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Improving targeting of weed biological control projects in Australia

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Over the years a great deal of work has been directed towards improving the selection, testing and evaluation of biological control agents for weed control. However our understanding of how to select target weeds against which biological control might become an important part of management remains limited.

Most classical biological control projects directed against weed targets have been conducted in South Africa, Australia, New Zealand, the USA and Canada. Classical biological control (or biocontrol) tends to be a public, community-level activity carried out by research institutions and government departments rather than by private enterprise.

Considerable resources are required if a biocontrol project is to be completed well, so it is important that the weeds selected for management using this approach justify the investment. In order to properly account for this public investment it is important to have in place decision-making processes that increase the likelihood of selecting biocontrol targets that are important, biologically and ecologically feasible, and have broad social support.

In practice, the means by which target species are selected varies widely, with only limited research guiding the use of the most important criteria.

Land & Water Australia commissioned Landcare Research New Zealand to develop a decision-making system to maximise the likely effectiveness of investment in biocontrol research and to ensure this is done in ways that are transparent and repeatable.

Inset: Close-up of an adult leaf-feeding beetle (*Zygogramma bicolorata*) feeding on parthenium. Photo K. Dhileepan, DPI&F. Main: Witches' broom caused by the rust fungus *Endophyllum osteospermi* on a boneseed plant. Photo Louise Morin, CSIRO Entomology.

Deciding which factors to include

Several previous studies from Canada[1], the USA[2], New Zealand[3] and Australia[4], were used to assist in determining which factors should be used to prioritise which weeds to target for biological control in the future.

The Landcare Research team identified three key dimensions influencing the priority of a weed as a target for biocontrol: Weed **Importance** and the predicted **Impact** of biological control and the **Effort** required to import, test and release biological control agents.

Importance of a particular weed takes account of a number of factors that were considered when Thorp & Lynch[5] developed the Weeds of National Significance (WoNS) list.

During the development of the prioritisation framework the ranking of each of the WoNS was used to reflect importance. However it is recognised that some species may have increased in abundance and importance during the 10 years since the WoNS species were ranked, while other species have been successfully biologically controlled and, therefore, declined in importance. The method developed since the WoNS list was developed and now used in the National Post-Border Weed Risk Management Protocol might offer a sound alternative to the WoNS ranking, as a measure of importance to be considered in further developing the prioritisation framework.

