A new post-border weed biosecurity risk management system

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Summary One of the key tools guiding weed management are risk assessment / management systems. Whilst a post-border weed risk management (WRM) system was established in Australia 15 years ago, very little further development and testing has occurred. More recently, the adoption of a biosecurity model for weed management predicated on the management response being proportional to the risk posed has been introduced. A review of the existing WRM system showed it was no longer fit-for-purpose as a standalone system, given the current biosecurity framework. Here we outline a new post-border weed biosecurity risk management system. The development of the new system is based on extensive research and testing, and multiple revisions over the past three years. The new system has also been successfully converted into a mirror draft version for pest animals and a freshwater aquatic weed version is in development. A short overview of the new system is outlined below.

Keywords Risk Assessment, biosecurity, prevention, eradication, containment, asset protection, species reduction, risk-response, general biosecurity duty.

INTRODUCTION

The development of weed risk assessment systems in Australia started in the late 1980s and culminated with a pre-border Weed Risk Assessment (WRA) system for screening out future weed species prior to entry (Pheloung *et al*. 1999), and later a national post-border Weed Risk Management (WRM) system for weed species that have become established in Australia (Anon. 2006); also adopted to individual states (e.g. SA (Virtue 2008), NSW (Johnson 2009) and the NT (Setterfield *et al*. 2010)).

Whilst the WRA system has been tested widely and adopted internationally, the WRM system has not (see Downey *et al*. 2010a). In fact, there has been limited testing or development of the WRM over the past 15 years. Ironically recent testing/developments of the WRM system have been undertaken internationally (e.g. in Iran (Sohrabi *et al*. 2020) and Bhutan (Dorjee *et al*. 2021)).

Since the development of the WRM system Australia has adopted a biosecurity model for managing weeds and other invasive species (i.e. based on Beale *et al.* 2008). Despite this, the WRM system has not been revised, developed or evaluated to determine how it meets the biosecurity requirements, specifically determining and managing the risk posed by invasive species [biosecurity matter] to the economy, environment and community.

The lack of publicly available evaluations as to whether the WRM system is fit-for-purpose for biosecurity weed risk management, is a major shortcoming.

REVIEW OF THE WRM SYSTEM

In 2019 a review of the WRM system was undertaken to determine how it could be modified to meet the requirements of the NSW *Biosecurity Act 2015*, specifically to account for the spatially variable nature of the risk posed by weed species (i.e. for most weed species its distribution and risk level is not uniform across the landscape). This review showed many issues with the WRM system including that: (a) the Feasibility of Control Component assessed generic control related questions, but then applied a specific management objective to the outcome (i.e. eradication) despite not asking any eradication-specific questions; (b) the system was not developed to account for the spatial variability of the risk and; (c) the scoring system led to outcomes which did not align to the risk for some species (Downey 2020). Further examination of 300+ completed WRM assessments using the NSW system showed that the system: (i) did not adequately handle new incursions when there was limited knowledge of the species; (ii) majority of assessments resulted in the ***manage weed*** outcome, which could indicate a problem; (iii) resulted in inconsistency between assessments of the same species; and (iv) some of the questions were problematic (Downey unpublished data).

Additionally, the WRM system does not readily align to more recent biosecurity legislation, for example, assessment of the impact is not specifically aligned to: (a) the economy; (b) the environment; or (c) the community; despite asking impact questions (i.e. the questions are not mutually exclusive on a sectoral basis). Lastly, the WRM system could be better aligned to the formal risk approach based on **likelihood** and **consequence**. This review showed that the WRM system was no longer fit-for-purpose as a standalone system for many species and that fixing the problems and making it so required a new system/approach rather than modifications to the existing WRM system.

In addition, to the issues raised in the review, other issues raised previously (i.e. Auld *et al*. 2012) were also considered during the development of the new system.

