

# Pathway risk analysis for weed spread within Australia (UNE61)

*Implications for Policy Makers*



**Australian Government**  
**Land & Water Australia**

**UNE**  
UNIVERSITY OF  
NEW ENGLAND



INSTITUTE FOR **Rural Futures**

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## Authors

Brian Sindel and Annemieke van der Meulen, School of Environmental and Rural Science, and Michael Coleman, Ian Reeve and Jonathan Moss, Institute for Rural Futures, University of New England.

## Contact

Professor Brian Sindel, Agronomy and Soil Science, School of Environmental and Rural Science, University of New England, Armidale, NSW, Australia 2351; 02 6773 3747; bsindel@une.edu.au

## Further Information

The final project report is available from Land & Water Australia, and may also be downloaded free of charge from [www.ruralfutures.une.edu.au](http://www.ruralfutures.une.edu.au) (Institute for Rural Futures, University of New England).

The final report for the related project, *Best practice for on-ground property weed detection*, is also available at the same address.

# Contents

<b>1 EXECUTIVE SUMMARY .....</b>	<b>4</b>
<b>2 DEFINITIONS .....</b>	<b>6</b>
2.1 WHAT IS A WEED?.....	6
2.2 WHAT IS A PATHWAY?.....	6
2.3 WHAT IS A SOURCE? .....	6
2.4 WHAT IS A PROPAGULE?.....	6
<b>3 INTRODUCTION.....</b>	<b>7</b>
<b>4 SHORTCOMINGS OF EXISTING POLICIES.....</b>	<b>7</b>
<b>5 PROJECT GOALS AND QUESTIONS .....</b>	<b>7</b>
<b>6 WEED SOURCES .....</b>	<b>8</b>
<b>7 WEED PATHWAYS, THEIR CURRENT RISKS AND POLICY PROBLEMS.....</b>	<b>9</b>
7.1 PATHWAYS.....	9
7.2 RISKS.....	10
7.3 REGULATION.....	11
7.4 INSUFFICIENT INFORMATION .....	12
<b>8 THE OUTLOOK FOR WEED SPREAD PATHWAYS.....</b>	<b>13</b>
<b>9 LEGISLATIVE AND REGULATORY RECOMMENDATIONS.....</b>	<b>14</b>
9.1 ORNAMENTAL PLANT TRADE .....	14
9.2 AQUARIUM PLANT TRADE .....	14
9.3 MEDICINAL PLANT TRADE.....	14
9.4 FOOD PLANT TRADE.....	15
9.5 FODDER TRADE .....	15
9.6 REVEGETATION AND FORESTRY .....	15
9.7 HUMAN APPAREL AND EQUIPMENT .....	15
9.8 MACHINERY AND VEHICLES .....	16
9.9 CONSTRUCTION AND LANDSCAPING MATERIALS .....	16
9.10 AGRICULTURAL PRODUCE.....	16
9.11 RESEARCH SITES .....	17
9.12 LIVESTOCK MOVEMENT.....	17
9.13 WASTE DISPOSAL.....	17
9.14 BIRDS .....	17
9.15 OTHER ANIMALS .....	18
9.16 WIND.....	18
9.17 WATER .....	18
<b>10 PATTERNS IN POLICY CHANGE .....</b>	<b>19</b>
<b>11 REFERENCES.....</b>	<b>19</b>

# 1 Executive Summary

This project sought to identify and evaluate both ‘sources’ of weeds, and the ‘pathways’ of weed spread within Australia, to assess the relative threats or risks posed by different sources and pathways.

Although governments (at all levels) are committed to preventing weed spread, and have implemented a range of policies to manage weed spread, the effectiveness of these appears to be limited by lack of resources and consistency at local, State/Territory, and Federal levels (Barker 2005).

The project comprised a review of literature, and a survey of Australian weed experts. Twenty-four weed *sources* were identified in the literature. Survey respondents considered each to be a relatively important source of weeds, though transport sites, land in transition, pastures, gardens and nurseries, and rivers were rated most important.

The literature review also identified seventeen *pathways* of weed spread within Australia. A list of pathways is included in Table 1. Survey participants were asked to evaluate the capacity of each pathway to spread weeds, and to identify potential improvements in regulation and management to minimise the risk of weed spread for each.

All pathways appear to pose a relatively high risk of weed spread. Many respondents also considered that there was insufficient information available to identify the importance of several high-risk pathways.

All pathways, with the exception of research sites, will be either ‘more important’ or ‘as important’ in the future. Pathways considered by respondents as most likely to become more important in the future include fodder trade, ornamental plant trade, and agricultural produce.

Many respondents noted insufficient regulation and management of many weed spread pathways. Legislative, regulatory and management improvements suggested by survey respondents for specific pathways included:

- *Ornamental, aquarium and medicinal plant trade* – education, extension and labelling, banning high-risk species, improved surveillance and inspection of shops and online retailers.
- *Food plant trade, fodder trade and agricultural produce* – risk assessments of, and research into, potential weed species, certification of weed status and vendor declarations, and holding growers financially responsible for weed escapes.
- *Revegetation and forestry* – financial accountability of the forestry industry, and ensuring prevention of weed species usage for forestry, revegetation and salinity projects.
- *Machinery and vehicles* – improved enforcement, fines and other disincentives, improved management codes and practices, mandatory wash-down of equipment.
- *Construction and landscaping, and waste disposal* – specified dumping areas, ensuring use of clean fill in sensitive areas, enhanced legal enforcement of management codes and practices, extra resources and staff, and education.
- *Livestock movement* – quarantine procedures, further research, alignment of State and Federal regulations, improved surveillance, and increased staff.
- Other pathways identified included *human apparel and equipment, research sites, birds, other animals, wind and water*. Little change appears necessary in the regulation of research sites. However, given the difficulties in regulating the remaining

pathways, survey respondents suggested education programs and regulation aimed at addressing potential spread at the source.

