FUTURE FARM INDUSTRIES CRC

PROFITABLE PERENNIALS™ FOR AUSTRALIAN LANDSCAPES

Environmental Weed Risk Assessment Protocol

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Introduction

This weed risk assessment (WRA) protocol forms part of the overall weed risk management of the Future Farm Industries Co-operative Research Centre (hereafter called "CRC"), as shown in the Weed Risk Management Flow Diagram. The aim of the WRA is to identify the level of weed risk that species under evaluation within the CRC pose to the natural environment. Although weeds occur in many landuses, such as agriculture, horticulture, irrigated crops and pastures, and forestry, the focus of this protocol is environmental weed risk.

Species that will be evaluated using this WRA protocol are those that are permitted entry to Australia, but have not been assessed for weed risk by Biosecurity Australia. These species have naturalised and/or are commercially available in Australia, and are not under official control.

This WRA is designed using the principles of the National Post-Border Weed Risk Management Protocol (Standards Australia, 2006) and includes many components found in the South Australian Weed Risk Management Guide (Virtue, 2004). It will be referred to as the CRC WRA protocol hereafter.

The CRC WRA Protocol

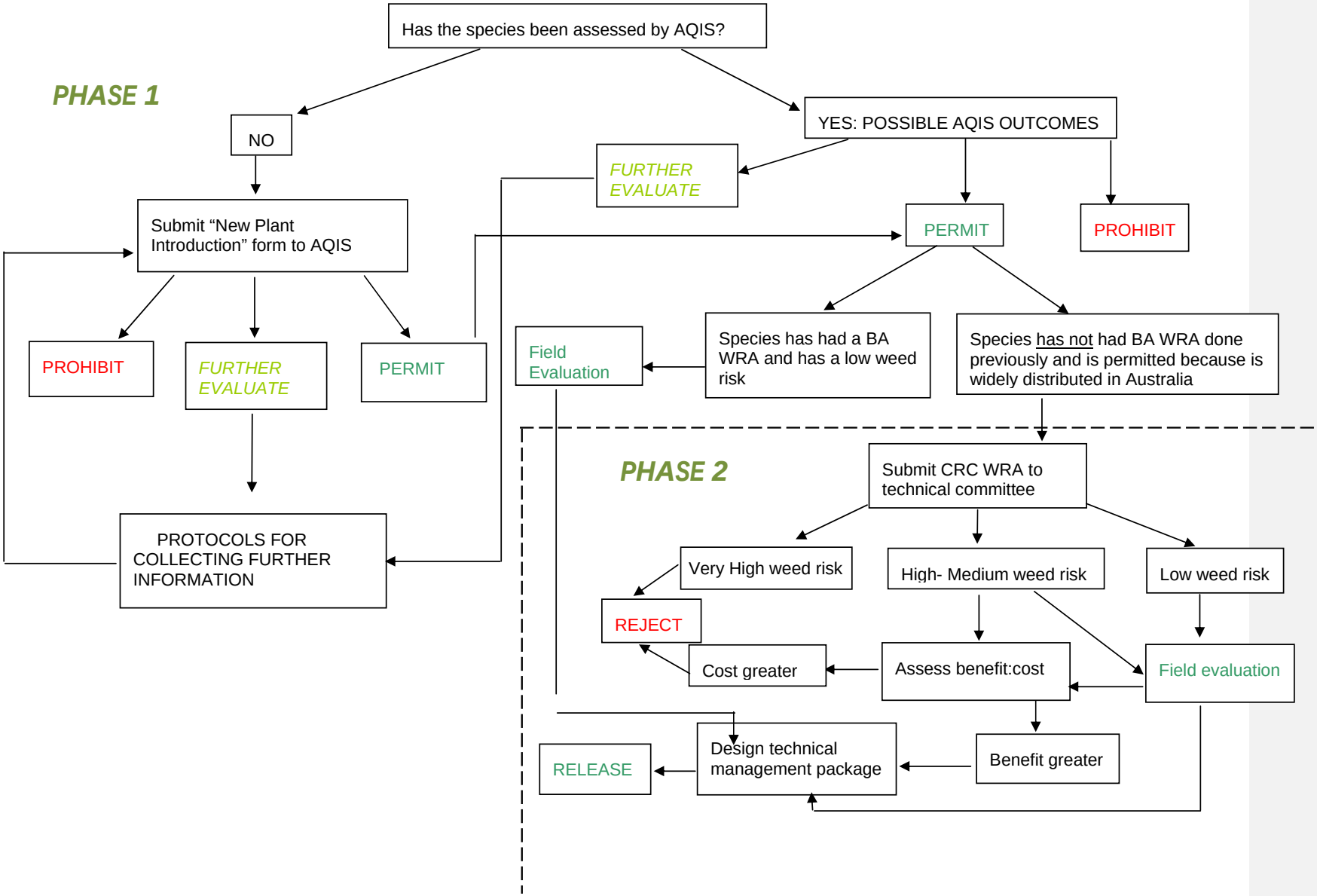
The protocol is divided into three sections:

- **Invasiveness**
- **Impacts**
- **Distribution**

Each section has a series of questions that will generate a score depending on the response given. A final weed risk score is calculated by multiplying the adjusted scores for each section, which can then be used to compare weed risk with other species.

Species identified as **low** weed risk can be evaluated in the field by the CRC. If the species is then released and promoted, a technical management package will be written providing information on the agronomy and weed risk of the species.Species identified as **high** to **medium** weed risk can also be evaluated in field trials, but further analysis is necessary to determine if release of the species is warranted. Results from the field trial may provide information for a more in-depth analysis to enable a better judgement of the proposed utility of the species.

This further analysis does not form part of the CRC WRA protocol described in this document. Species identified as **very high** weed risk will not be pursued by the CRC, and should be removed from field trials.


PHASE 1
Has the species been assessed by AQIS?
NO
YES: POSSIBLE AQIS OUTCOMES
FURTHER EVALUATE
PERMIT
PROHIBIT
Submit "New Plant Introduction" form to AQIS
PROHIBIT
FURTHER EVALUATE
PERMIT
Field Evaluation
Species has had a BA WRA and has a low weed risk
Species has not had BA WRA done previously and is permitted because is widely distributed in Australia
PROTOCOLS FOR COLLECTING FURTHER INFORMATION
PHASE 2
Submit CRC WRA to technical committee
Very High weed risk
High- Medium weed risk
Low weed risk
REJECT
Cost greater
Assess benefit:cost
Field evaluation
RELEASE
Design technical management package
Benefit greater

Answering the questions

All questions require a search of scientific literature, but many of the questions are phrased such that observations from pasture field trials and unpublished information is acceptable. ***References to support your answers should be provided where possible.***

There is a resource list attached as an Appendix to this WRA. Please consult these references where necessary, and contact weed experts in one or more States to determine if the species of interest has a weed history in Australia. If the species of interest is a weed, these people may also have some knowledge of impacts on natural ecosystems.

If an answer of "Don't know" is given, a medium-risk score of 2 usually results. Please consult with other breeders, evaluators and weed experts before answering "don't know" to ensure the most accurate representation of the species is made in the assessment.

The completed CRC WRA will be submitted to and reviewed by a CRC Technical Committee to ensure that the assessment is *comprehensive* and clearly explained. Therefore, it is vitally important that for each question, you explain how you reached the answer you did, and *provide references* where possible.

Please provide a short summary of the species at the beginning of the assessment, to provide context for where and why the species is intended for use. If possible, describe the envisaged system where the species of interest will fit, and what it will provide that is different to other species already in use.

Section 1: Invasiveness

These questions give an indication of the potential ability of a species to spread beyond agricultural systems. Characteristics such as how well the species can establish, reproduce and disperse are assessed.