A NEW POST-BORDER SYSTEM

The development of the new weed biosecurity risk management system started with three key aspects, being to create a: (a) spatially variable risk framework that enabled property and/or site level assessments to help determine the individual duty; (b) system that assessed the key management objectives of prevention, eradication, containment and asset protection; and (c) system that aligns to the biosecurity model.

A draft model was developed and Alpha-tested on a variety of weed species in 2020 (see Downey 2020). The draft version was Beta-tested in late 2021 with Weeds Officers and other stakeholders in south-east NSW, and a revised version developed (Downey 2022). The new biosecurity risk management system involves three components (Figure 1), which are briefly outlined below.

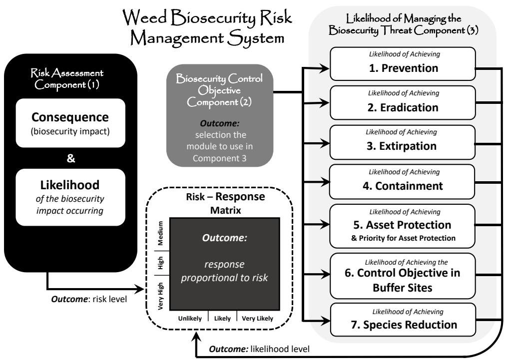

Figure 1. An overview of the three components of the new Weed Biosecurity Risk Management system.

Component 1 – Weed Risk Assessment Whilst loosely based on that of the existing WRM system, Component 1 has been totally revised to align to the biosecurity framework. For example, the assessment of impact has been developed to determine the impact level/severity to the: (a) economy; (b) environment; and (c) community; through standalone assessments (e.g. to provide an economic impact score). In addition, weed species which pose a current adverse effect [biosecurity impact] (e.g. a transformer species) are not assessed further to determine their invasiveness or potential distribution [likelihood] because the consequence has occurred and thus assessing the likelihood is moot. In fact, evaluation of the current WRM system revealed that for such species assessing their potential distribution could actually reduce their overall risk level if they were widespread or had a small or limited potential distribution; which is a major problem.

Component 2 – Biosecurity Objective This new component creates a system for determining the indicative biosecurity or control objective for a weed species spanning a range of spatial scales (i.e. property or region), based on the following nine biosecurity objectives:

1. Prevention;
2. Eradication;
3. Extirpation (local eradication);
4. Containment;
5. Asset Protection;
6. Buffer Sites (control aimed at supporting programs being managed on neighbouring lands for another objective (i.e. eradication);
7. Species Reduction (to reduce the overall threat at a landscape level, as opposed to a specific asset);
8. Inspect – monitoring and surveillance; and
9. Alternative Measures (for species which can't be managed through other objectives or for which control options are not available or practical).

These nine biosecurity objectives are an expansion of the four key management categories of the invasion curve (prevention, eradication, containment and asset-protection) (see EWWG 2007), to include a management objective for every weed species.

Component 3 – Likelihood of Managing the Biosecurity Threat The first seven objectives from Component 2 form the basis for individual modules in Component 3 (i.e. the Likelihood of Achieving Eradication). These seven modules were developed based on specific questions relating to the biosecurity objective derived from the literature. For example, the likelihood of achieving eradication is highly dependent on: (i) the number of known infestations; and (ii) the size of the area invaded (see Rejmánek and Pitcairn 2002; Panetta and Timmins 2004); both of which informed questions in the Eradication Module. The specific risk event associated with each objective is also defined. For example, the risk event associated with eradication is *the failure to destroy all infestations of a new weed species not previously known to occur in a region (new incursion)*.

When assessing the likelihood of achieving asset protection, the assessment focus needed to be expanded to incorporate both the weed species and the asset to be protected; something that the current WRM system did not address, as highlighted by the outcome being *Protect Sites* and not assets. Furthermore, the importance of the asset being protected needed to be determined, to prioritize site management. This required a second part to the Asset Protection Module, to: (1) assess the likelihood of achieving asset protection through weed control, which is not dependent or determined in anyway based on the priority of the asset; and (2) rank the priority of the asset based on its relative value (i.e. control should be directed at high priority assets, where weed control can deliver protection to the asset (see Downey *et al.* 2010b)).