It is apparent that an integrated regulatory and management approach is required to deal with the spread of weeds. Policy makers need to consider the spread capacity of particular weed species, sources of weeds, and pathways for the spread of weeds, in the implementation of weed control policies.

The full project report is available for download from [www.ruralfutures.une.edu.au](http://www.ruralfutures.une.edu.au) (Institute for Rural Futures, University of New England).

## **2 Definitions**

### **2.1 *What is a weed?***

A weed is a plant that requires some form of action to reduce its harmful effects on the economy, environment, human health and amenity (Australian Weeds Committee 2006). This definition includes plants not native to Australia and native plants growing outside their known natural range.

### **2.2 *What is a pathway?***

A pathway is described by Barker (2006) as any means or mechanism by which weed plants or propagules may be dispersed. In the case of human directed activities, spread may be through either the intentional trade in invasive plants or their propagules for some perceived benefit, or as the result of contaminated products, clothing, machinery, equipment etc.

### **2.3 *What is a source?***

A source differs from a pathway in that it is not the means of moving weeds. It is a site or area of land where weeds are actively growing and from which new invasions may emerge.

### **2.4 *What is a propagule?***

A propagule is any structure with the capacity to give rise to a new plant, e.g. a seed, stem or a vegetative part of a plant, capable of independent growth if detached.

### **3 Introduction**

Despite the enormous cost of invasive weeds to the Australian environment and its economy through lost agricultural production, no national studies have previously been undertaken to ascertain the way that weeds spread once present within Australia, or to assess the relative threats or risks of different sources and pathways of spread.

This project, funded by the Land & Water Australia Defeating the Weed Menace R&D, sought to identify and evaluate the impact of weed ‘sources’ (sites from which new weed invasions may emerge) and weed ‘pathways’ (means by which weed plants or propagules, including seeds and stems capable of independent growth, might be spread).

### **4 Shortcomings of existing policies**

A wide range of tools has been developed and is being implemented to manage weed spread by humans. The effectiveness of these tools, including policy, legislation, vendor declarations, industry codes of practice and certification schemes, in reducing human-induced weed spread has been assessed by a national scoping study (Barker 2005). The major findings of this study were:

- government, industry and other organisations are committed to preventing weed spread;
- no one tool was seen as effective across Australia, and only a few tools were identified at the State/Territory level;
- there is a lack of objective measures to evaluate the effectiveness of weed prevention tools;
- participants in the study found it difficult to determine whether ineffective tools were themselves flawed, or rendered ineffective because of insufficient resources for implementation; and
- it was strongly recommended that weed spread management be made consistent across all States and Territories and at all levels of government.

### **5 Project goals and questions**

The goals of this project were to:

1. Assess the relative risks of sources and pathways of weed ingress within Australia; and
2. Identify ways to reduce these risks.

The specific questions addressed by the research were:

- How do weed propagules spread within Australia?
- Which sources and pathways account for the majority of weed ingress?
- Which sources and pathways currently pose the greatest risks?
- In what ways are the risks changing with changing environmental conditions, local trade and other patterns of movement?
- How can current and emerging risks be managed?
- On what potential sources and pathways do we have insufficient information to identify their importance or to design management strategies?

To address these questions, the project was comprised of:

- An evaluation of Australian and international literature, which identified the various sources and pathways of weed spread within Australia, and strategies currently available to manage each source and pathway. Twenty-four weed sources and seventeen weed pathways (both natural and a consequence of deliberate and accidental human activity) were identified.
- A survey of over 100 Australian weeds professionals in late 2007, drawing on their expertise to identify knowledge gaps, research specific to weed spread in the Australian context, and shortcomings in current management strategies.

## 6 Weed sources

Twenty-four weed sources were identified in the review of literature. Survey respondents were asked to rate the importance of each weed source (Figure 1).