The most reliable indicator of weed potential is a history of weediness elsewhere. Species with close relatives that are known weeds also have a higher weed risk. Because many of the species assessed by this WRA are naturalised or commercially available in Australia, there will likely be literature on how the species has behaved under Australian conditions. Weed experts may also assist you in answering this question (consult Appendices for contact details).

1. Does the species have a *documented* environmental weed* history?

- **a) Is an environmental weed in Australia**
- **b) Is an environmental weed overseas**
- **c) Species not known to be an environmental weed but there are environmental weed species in the genus**
- **d) Genus has no known environmental weeds**

** "Environmental weed" refers to plant species that invade natural ecosystems, including extensive grazing systems based on native pastures (also known as invasive or wildland weeds). To distinguish environmental weeds from naturalised plants, there should be evidence that the former have been specifically targeted for control measures to protect natural ecosystems.*

Species that can establish well in competition with other plants and insect pests have greater potential to become weeds in natural ecosystems.

2. What is the species' ability to establish in competition with other plant competitors and pests, such as weeds or native species, in trial plots or other situations?

- **a) Establishment superior to other plant species (90 - 100% establishment, other plants suppressed)**
- **b) Establishment relatively unimpeded (50 - 89% establishment)**
- **c) Establishment impeded (10 - 49% establishment)**

d) **Establishment impeded significantly (<10% establishment)**

e) **Don't know**

To determine establishment in trial plots, divide observed plant numbers after approximately six months, by the number of seedlings counted 6-8 weeks after seeding. If this data is not available, use best estimates and/or other published data.

This question assumes that any other plant species present in the trial plot are germinating and establishing at a similar time to the species of interest, i.e. that the plot was cleared of vegetation prior to sowing of the desired species, and that the seed of the species of interest is viable. Assume there is no management intervention to control other plants, such as selective herbicides. A plant is considered "established" if it is an annual that has been able to reproduce by the end of the first growing season (e.g. at the end of spring) or a perennial that has survived its first summer. Include susceptibility to predation by insects and disease e.g. red-legged earth mite predation of seedlings.

If species are highly susceptible to overgrazing and plants are killed, then this could indicate the species would be less likely to persist in large numbers in native vegetation where grazing by native and feral animals may occur. However, it is acknowledged that some palatable species, such as phalaris and perennial veldt grass, have become problematic weeds in some areas. If the species is not palatable and animals graze it only as a last resort, answer "a)"

3. To what degree can the species tolerate herbivory pressure?

a) **Is not palatable and is rarely grazed**

b) **Will tolerate continuous grazing for an extended period of time**

c) **Will tolerate rotational grazing all year round**

d) **Will tolerate some grazing at particular times of the year**

e) **Has low tolerance to grazing, plants are easily killed**

f) **Don't know**

Some species may establish well in the first year, but persist poorly in subsequent years. Those that do persist well may become problematic weeds in natural ecosystems.

4. What is the species' ability to persist as a long-term sward or stand without management?

a) **Plant numbers increase substantially with successive reproductive cycles to form a near monoculture**

b) **Plant numbers remain at a steady level, persisting as a significant component of a mixed sward/stand**

c) **Plant numbers decline slowly over successive years so that it becomes a minor component of the vegetation**

d) **Plant numbers decline rapidly over successive years so that only occasional plants can be found**

e) **Don't know**

Compare the number of plants that originally established in trial plots in the first year to how many regenerated/persisted in subsequent years. Assume no management of competing plant species.

Species that have efficient primary dispersal mechanisms that enable rapid spread from the initial area of growth pose a higher risk of spread to neighbouring areas.

