

Weed spread pathways risk assessment in Victoria

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Summary Weed spread pathways are any means that lead to the entry or spread of weeds. The relative risk of weed spread via pathways needs to be understood so that resources can be prioritised appropriately toward prevention strategies. In this study, a framework was developed to establish a quantifiable risk assessment of weed spread pathways into and within Victoria. The risk assessment framework was then applied to 98 pathways and the analysis resulted in a list of potential weed spread pathways ranked by relative risk score.

Keywords Prevention, surveillance, risk mitigation.

- contaminated vehicles;
- contaminated equipment;
- contaminated aquatic equipment;
- contaminated goods or produce;
- waste disposal; and
- animal movement (other than livestock).

Although wild animals, wind and water are also well known spread vectors, they were not included here as this study was focused on human induced pathways.

The industries and organisations that have the potential to introduce and spread weeds by one or more of the above vectors are shown in Table 1.

INTRODUCTION

Preventing the spread of serious new weeds in Victoria is dependent on early detection and prompt eradication of small incursions before they become established. Surveillance for these weeds can be streamlined by focusing on the most likely pathways through which these weeds might travel to, enter or spread within Victoria. Once the relative risks of these pathways for weed spread are known, resources can be appropriately prioritised to implement targeted surveillance and other risk mitigation strategies.

MATERIALS AND METHODS

The risk assessment framework identified 10 activities or vectors implicated in potential weed introduction and spread in Victoria. A matrix was developed referencing the activities with 28 industries and organisations which may introduce or spread weeds by one or more of these activities. A set of 15 criteria, each with five associated intensity ratings was developed to assess 98 organisation/activity combinations (pathways) for their risk of introducing and distributing 86 high priority weed species into Victoria. A decision support system was then used to assist decision making on the relative weightings of each of the criteria.

Pathway matrix

The 10 vectors of spread were defined as:

- deliberate introduction via community;
- deliberate introduction via business;
- human movement;
- controlled livestock movement;

Risk assessment criteria Criteria were developed for the risk assessment framework with associated definitions for five intensity ratings: High, Medium High, Medium, Medium Low and Low. A total of 15 criteria were developed and grouped into six categories. The criteria are:

1. Weed importance

- 1.1 What proportion of priority weeds (Victorian Alert and State prohibited weeds, Victorian priority weeds, National Alert weeds and Weeds of National Significance) may be spread by this pathway?

Table 1. Industries/organisations having the potential to introduce and spread weeds.

Agricultural contractors	Forestry
Agricultural/Natural Resource Management service providers	Grains
Aquarium/pet shops	Horticulture
Botanical gardens	Landscaping
Bulk suppliers (soils etc)	Linear reserves
Catchment Management Authorities	Livestock
Community groups	Mining
Councils	Nursery
Defence	Plant research
Developers	Public
Earth moving	Recreation/tourism
Equipment/vehicle hire	Seed
Fire management	Transport
Fodder	Turf

1.2 To what extent do the priority weeds introduced by this pathway impact upon social, agricultural and environmental values? (Scores weighted: social–20%, agricultural–40%, environmental–40%)

2. Distance (rapidity)

- 2.1 What is the extent of the industry/organisation pathway?
2.2 How long is the produce stored prior to distribution via the pathway?

3. Introduction

- 3.1 What amount of viable propagules per unit of commodity is moved either by a single transaction, or in total?

4. Frequency of activity

- 4.1 For what proportion of the year does this industry/organisation use this pathway?
4.2 When in use, how frequently does the industry/organisation use this pathway?
4.3 How important are major events (flood, drought, fire and fire management) in increasing the chance of the industry/organisation or pathway spreading weeds?

5. Establishment

- 5.1 How likely is this industry/organisation or pathway to distribute viable propagules to a suitable habitat or likely establishment sites (either at delivery point or *en route*)?
5.2 How often does the pathway have the potential to move viable propagules?
5.3 Does the industry/organisation promote deliberate establishment via this pathway?
5.4 Does the industry/organisation tolerate accidental establishment via this pathway?