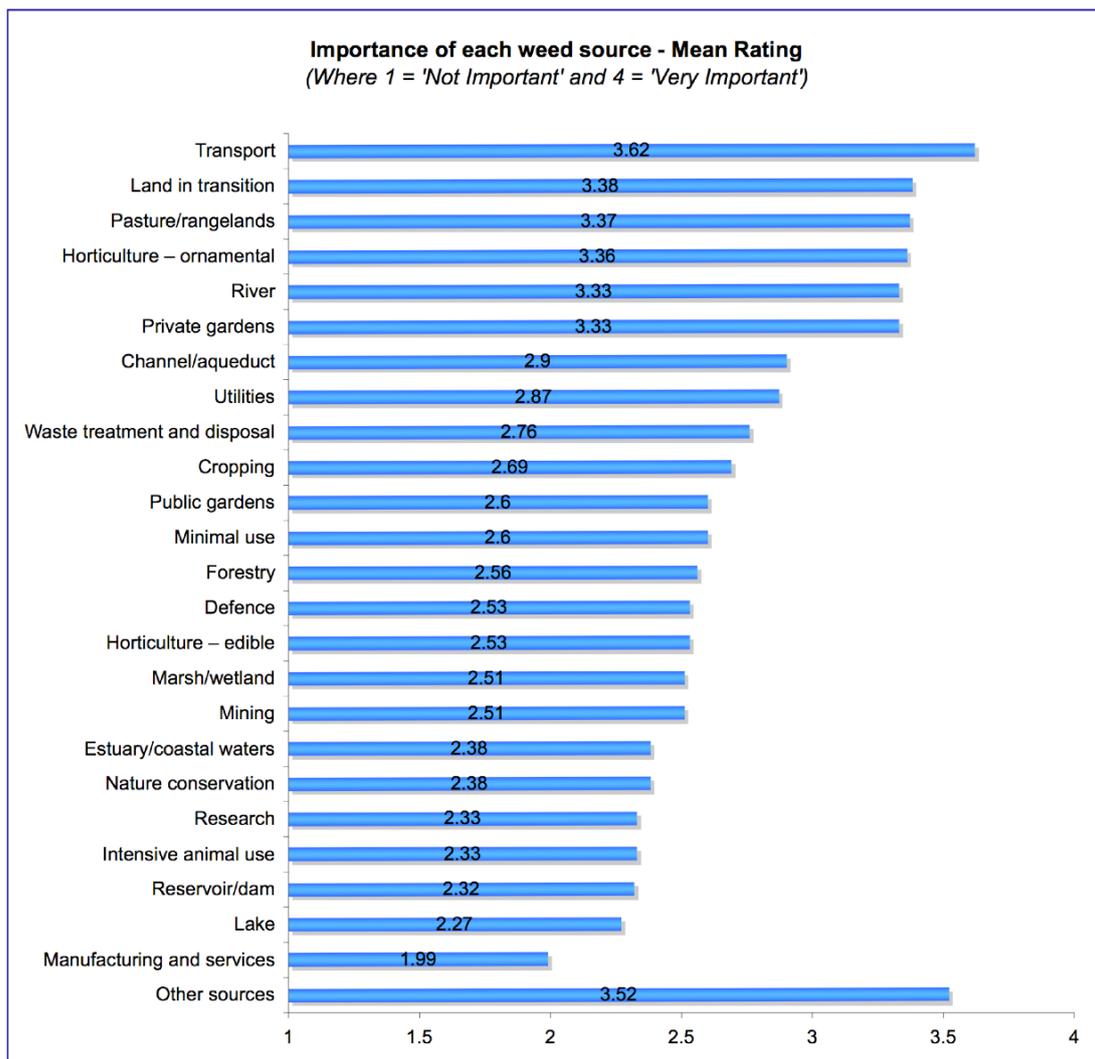


Figure 1 Importance of each weed source.

## 7 Weed pathways, their current risks and policy problems

### 7.1 Pathways

Seventeen different pathways for weed spread in Australia were identified in the review of literature. The pathways, along with their definition, are listed in Table 1.

<b>Pathways for the spread of weed propagules within Australia</b>	
<b><i>Deliberate Spread by Humans</i></b>	
1. Ornamental plant trade	Through nursery sales and escape of garden and landscaping plants.
2. Aquarium plant trade	Through sales at nurseries, pet shops and escape into waterways.
3. Medicinal plant trade	Plants propagated and sold in nurseries and among alternative medicine enthusiasts.
4. Food plant trade	Plants grown and promoted as food for humans.
5. Fodder trade	Sales and planting of fodder plants for livestock grazing.
6. Revegetation and forestry	Planting for soil conservation and to produce timber.
<b><i>Accidental Spread by Humans</i></b>	
7. Human apparel and equipment	Attachment of seeds to clothes and footwear.
8. Machinery and vehicles	Attachment of seeds to passenger vehicles, slashers, farm equipment, boats, and earth moving equipment.
9. Construction and landscaping materials	Contamination of gravel, soil, sand, mulch and turf.
10. Agricultural produce	Contamination of hay, grain and pasture seed.
11. Research sites	Escape from research sites.
12. Livestock movement	Through faeces or attached to livestock such as sheep, cattle, horses and goats.
13. Waste disposal	Unsafe dumping of garden refuse and aquarium plants.
<b><i>Natural Spread</i></b>	
14. Birds	Through consumption and excretion of seeds and fruits.
15. Other animals	Through consumption and excretion of seeds and fruits, and external attachment to native and introduced wildlife.
16. Wind	Distribution of wind blown seeds.
17. Water	Distribution of seeds or plant parts via waterways.

*Table 1 Pathways of weed spread.*

## 7.2 Risks

Overall, respondents to the survey believed that all pathways have a relatively high capability for weed spread within Australia. Figure 2 depicts the mean overall current risk capability of each pathway according to a range of criteria. The specific risk factors vary between pathways, and are detailed in the full report.