5. Is the plant likely to rapidly colonise a site?

a) **a) At least 30 plants are found growing > 5 m from the original plots in the second or third years after planting for annuals, or within 10 years for perennials**

b) **b) At least 30 plants are found growing > 1 m from the original plots in the second or third years after planting for annuals, or within 10 years for perennials**

c) **c) At least 5 plants are found growing > 1 m from the original plots in the second or third years after planting for annuals, or within 10 years for perennials**

d) **d) No plants are found outside the plot, or plants are found growing within 1m of the original plots in the second or third years after planting for annuals, or within 10 years for perennials**

e) **e) Don't know**

When answering these questions, include any vegetative propagules (e.g. broken fragments of roots or stems) bulbils, corms and seeds that have self-sustaining root systems. For example, some propagules may still be attached to the parent plant, but are able to survive if that attachment is severed. Search the literature for further evidence of rapid colonisation.

Australia generally has nutrient-poor soils. Species that can grow in this environment pose a higher weed risk than those that require higher nutrient levels for growth and reproduction. For legume species, you may consider whether there are specific rhizobia requirements that are not met by rhizobia present in Australian soils, and to what extent their absence affects establishment and reproduction. Provide documented evidence.

Will the species establish and reproduce in low-nutrient Australian soils?

a) **Establishment and reproductive ability uninhibited in low-nutrient soils**

b) **Establishment and reproductive ability reduced in low-nutrient soils**

c) **Establishment and reproductively severely diminished in low-nutrient soils**

d) **Establishment and reproduction not likely in low-nutrient soils without soil additives**

e) **Don't know**

Question 7 has 4 parts, which cover the main natural means of dispersal of a species. Please use your own observations and those from the literature when deciding on your response. Species with several means of dispersal tend to spread faster than those with only one. Consider if the propagules are adapted for long-distance dispersal by any of the means below, and how regularly these means of dispersal occur.

7I. How likely is long-distance dispersal (>100m) by flying animals (birds, bats)? *Features favouring long-distance dispersal by birds are fruits that are eaten whole, and seeds that are defecated or regurgitated (eg olives, blackberry)*

a) **Common**

b) **Occasional**

c) **Unlikely**

d) **Don't know**

7II. How likely is long-distance dispersal (>100m) by other wild animals? *Consider whether propagules have hooks, barbs or sticky substances that attach to feathers, hair or skin (eg brome grass), very small seeds that can lodge within feathers, hair or feet (eg nutgrass), or seeds that may pass through the gut and be defecated.*

a) **Common**
b) **Occasional**
c) **Unlikely**
d) **Don't know**

7III. How likely is long-distance dispersal (>100m) by water? *Consider whether propagules will readily float (e.g. leguminous pods that do not shatter) and whether the species may be located near watercourses (e.g. willows, para grass).*

a) **Common**
b) **Occasional**
c) **Unlikely**
d) **Don't know**

7IV. How likely is long-distance dispersal (>100m) by wind? *Long distance dispersal by wind may be aided by parachutes, wings or plumes attached to the seed, very small seed that can be spread in dust storms (e.g. serrated tussock) or plants that break off whole or in parts to be blown across the soil surface (e.g. windmill grass).*

a) **Common**
b) **Occasional**
c) **Unlikely**
d) **Don't know**

Question 8 has 3 parts, and determines the likelihood of dispersal by human-influenced means. People will intentionally move pasture plants, but the questions focus on accidental spread. When answering these questions, consider how often you think new populations could start at least 100 metres from the original planting.

8I. How likely is long-distance dispersal (>100m) accidentally by people and vehicles? *Features that favour accidental human-influenced spread include: species that are dragged by farm machinery (e.g. root fragments of couchgrass), propagules that have hooks, barbs or sticky substances to attached to objects (eg caltrop, brome grass), species with small bulbils or corms (e.g. soursob or watsonia) or species with very small seeds that are released from pods upon contact to lodge in footwear, clothing or vehicles (e.g. Brassica spp.).*

a) **Common**
b) **Occasional**
c) **Unlikely**
d) **Don't know**

8II. How likely is long-distance dispersal (>100m) accidentally by contaminated produce? *Contaminated produce may include crop seed, pasture seed, hay, soil, gravel, fertilisers, manures and/or mulch. Some species that are commonly spread this way include salvation Jane in hay and soursob in soil.*