Risk-Response Matrix Each of the seven modules contain a specific risk-response matrix, based on the combination of the risk posed by the weed species and the likelihood [of achieving the control objective] levels. The cells of this risk-response matrix are tailored to the specific management action for the combination. For example, a *medium risk* and an *unlikely* [control] outcome combination contains a statement about revising the objective and/or undertaking risk reducing operations to determine if management could increase the likelihood level. **Note**: This is determined through a risk mitigation process in each of the modules.

The last two management objectives in Component 2 (Inspect and Alternative Measures), whilst not assessed through individual modules in Component 3, are assigned through the outcome of the risk-response matrix. For example, in the Prevention risk-response matrix one of the management outcomes assigned is inspect (surveillance), and in the Species Reduction risk-response matrix an unlikely outcome is investigate alternative control measures (e.g. biological control).

Lastly, the outcome of the risk-response matrix can provide an indicative statement about the likely general biosecurity duty associated with the risk level posed by the weed species and the likelihood of achieving a specific management outcome at a specific location.

Technical manual and electronic scoresheet The new weed biosecurity risk management system is underpinned by a several hundred page technical manual which provides justification for all aspects of the system and links to the literature that supports each question (see Downey 2022). For example, the Eradication module questions are based on published eradication studies or reviews of such studies (e.g. Panetta and Timmins 2004). Despite the extensive scale of the technical manual, the actual assessment process (i.e. questions, attributes and criteria) has been developed to be simple to use by a wide range of end users, as demonstrated by the successful Beta-testing stage. An accompanying electronic scoresheet has also been developed to help with assessments. Based on the outcomes and feedback from the Beta-testing stage, assessments for weed species known or familiar to the assessor are much quicker through the new system than the existing WRM system, with outcomes that more closely align to the on-ground reality.

AN AQUATIC WEEDS VERSION

A freshwater aquatic weeds version of the risk analysis system is currently being developed and is scheduled to be completed by mid-2023.

A MIRROR VERSION FOR PEST ANIMALS

A draft version of a pest animal mirror version of the weed biosecurity risk management system has been developed and alpha tested. Apart from the species-specific context differences (i.e. seed banks in weeds, and the mobility of pest animal species), the questions do not differ between weed and pest animal species versions of the biosecurity risk management system. The successful conversion of the system to pest animals means that both groups of invasive species can be assessed under a similar process; something that has not been achieved previously.

FUTURE DIRECTION

Whilst the extensive development of the weed biosecurity risk management system has occurred in SE NSW over the past 3 years, the Beta-testing and conversion of the system to pest animal and aquatic weed versions illustrates that the approach can be adopted more broadly (i.e. to other regions). Also, the successful creation of a mirror version for pest animal species suggests that investigation into the possible inclusion of other biosecurity matter is worth exploring. Whilst the system has undergone extensive testing and revisions, further testing and use is needed to ensure broader adoption.

A key future development will be to transition the system from a technical manual and accompanying electronic scoresheet to an on-line system which is underpinned by a range of spatial layers, especially given the system is built to be spatially enabled. Furthermore, other datasets could also be integrated, for example information on assets (i.e. threatened species) to provide a more integrated assessment process. Lastly an online system would reduce assessment times by prefilling responses which do not change between assessments, as well as to enable access to the risk assessment process to all stakeholders. At present weed risk assessments are kept behind a restricted access departmental portal, which is a problem for the delivery of a shared model of biosecurity.

This biosecurity risk management system provides a significant development in the evolution of post border weed risk assessment systems, by addressing the shortcomings of the existing system, transitioning the approach to the biosecurity model for managing invasive species, integrating the invasion curve categories into the assessment system and accounting to the spatial variability of the risk.

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