plant material or seed of unknown identity.
- Weeds can also be introduced as contaminants of other imported commodities such as commercial seed for sowing or consumption, on used machinery, dirty ships and shipping containers, or travellers clothing. Effective inspection protocols are essential to manage this risk. AQIS is examining the inspection and sampling protocols currently in place to manage the risk of contaminants in imported commercial seed.

Table 1. The Weed Risk Assessment Scoring Sheet with answers for *Asparagus asparagoides*. Details of the scoring process are given in Walton *et al.* 1998.

Botanical name: <i>Asparagus asparagoides</i>			Outcome: Accept <0 Evaluate 0–6 Reject >6		Reject 22 PCP
Common name: Bridal creeper			Score: (Ag = 12; Env = 20)		
Family name: Asparagaceae			Your name:		
History/Biogeography					
A	1	Domestication/	1.01	Is the species highly domesticated? If answer is 'no' got to question 2.01	N
C		cultivation	1.02	Has the species become naturalized where grown	
C			1.03	Does the species have weedy races	
	2	Climate and	2.01	Species suited to Australian climates (0–low; 1–intermediate; 2–high)	2
		distribution	2.02	Quality of climate match data (0–low; 1–intermediate; 2–high)	2
C			2.03	Broad climate suitability (environmental versatility)	Y
C			2.04	Native or naturalized in regions with extended dry periods	Y
			2.05	Does the species have a history of repeated introductions outside its natural range	Y
C	3	Weed	3.01	Naturalized beyond native range	Y
E		elsewhere	3.02	Garden/amenity/disturbance weed	Y
A			3.03	Weed of agriculture/horticulture/forestry	
E			3.04	Environmental weed	Y
			3.05	Congeneric weed	N
Biology/Ecology					
A	4	Undesirable	4.01	Produces spines, thorns or burrs	N
C		traits	4.02	Allelopathic	N
C			4.03	Parasitic	N
A			4.04	Unpalatable to grazing animals	
C			4.05	Toxic to animals	N
C			4.06	Host for recognized pests and pathogens	
C			4.07	Causes allergies or is otherwise toxic to humans	N
E			4.08	Creates a fire hazard in natural ecosystems	Y
E			4.09	Is a shade tolerant plant at some stage of its life cycle	Y
E			4.10	Grows on infertile soils	Y
E			4.11	Climbing or smothering growth habit	Y
E			4.12	Forms dense thickets	N
E	5	Plant type	5.01	Aquatic	N
C			5.02	Grass	N
E			5.03	Nitrogen fixing woody plant	N
C			5.04	Geophyte	Y
C	6	Reproduction	6.01	Evidence of substantial reproductive failure in native habitat	N
C			6.02	Produces viable seed	Y
C			6.03	Hybridizes naturally	
C			6.04	Self-fertilization	
C			6.05	Requires specialist pollinators	
C			6.06	Reproduction by vegetative propagation	Y
C			6.07	Minimum generative time (years)	1
A	7	Dispersal	7.01	Propagules likely to be dispersed unintentionally	Y
C		mechanisms	7.02	Propagules dispersed intentionally by people	Y
A			7.03	Propagules likely to disperse as a produce contaminant	
C			7.04	Propagules adapted to wind dispersal	
E			7.05	Propagules buoyant	
E			7.06	Propagules bird dispersed	Y
C			7.07	Propagules dispersed by other animals (externally)	
C			7.08	Propagules dispersed by other animals (internally)	Y
C	8	Persistence	8.01	Prolific seed production	Y
A		attributes	8.02	Evidence that a persistent propagule bank is formed (>1 yr)	
A			8.03	Well controlled by herbicides	Y
C			8.04	Tolerates or benefits from mutilation, cultivation or fire	Y
E			8.05	Effective natural enemies present in Australia	Y

Weed type characteristic A= agricultural, E = environmental, C= combined.

- AQIS must determine quarantine status as a basis for assessing risk and taking necessary actions to prevent entry of new weedy plants. For weedy plants found to be present in Australia, States/Territories need to backup such decisions with effective response to incursions and regulatory measures.

Conclusion

Many potential new weeds of Australia can be identified on the basis of substantial problems elsewhere in the world. The major weeds of production are reasonably easy to identify from published information and AQIS's permitted list system ensures that they are recognized on a case by

case basis. Recognizing other potential weeds of Australia, that may not have yet become weeds elsewhere or that are less well documented environmental weeds, requires a more detailed approach and AQIS's WRA system attempts to achieve this.

Acknowledgments

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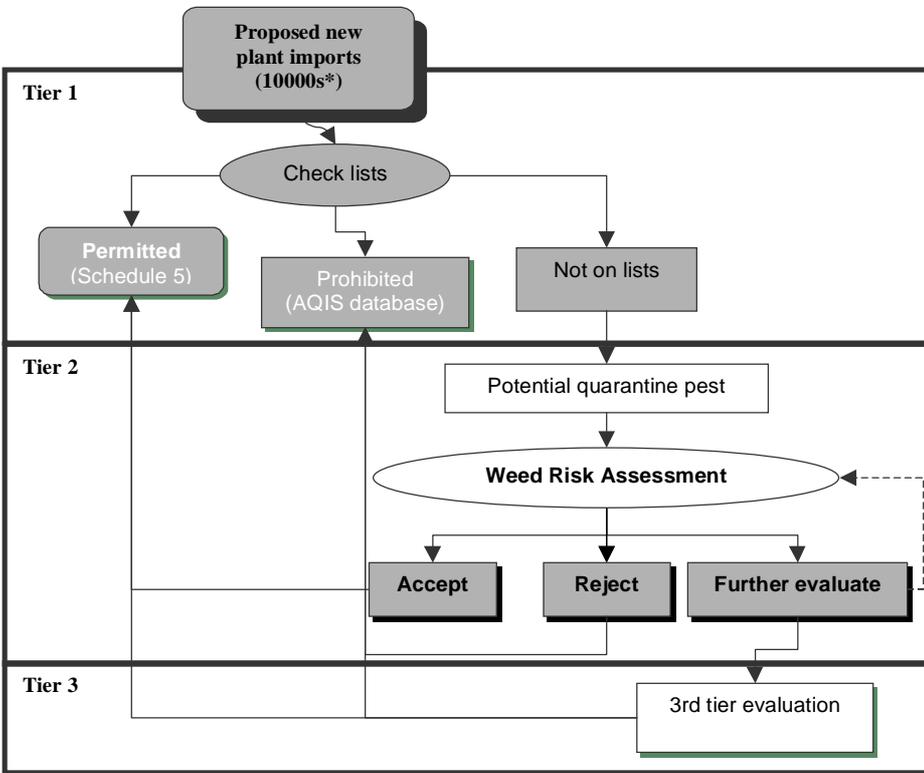


Figure 1. The three tiered process AQIS uses to screen proposed new plant introductions for weed potential.

Table 2. Weed Risk Assessment results, over an 18 month period, for proposed new plant introductions. In addition to the principle outcomes of *Accept, Reject or Further evaluate*, information on some taxa was too limited to make any kind of determination. For example, in some cases no published verification of the supplied botanical name could be found. Other taxa were found to be well established in Australia and thus could not be treated as a quarantine pest.

Result	Number assessed	Proportion of total assessed (%)
Accept	306	64
Reject	95	20
Further evaluate	54	11
More information required	23	5
Total	478	100