e) **Common**
f) **Occasional**
g) **Unlikely**
h) **Don't know**

8III. How likely is long-distance dispersal (>100m) accidentally by domestic/farm animals? *Features favouring dispersal by domestic/farm animals (e.g. sheep, cattle, horses, dogs) include those species with whole fruits that are eaten and seeds later defecated or regurgitated (e.g. kikuyu dispersed through manure), propagules with hooks, barbs or sticky substances that attach to feathers, hairs or skin (e.g. horehound, brome), or very small seeds that can lodge within feathers, hairs or feet.*

a) **Common**
b) **Occasional**
c) **Unlikely**
d) **Don't know**

Question 9 *looks at the reproductive ability of the species. To answer these questions, please use your own knowledge, and that reported in the literature.*

9I. What is the species' minimum generation time? *The minimum generation time of a species is the time from germination to production of viable propagules. The shorter the generation time, the more likely a species will become a weed.*

a) **≤ 1 year**
b) **2-3 years**
c) **>3 years/never**
d) **Don't know**

9II. What is the species' average seed set*?

a) **High (>1000 m^{-2}/year for woody species, >5000 m^{-2}/year for herbaceous species)**
b) **Low**
c) **None**
d) **Don't know**

** This is measured as annual seed fall immediately below plants and applies to the typical plant density within 1 m^2 (i.e. can be one to many individuals).*

9III. What is the species' seed persistence in the soil seedbank? *If more than 1% of the seed is viable after 1 year, it is considered to have persisted.*

a) **> 5 years**

b) **2-5 years**

c) **< 2 years**

d) **Don't know**

9IV. Can the species' reproduce vegetatively*? *Vegetative means of reproduction include bulbs, bulbils, corms, tubers, rhizomes, stolons, root suckers, root fragments and shoot fragments. Please consider that some species may reproduce vegetatively only after fire or other disturbance. Species that reproduce rapidly via vegetative means include couchgrass and kikuyu.*

a) **Yes – rapid vegetative reproduction**

b) **Slow**

c) **No**

d) **Don't know**

** Form new plants with self-supporting root systems (even if still attached to parent plant).*

Section 2: Impacts

This section provides an indication of the potential detrimental impacts a species may have in natural ecosystems. Estimating the potential impact a species may have is difficult without doing specific experiments across many ecological systems and conditions. However, a search of the literature may provide historical evidence of high or low impacts in other natural ecosystems, and this is one of the most reliable indicators of species behaviour when assessing weed risk.

The questions in this section are worded such that a *literature search is required*, but there is also room for intuitive responses from experienced pasture scientists. It is asked that each response is as comprehensive as possible, and that consultation among others with expertise in certain species is sought before an answer is given. It is advisable to consult the weed experts listed in the Appendix for further information.

Please indicate what assumptions you have made about the density that your species may reach in native vegetation, and answer the questions based on this density. Particular vegetation types may be invaded at high density, and others not at all, so please consider as many types of natural vegetation as possible when providing your answers. It may be that some species may have a greater potential impact on different soil types (e.g. veldt grass has a high impact on native vegetation of the sandplains in Western Australia, but is not reported as a major weed on heavier soils). For native species, weed potential may only be expressed outside their natural distributions eg *Acacia pycnantha* (Golden wattle), *Billardiera heterophylla* (Australian bluebell).