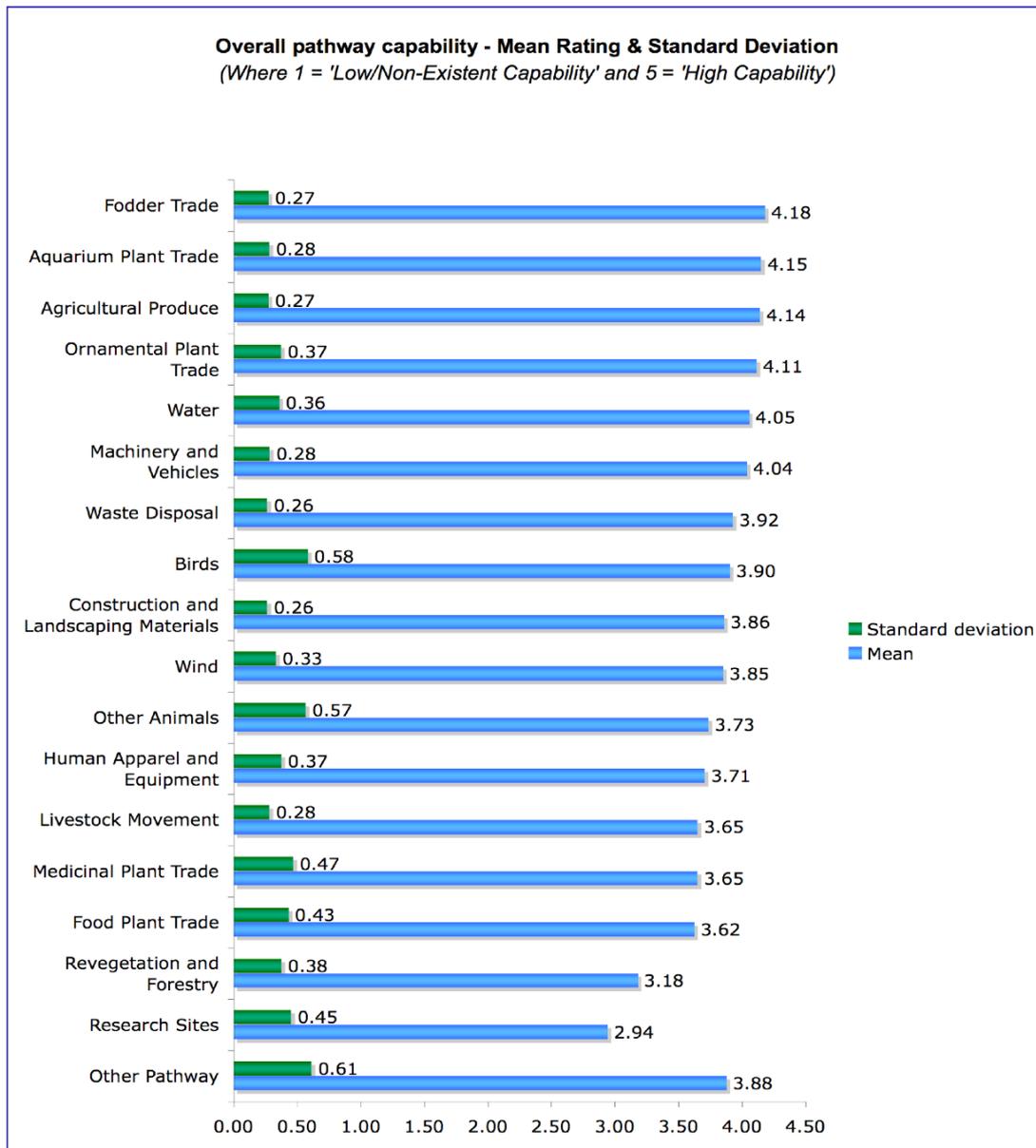


Figure 2 Overall pathway capability for weed ingress within Australia.

### 7.3 Regulation

A relatively high proportion of weed experts (>69 per cent for eight of the pathways) considered the pathways identified by the project to be insufficiently regulated for weeds. Waste disposal was viewed by a significantly higher proportion of respondents (83.3 per cent) than any other pathway to be an insufficiently regulated pathway for weed spread. Trade in plants and fodder also feature as insufficiently regulated pathways, however food plant trade was viewed as insufficiently regulated by only 36.7 per cent of those who were familiar with this pathway (Figure 3).

Many of the pathways that were rated as a high overall risk regarding weed spread (see Figure 2) were also considered by survey respondents to be insufficiently regulated (notably, ornamental plant trade, fodder trade, and aquarium plant trade) (Figure 3).

Section 9 provides a summary of the regulatory and legislative changes recommended by respondents for each pathway.