6. Management

- 6.1 Does the industry/organisation have processes in place to detect/assess and/or reduce the risk of spread via this pathway?
6.2 How effective are these risk assessment and mitigation processes?
6.3 How feasible is it to prevent introduction and spread of weeds of interest via this pathway?

Criteria weighting All of the criteria were given specific weighting values using an analytical hierarchical process. The weighting process was used for determining which criteria were most important in assessing which pathway was more of a threat compared with others. The weights were determined using a software program, called Catchment Decision Assistant© that

guided members from the assessment team through a process of pair-wise comparisons of all criteria and categories. Table 2 shows the weights assigned for the categories of criteria.

Conducting the risk assessments Information was collected from a variety of sources in order to address each criterion in the risk assessment model for every industry and pathway in the matrix. These included databases, journal articles, floras of the world (books or articles describing the species of a particular country or region), on-line information, departmental reports, personal communications and other sources.

However, information relating directly to specific criteria was not always available and often anecdotal information was the only available source. To address this limitation, the lowest confidence scores were applied to indicate a greater degree of uncertainty in the risk assessment score and missing data for that criterion.

During the assessment of pathways, intensity ratings of High (H = 1.0), Medium–High (MH = 0.75), Medium (M = 0.5), Medium–Low (ML = 0.25), and Low (L = 0), were assigned to score each criterion. The scored intensity ratings for each criterion were then weighted and totalled to produce a final Pathway Risk Score for each industry pathway, i.e. Pathway Risk Score = $\Sigma ((\text{Intensity rating}) \times (\text{Criterion weighting} \times \text{Group weighting}))$.

The closer the resulting pathway risk assessment score was to 1.0, the higher the risk of the pathway. The Pathway Risk Score for each industry pathway was then ranked relative to the risk scores for all other pathways.

The risk assessment scores were allocated to a high, medium or low risk group, based on the distribu-

Table 2. Criteria weights.

Criteria category	Weight (%)
Weed importance	4
Distance (rapidity)	8
Introduction (quantity)	8
Frequency of activity	13
Establishment	40
Management	27

Table 3. Risk and confidence score groups.

Group	Risk score	Confidence score
High	>0.75	>0.51
Medium	0.54 – 0.75	0.15 – 0.51
Low	<0.54	<0.15

tion of all of the risk assessment scores. Confidence scores were not weighted but grouped in a similar way to the risk scores as shown in Table 3.

RESULTS

The 10 highest risk pathways are shown in Table 4.

The highest Pathway Risk Score for spread of the priority species was ‘Deliberate introduction via business’ which featured in four of the five highest industry/pathway risk rankings. Other high Pathway Risk Scores were:

- Deliberate introduction via community.
- Contaminated goods/produce.
- Contaminated vehicles.
- Contaminated equipment.

DISCUSSION

This study developed and applied a robust risk assessment framework to deliver a transparent and reproducible method for assessing the relative risk of weed spread pathways for different industries and organisations in Victoria. A number of limitations were also identified around gaps in knowledge and a lack of data for accurate assessment of risks.

There is a need for further research to address these knowledge gaps and to test the assessment results against on-ground weed incursion data. This will significantly improve the confidence ratings within the model and therefore the reliability of the Pathway Risk Scores.

Further work is also required to investigate the high risk industries identified by this study in order to understand better what weed spread risk management strategies are in place (if any) and their effectiveness. Where no strategies are in place, engagement programs need to be developed which work in partnership with these industries to assist them to understand the risks and jointly develop feasible and effective risk management strategies.

Table 4. Top 10 pathways by weed spread risk.

Industry	Pathway	Risk
Seed	Deliberate introduction via business	0.89
Aquarium trade	Deliberate introduction via business	0.89
Landscaping	Deliberate introduction via business	0.83
Public	Deliberate introduction via community	0.82
Nursery	Deliberate introduction via business	0.81
Landscaping	Contaminated vehicles	0.81
Aquarium trade	Contaminated goods/produce	0.79
Earth moving	Contaminated equipment	0.79
Earth moving	Contaminated vehicles	0.77
Forestry	Contaminated vehicles	0.76

The risk assessment framework used in this study is flexible enough to be adapted for other spread pathway risk assessment projects in different jurisdictions and with different priority species.

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