1. Could the species reduce the biodiversity value of a natural ecosystem, either by reducing the amount of biodiversity present (diversity and abundance of native species), or degrading the visual appearance? *Consider habitat and species richness of plants, animals and insects. This will impact on the value of the vegetation for conservation, and for nature-based tourism.*

a) **The species could significantly reduce biodiversity such that areas infested become low priorities for nature conservation and/or nature-based tourism**

b) **The species could have some effect on biodiversity and reduce its value for conservation and/or tourism**

c) **The species would have marginal effects on biodiversity but is visually obvious and could degrade the natural appearance of the landscape**

d) **The species would not effect biodiversity or the appearance of natural ecosystems**

e) **Don't know**

2. Does the species have a history of, or potential to in your view, of reducing the establishment of other plant species? *Many high-impact weed species have the ability to prevent germination and establishment of other plant species through shading, competition for resources or release of allelopathic substances. For example, a tall dense shrub may shade out ground covers and herbs, or a dense tussock-forming grass may prevent the establishment of herbs and seedling trees or shrubs.*

a) **The species can significantly inhibit the establishment of other plants (e.g. regenerating native vegetation) by preventing germination and/or killing seedlings, and/or the species forms a monoculture**

b) **The species can inhibit the establishment of other plants and/or does/will become dominant.**

c) **The species can cause some minor displacement by inhibiting establishment, but will not become dominant.**

d) **The species does not inhibit the establishment of other plants.**

e) **Don't know**

3. Could the species alter the structure of any native ecosystems at risk of invasion from this species by adding a new strata level? *There are 6 commonly recognised strata levels in native vegetation: trees >20m, trees 10-20m, shrubs 2-10m, shrubs <2m, tussock grasses, ground covers/ herbs. Think about what type of ecosystems are most likely to be invaded by this species, to decide if it could creating a new strata level. For example, pine trees invading grassy rangelands, acacia's invading grassy woodlands, mimosa invading wetlands.*

a) **a) Will add a new strata level, and could reach medium to high density**

b) **b) Will add a new strata level, but at low density**

c) **c) Will not add a new strata level**

d) **d) Don't know**

Invasive species that add a new strata level (or life-form) to an ecosystem often dramatically alter the function of the ecosystem if they are present at high density. Some "transformer" species fall into this category.

4. Could or does the species restrict the physical movement of people, animals, and/or water? *Species that can restrict physical movement may be prickly (e.g. mesquite), form dense monocultures that are impenetrable (e.g. suckering stands of Acacia), form tangled mats or blankets over vegetation (e.g. bridal creeper), or form thickets that divert water from main watercourses (e.g. willows)*

a) **Species infestations could become impenetrable throughout the year, preventing the physical movement of people, animals and/or water**

b) **Species infestations could significantly slow the physical movement of people, animals and/or water throughout the year**

c) **Species infestations could slow the physical movement of people, animals and/or water at certain times of the year or provide a minor obstruction throughout the year.**

d) **Species infestations have no effect on physical movement**

e) **Don't know**

5. Is the species toxic to animals, have spines or burrs, or host other pests or diseases that could impact on native fauna and flora?

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a) **a) Yes**

b) **b) No**

6. Does the species have, or show the potential to have, a major effect on fire regime? *This includes changes to the normal frequency and/or intensity of fires. For example, exotic grasses invading shrubby native woodland increase fire frequency and intensity. Consider what vegetation is already present, and if the species may dramatically change the current fire regime.*

a) **Major effect on frequency and/or intensity**

b) **Minor effect on frequency and/or intensity**

c) **No effect**

d) **Don't know**

7I. Could the species provide food or shelter for pest animals? *For example, blackberry harbouring rabbits. Only answer yes if the plant species is likely to encourage population growth of the pest.*

a) **Yes – more than what native vegetation provides**

b) **No – not above what native vegetation provides**

c) **Don't know**

7II. Does the species have, or show the potential to have, a major effect on nutrient levels in intact native vegetation? *For example, leguminous species can increase soil nitrogen and make native vegetation more prone to invasion by other weeds.*

a) **Will significantly increase soil nutrient levels**

b) **Will significantly decrease soil nutrient levels**

c) **Will have minimal effect on soil nutrient levels**

d) **Don't know**

7III. Could the species reduce water quality or cause silting of waterways? *For example, dense thickets of willows (Salix spp.) cause erosion by diverting water outside main watercourses causing flooding and erosion of watercourse banks. Willow leaves also reduce the quality of water by causing a flush of organic matter that reduces available oxygen.*