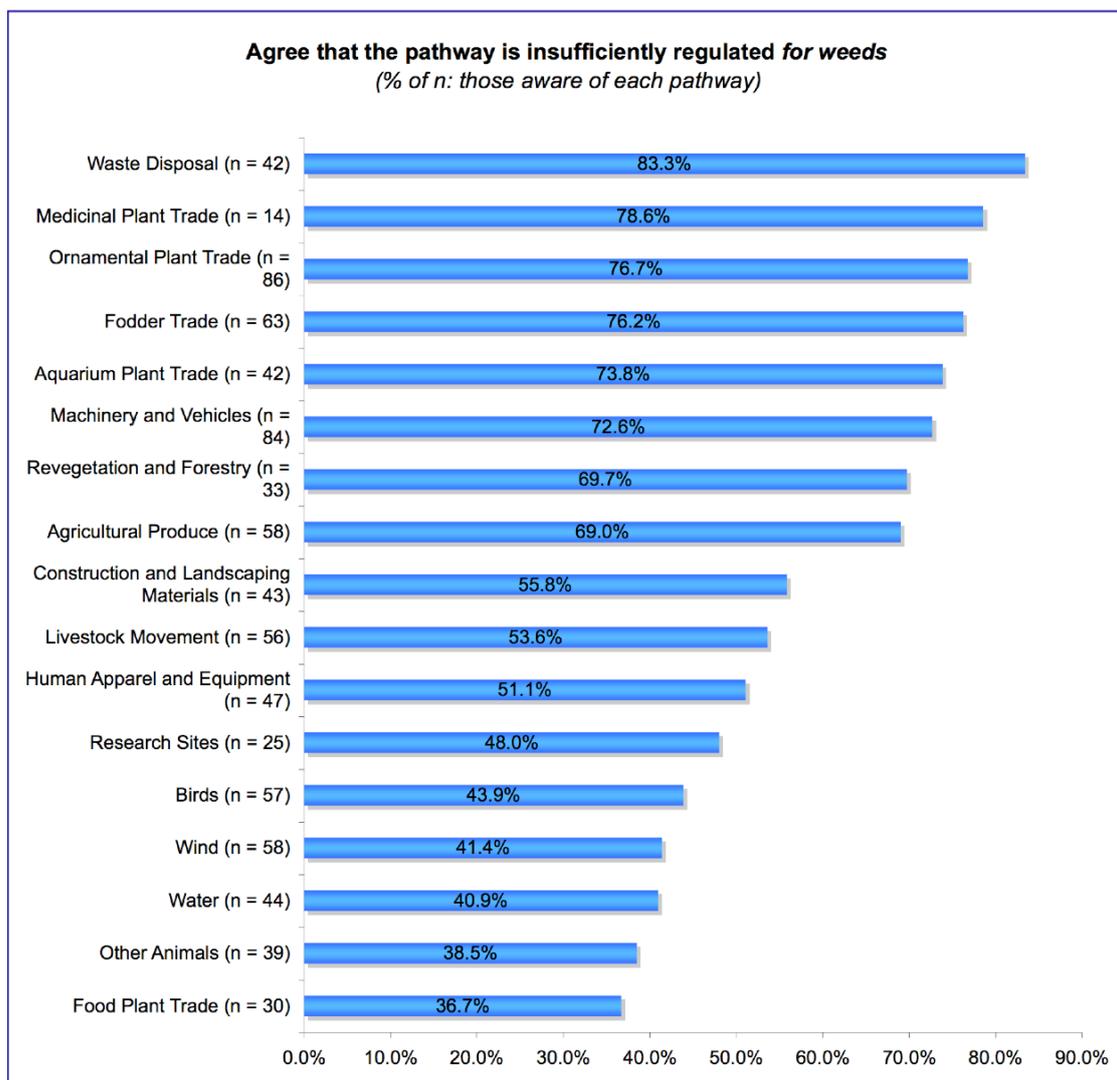


Figure 3 Sufficiency of regulation of each pathway for weeds

## 7.4 Insufficient information

Overall, the majority of respondents considered that *sufficient* information exists to identify the importance of each pathway identified in the project. However, as Figure 4 shows, the largest proportion of respondents indicated that there was *insufficient* information available on the human apparel and equipment, food plant trade and revegetation and forestry pathways. Relatively few respondents considered there to be insufficient information on the water, agricultural produce, and wind pathways. This response may suggest a need for further targeted research into the significance of particular pathways.

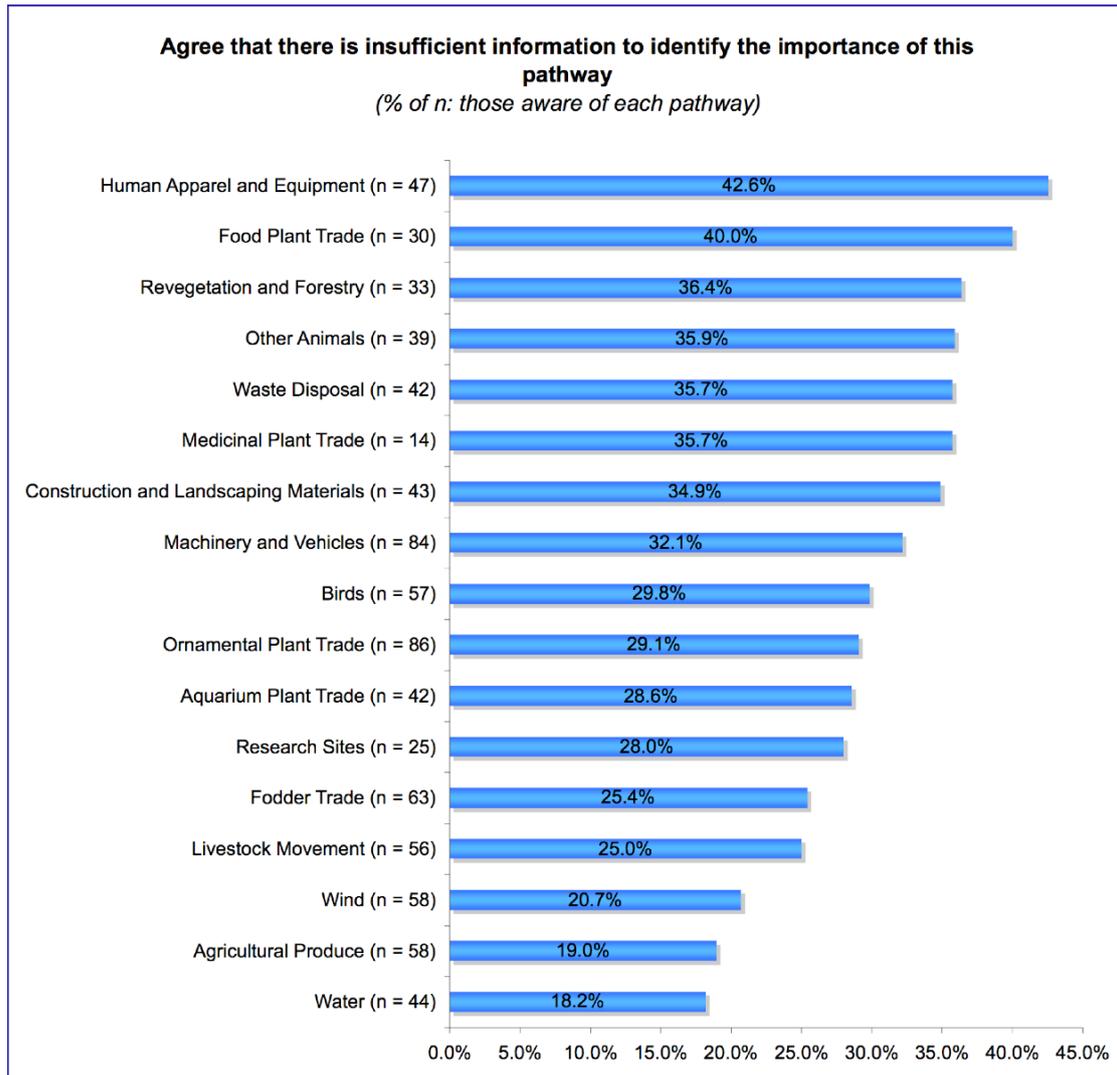


Figure 4 Proportion of respondents who agree that there is insufficient information to identify the importance of weed pathways needs.