a) **Will significantly reduce water quality or cause silting of waterways**

b) **May have some effect on water quality or silting of waterways in a small number of ecosystems**

c) **Minor or no effect on water quality**

d) **Don't know**

7IV. Does the species have, or show the potential to have, a major effect on the soil water table below intact native vegetation? *Does the species significantly lower the soil water table compared to other plants present in a natural ecosystem? Compare to what is already present in the native vegetation. For many species, the overall effect on the water table will not be dissimilar to what naturally occurs in native vegetation. An example of a species that significantly lowers the water table is the invasion of native grasslands by pine trees.*

a) **Will significantly lower the water table**

b) **Will have no effect**

c) **Don't know**

Section 3: Potential Distribution

The potential distribution will be determined by digitally overlaying climate, soil preference and native vegetation layers to find the areas of Australia where the species is most likely to grow. This output will be a broad indicator only.

Climate analysis is done using CLIMATE®, a software package designed specifically for weed risk assessment. This program uses global distribution data (collection information, particularly GPs locations) to model where in Australia the species is suited. For more information on this program, please contact Lynley Stone (lynley.stone@dec.wa.gov.au, ☎ 08 9334 0313).

To map the vegetation layer, the National Vegetation Information Service (NVIS) dataset of all vegetation in Australia is used. Only native vegetation is used in the analysis, as the focus is of this assessment is risk to natural ecosystems.

To map the soil preference, an electronic dataset of Northcote soils is used, by selecting the soil tolerances of the species.

1. Please select the soil preferences of your species from the table below.

Table 1. Northcote soil classifications

	Y/N		Y/N
Sands (Uc)		Brown duplex (Db)	
Loams (Um)		Yellow duplex (Dy)	
Non-cracking clay (Uf)		Black duplex (Dd)	
Cracking clay (Ug)		Grey duplex (Dg)	
Calcareous earths (Gc)		Organic (O)	
Massive earths (Gn)		Rock	
Red duplex (Dr)		Lakes	

For more information, please refer to the websites listed in the Appendix, or the book:

Northcote, KH, Hubble, GD, Isbell, RF, Thompson, CH and Bettenay, E. (1975) "A Description of Australian Soils." CSIRO Australia.

How the potential distribution of the species will be evaluated and scored

The distribution analysis will be done on a state-by-state basis.

The climate and soils maps will be digitally overlayed, and areas where the climate and soils match to within 80% of the mean will be used to estimate the potential distribution of the species. The number of hectares that are suitable for the species will be estimated for each state. The size of each output square in CLIMATE is approx 250,000ha, therefore the smallest match for any species, other than no match, is 250,000ha.

For Western Australia, hectares suitable for the species will be calculated SOUTH of the Tropic of Capricorn only. This is to eliminate bias against species that may be suitable to the northern parts, but show little suitability in the regions where they are intended for planting. A whole-of-state calculation can be easily calculated if necessary.

How many hectares are suitable for the species?

Million ha	SCORE
> 50	10
≤ 50	9
≤ 20	8
≤ 10	7
≤ 5	6
≤ 3	5
≤ 2	4
≤ 1	3
≤ 0.5	2
≤ 0.25	1
0	0.5

Section 4: How a Weed Risk Score will be calculated

To calculate the weed risk score, the scores for invasiveness and impacts are adjusted to range from 0 to 10 (potential distribution is already a score ranging between 0 and 10).

To adjust the scores for Invasiveness and Impacts to range between 0 and 10:

a) **Invasiveness: Divide raw score by 27 and multiply by 10. Round off to one decimal place.**

b) **Impacts: Divide raw score by 20 and multiply by 10. Round off to one decimal place.**

The adjusted scores for each section are then multiplied together.

WEED RISK = Invasiveness x Impacts x Potential Distribution

The possible scores have been divided into bands of 20% to provide cut-offs for classes of weed risk. These cut-off scores are provided below.