## 8 The outlook for weed spread pathways

As Figure 5 shows, respondents consider that all pathways, with the exception of research sites, will be either ‘more important’ or ‘as important’ in the future. Pathways considered most likely to become more important in the future include fodder trade, ornamental plant trade, and agricultural produce.

Fodder trade was assessed as becoming more important for weed spread by respondents due to increasing frequency of drought associated with climate change, and a greater need to grow more hardy fodder crops and transport more fodder into drought affected areas. Fodder (and, indeed, agricultural produce) is often contaminated with weed seeds.

Ornamental plants are a major and growing source of noxious weeds. The industry continues to grow in popularity, and the urban and peri-urban sprawl is taking ornamental plants out into previously rural areas. Furthermore, because of climate change, the public are increasingly seeking drought-adapted species that can be used in dry gardening.

Change in weed spread regulation and legislation, discussed in section 9, may need to account for the potential of particular weed spread pathways to become more important in the future.

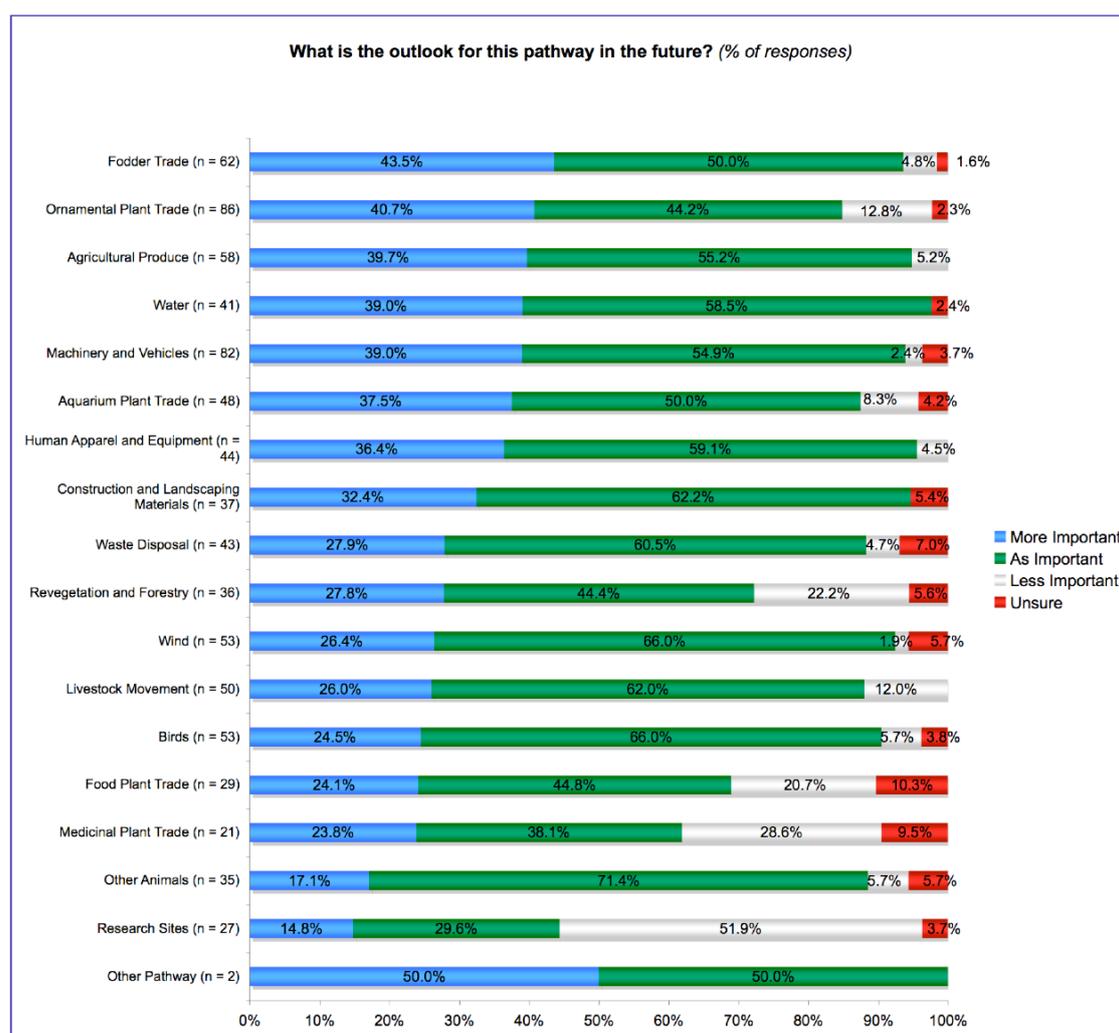


Figure 5 Outlook for weed spread pathways in the future

## 9 Legislative and regulatory recommendations

### 9.1 Ornamental plant trade

*This pathway involves nursery sales and escape of garden and landscape plants.*

Improvements in education, labelling, extension, and publicity-related activities were the major suggested regulatory improvements for the ornamental plant trade (21.3 per cent of respondents).

Other improvements noted in the survey included banning high risk species after appropriate weed risk assessments (8.0 per cent of responses), improved enforcement of legislation (8.0 per cent of responses), alignment of State and Federal regulations (6.7 per cent of responses), and improved monitoring of nurseries (6.7 per cent of responses).

Comments made by respondents include the need to *“get the nursery industry on board and visit all outlets regularly, keep promoting the message, develop much more information, run training programs for nursery people, and make it mandatory, conditional on being able to trade, that they meet certain requirements in this area”*.

Another suggestion was that *“all local nurseries need to have displays about their own local weeds.”*

### 9.2 Aquarium plant trade

*This pathway involves sales at nurseries, pet shops and escape into waterways.*

The most important changes to regulation suggested by respondents involved improving surveillance and inspection of aquatic plant and aquarium traders, and water ways (21.5 per cent of responses). Education and publicity-related activities were also considered important (15.8 per cent of responses).

Some respondents focused on the importance of research into aquatic weed control. One respondent stated that *“for many of the new and emerging aquatic weeds, and even some of the established ones, there are no safe aquatic herbicides. Issues of maintaining water quality for potable water, preventing damage to local flora and fauna, all pose issues for the registration of herbicides. More work is also required on non-chemical means of managing aquatic weeds.”*

However, another respondent argued that *“we know what has to be done, don’t develop more strategies, just get the resources and get it done.”*

### 9.3 Medicinal plant trade

*This pathway involves plants propagated and sold in nurseries and among alternative medicine enthusiasts.*

Regulation of this pathway currently involves legislation and weed declaration. Two respondents made comments relevant to medicinal plant trade regulation:

- *“because of the huge conflicts of interest, industry speculation in some cases, and small size of the trade in other cases, little is done about this group of species”*; and
- *“while this trade should be regulated the same as the nursery trade, it manages to combine a significant underground element in its trade in plant materials, as many members of the herbal trade do not consider the bans on many species to apply to them, as they need them for medicinal purposes. In fact, there is at times some pride amongst herbalists that they have them, or have access to, quarantine species that they know are illegal to own and import.”*

Overall, there was no clear agreement between experts on ways to improve regulation of this pathway. However, suggestions given include a need for a *“full-time person at a national*

level searching the net for weed sellers, and reporting to states on sites that pose a risk to Australia or the states” and to “investigate the organizational structure of the industry, and target them with information about the weedy characteristics of plants.”

## **9.4 Food plant trade**

*This pathway involves plants grown and promoted as food for humans.*

There were too few responses to this pathway to identify a clear trend amongst respondents specific to improvements in regulation. However respondent comments included that while “*little is known about the weed potential of food plants*”, “*the number of weeds that originated from the herb industry is significant*” and “*the responsibility for control/prevention of escape/spread of these species needs to be put on the growers*”.

Two further comments were made: “*we need to identify what food plants pose a weed risk*”; and “*compulsory weed management system for all weed potential plants [needs] to be written into management plans and implemented/regulated*”.

## **9.5 Fodder trade**

*This pathway involves the sale and planting of fodder plants for livestock grazing.*

The most common regulatory improvement required for this pathway was considered to be certification of weed status for fodder vendors (15 per cent of responses). Extra resources and staff were also suggested (10 per cent of responses). The response suggested that some may have confused this pathway, which was meant to represent fodder plants themselves as potential weeds, with the agricultural produce pathway (detailed below), which was intended to represent contaminated hay, grain and pasture seed.

However, one respondent commented that “*if the people who plant or promote a species were made financially responsible for containing it to the area planted, and held financially responsible for the cost of any escapes, then the use of invasive fodder species would cease overnight*”.

## **9.6 Revegetation and forestry**

*This pathway occurs through planting for soil conservation and to produce timber.*

The main suggestions with regard to regulation of this pathway were a perceived need for extra resources and staff (18.8 per cent of responses), and improved education (18.8 per cent of responses). Other suggestions included greater industry financial accountability (12.5 per cent of responses), and the containment and control of weed sources within the industry (12.5 per cent of responses).

One respondent commented that the use of weed species should be prevented for “*salinity and re-veg project[s], especially for State/Federally funded projects*”, and that there is a need for “*more research into native spp. that [might] be used in these situations*”.

## **9.7 Human apparel and equipment**

*This pathway occurs through the attachment of propagules to clothing and footwear.*

The majority of suggestions for improving the effectiveness of regulation of this pathway regarded education and publicity (71.4 per cent of responses). However, 14.3 per cent of responses indicated that this pathway is either difficult or impossible to regulate. In the absence of effective regulation, education and publicity may be one of the few fall-back positions to minimise the spread of weeds via this pathway.

## 9.8 Machinery and vehicles

*This pathway occurs through the attachment of propagules to passenger vehicles, slashers, farm equipment, boats and earth moving equipment.*

The main suggested improvements for regulating this pathway included:

- greater enforcement, fines, disincentives or legal action (21.2 per cent of responses);
- better management practices and codes for vehicle movement by earthmoving and machinery contractors, councils, energy and telecommunications suppliers (18.2 per cent of responses);
- improved education and publicity (15.2 per cent of responses); and
- mandatory wash-down of vehicles and equipment (15.2 per cent of responses).