FREQUENCY BAND	WEED RISK SCORE	WEED RISK
80-100% (top 20% of possible scores)	≥ 236	Very High
60-80%	< 236	High
40-60%	< 111	Medium
20-40%	< 49	Low
0-20% (bottom 20% of possible scores)	< 18	Negligible

Multiplying the scores for each section is logical, as it acknowledges the interactions between the criteria, and gives a broader spread of scores.

Acknowledgements

The assistance of the following people is acknowledged in the preparation of these protocols.

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References

Standards Australia (2006) HB 294:2006 National Post-Border Weed Risk Management Protocol, CRC Australian Weed Management, Adelaide, and Standards Australia International Ltd, Sydney

CLIMATE –Beta version (October 2005). Bureau of Rural Sciences, Department of Environment and Heritage, Commonwealth of Australia.

Northcote, KH, Hubble, GD, Isbell, RF, Thompson, CH and Bettenay, E. (1975) “A Description of Australian Soils.” CSIRO Australia.

Virtue, J. (2004) SA Weed Risk Management Guide, Animal and Plant Control Commission, South Australia.

Appendix 1

Resource List

WEBSITES

Checking nomenclature (are you using the most current species name?)

Specific floras

Australia

- Australia's Virtual Herbarium (also good for Australian distribution of a species): http://www.chah.gov.au/avh/
- South Australia: http://www.flora.sa.gov.au
- Western Australia: http://florabase.calm.wa.gov.au
- New South Wales: http://plantnet.rbgsyd.nsw.gov.au

International

- eFLORAS.org – links to online floras from around the world: http://www.efloras.org
- Jepsons Online Interchange (plants in California):
- http://ucjeps.berkeley.edu/interchange.html
- Flora Europaea: http://193.62.154.38/FE/fe.html

General database resources

- Germplasm Resources Information Network (GRIN/NPGS Database):

  http://www.ars-grin.gov/cgi-bin/npgs/html/tax_search.pl

- International Legume Database and Information Service: http://www.ildis.org/LegumeWeb
- International Plant Name Index: http://www.ipni.org/ipni/query_ipni.html
- TROPICOS – a large database of plant nomenclatural information from around the world (can map world distribution of species): http://mobot.mobot.org/W3T/Search/vast.html
- Electronic plant information centre (ePIC) – Royal Botanic Gardens, Kew: http://www.kew.org/searchepic/searchpage.do
- Global Biodiversity Information Facility (GBIF) Prototype Data Portal http://www.secretariat.gbif.net/portal/index.jsp

Weeds

- CRC for Australian Weed Management (go to “weed links”) http://www.weedscrc.org.au
- Weeds Australia: http://www.weeds.org.au/
- Noxious weeds in Australian States and Territories: http://www.weeds.org.au/noxious.htm
- Pacific Island Ecosystems at Risk (PIER) has information on a range of temperate and tropical weeds: http://www.hear.org

- The Nature Conservancy has information on temperate weeds: http://tncweeds.ucdavis.edu
- United States Department Agriculture (USDA): http://plants.usda.gov/topics.html
- Enviroweeds list server – managed by CRC Australian Weed Management, is a forum for discussion of management of weeds in natural ecosystems http://www.weedscrc.org.au/main/enviroweeds.html

Soils

- http://audit.deh.gov.au/anra/land/docs/national/soil_classn.html#key
- Description of the Digital Atlas of Australian Soils used in the distribution analysis (Australian Natural Resources Data Library) http://adl.brs.gov.au/anrdl/php/full.php?fileidentifier=http://adl.brs.gov.au/findit/metadata_files/pa_daaslr9abd_00111a00.xml
- Northcote factual key description and general information http://www.anra.gov.au/topics/soils/overview/index.html

WEED EXPERTS IN AUSTRALIA

Western Australia

Mr Rod Randall, Department of Agriculture and Food, Western Australia

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South Australia

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