However, one respondent commented that the machinery and vehicles pathway was “*not practical to regulate effectively due to volume of traffic, number of interstate entry points from some states, intrastate movement issues, etc.*”

## 9.9 Construction and landscaping materials

*This pathway involves contamination of gravel, soil, sand, mulch and turf.*

Suggested improvements in regulation of this pathway included:

- education and publicity (22.2 per cent of responses);
- specified dumping areas (11.1 per cent of responses);
- using clean fill in sensitive areas (11.1 per cent of responses);
- better management codes (11.1 per cent of responses);
- greater legal enforcement (11.1 per cent of responses); and
- extra resources and staff (11.1 per cent of responses).

However, this pathway was also considered by some experts as difficult or impossible to regulate. One respondent noted that while “*quality assurance schemes for soil traded or being sold could be implemented*” for waste soils, “*it is difficult to see how it could be managed at all*”.

## 9.10 Agricultural produce

*This pathway involves contamination of hay, grain and pasture seed.*

The highest proportion of respondents considering regulation of this pathway suggested strengthening weed status and vendor declarations (20.0 per cent of responses). Some respondents also saw a need for increased resources and staff for monitoring and enforcement of pathway regulation (12.0 per cent of responses). A range of other improvements suggested included zero weed tolerance, enforcement, surveillance, and tracking.

One respondent noted that “*in drought situations it is inevitable that the imminent risk of stock loss will be considered more important than the medium/long-term impact of weed invasion, despite the fact that this is likely to be more costly. Therefore, regulatory provisions will be relaxed in times of emergency.*”

### **9.11 Research sites**

*This pathway involves the escape of plants from research sites.*

Due to a low number of responses to this pathway, no trend for improvements in regulation of the research sites pathways was obtained.

However, suggestions included improved education and hygiene, financial liability for the eradication of all escaped plants, and better management codes. A pertinent comment was that weed control should be “*implemented before [the] sale of research stations, and at the end of research projects*”.

### **9.12 Livestock movement**

*This pathway occurs through faeces or attached to livestock such as sheep, cattle, horses and goats.*

According to survey respondents, improvements are required principally in the quarantine processes undertaken by producers (14.3 per cent of responses), and through education and publicity activities (14.3 per cent of responses). Other suggestions included:

- research to determine the weed species spread by this means and the key times to quarantine stock (9.5 per cent of responses);
- alignment of State and Federal regulations (9.5 per cent of responses);
- improved surveillance (9.5 per cent of responses); and
- an increase in staff and resources for monitoring and enforcement (9.5 per cent of responses).

### **9.13 Waste disposal**

*This pathway involves unsafe dumping of garden refuse and aquarium plants.*

The main improvements required in regulation of this pathway involved implementing new enforcement methods (28.0 per cent of responses). However, a further 20 per cent of responses indicated that education was also an important improvement. Extra resources and staff (12.0 per cent of responses) and better management codes (8 per cent of responses) were also mentioned.

However, some respondents considered that the waste disposal pathway is difficult or impossible to regulate. As one respondent noted, “*dumping of garden waste is a significant social problem, the same as the dumping of unwanted cats, dogs and aquaria fish. A major social change needs to [occur] to remove this problem.*”

Another respondent explained that “*in many instances, neighbours to bushland areas are the main offenders.*”

Furthermore, “*all local government bodies should provide areas for free dumping of garden waste (to discourage dumping in bush areas).*”

### **9.14 Birds**

*This pathway involves consumption and excretion of seeds and fruits by birds.*

Weeds spread via this pathway were considered very difficult or impossible to regulate by many respondents (43.8 per cent of responses). Given this difficulty, suggested regulatory improvements for this pathway included control and containment of weeds at

the source (25 per cent of responses), the use of weed alternatives (12.5 per cent of responses), and education of householders (12.5 per cent of responses).

As one respondent commented, this pathway requires *“landholders to treat weed sources before they seed, and introduce alternative food sources [for birds]”*. Likewise, *“informing land and householders about reducing weed propagules in gardens, i.e. remove agapanthus flowers after they are spent to reduce seed development and movement by birds – cut down all camphor laurel trees, etc.”*

### **9.15 Other animals**

*This pathway occurs through the consumption and excretion of seeds and fruits, and external attachment of propagules to native and introduced wildlife.*

Too few responses were obtained to form a clear idea of improvements in regulation of this pathway, though perhaps this is why one respondent commented on the need for *“additional research into what animals are moving what weeds, and where?”*.

### **9.16 Wind**

*This pathway involves distribution of wind blown seeds.*

Twenty per cent of the responses with regard to the spread of weeds by wind suggested that public education was required to improve management of the pathway. Planting wind buffer strips was also suggested by 13.3 per cent of responses, since *“windbreaks along ridgelines act as traps to reduce weed seeds from being in the best position to be distributed by wind”*. Improved management codes and practices were also suggested, though the difficulty involved in regulating this pathway was noted.

### **9.17 Water**

*This pathway involves distribution of seeds or plant parts via waterways.*

Very few suggestions were obtained from respondents on how to regulate the spread of weeds by water. It was suggested, however, that regulation could be effective. For example, *“regulation prevents weeds getting into the pathway, or ensures they are removed from it”*, and *“removal of plants producing vegetative propagules can be effective in the case of willows”*.

## 10 Patterns in policy change

For most pathways, suggested improvements in regulation and management ranged across a wide range of categories, indicating that no one improvement would stop weeds being spread by a particular pathway. Rather, an integrated *regulatory* and *management* approach is required to deal with the pathway problem. Furthermore, the variety of pathways identified by this project, involving a mixture of human, animal and other natural means of weed spread, suggests a *targeted approach* to regulation of a *particular pathway* or pathways, rather than a holistic approach. It is important for policy makers to consider the spread capacity of particular weed species, sources of weeds, and pathways for the spread of weeds, in the implementation of weed control policies.

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