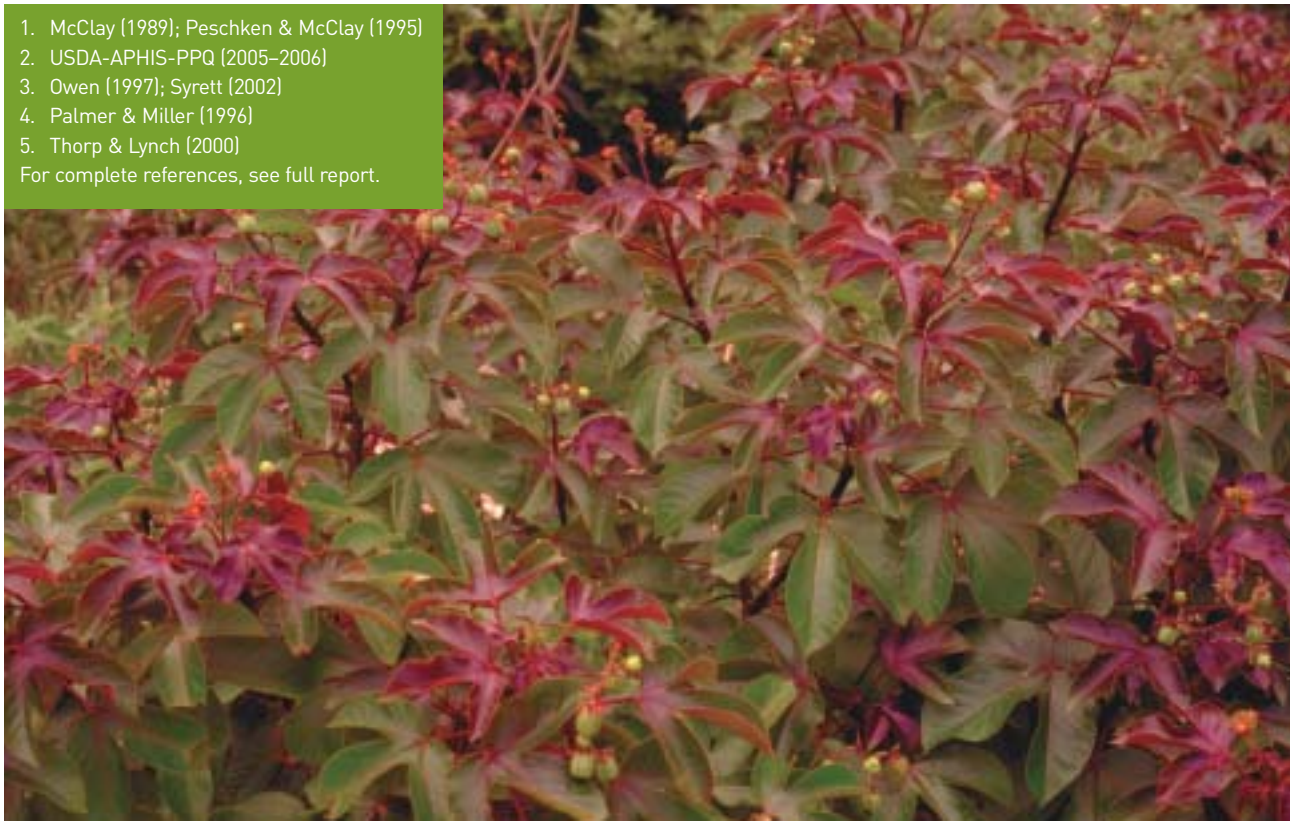
Impact of biocontrol can best be predicted by the existence of a successful precedent in another country. However where Australian weeds present novel targets not previously addressed through biocontrol experiments, the habitat, life cycle and reproduction of the plant species are important considerations, as are the native range of the species, existence of multiple forms of the plant, and competition in the growing environment.

Effort required to control a weed species using biocontrol was included as an important factor because as effort and associated costs rise, the feasibility of progressing a biocontrol project decreases.

Once developed, the framework was tested by ranking species that have been the subject of biocontrol research in the past, using reports from South Africa and the USA. It was also verified through input from state and nationally based biological control researchers and senior policy makers with a demonstrated interest in the biological control of weeds.

Applying the scoring system to assess past biological control efforts in Australia, South Africa and continental USA, biocontrol impacts were invariably major against those weeds that scored more than 70 (out of a possible score of 100). For weeds that scored between 50 and 70, impact was variable (approximately 40% successes and 60% failures), while biocontrol most often had no impact against weeds that scored less than 50.

Bellyache bush (*Jatropha gossypifolia*) is a target species for biocontrol. Photo Tim Heard.



1. McClay (1989); Peschken & McClay (1995)
2. USDA-APHIS-PPQ (2005–2006)
3. Owen (1997); Syrett (2002)
4. Palmer & Miller (1996)
5. Thorp & Lynch (2000)

For complete references, see full report.

Using the framework to assess weed priority for biocontrol development

By working through a simple series of questions in which responses receive weighted scores, the user of the framework can develop an overall score for the priority of the species as a target for biocontrol (see figure below).

Scores on each of the key factors are combined using the formula

$$\frac{\text{Total } \textbf{Impact} \times \textbf{Importance}}{\textbf{Effort}}$$

Two questions, asked at the beginning of each weed assessment present Stop/Go decision points:

- Is the weed a native species and is it in its natural range?

and

- Is opposition to biocontrol likely and does the weed species have socio-economic value?

If the answer to the first question is 'Yes' then biological control is undesirable and should not proceed. For the second question biological control should also not proceed unless a cost: benefit analysis indicates that the benefit of control would outweigh any socio-economic value a weed may have.

The research team notes that by adjusting the weightings given to **Impact**, **Importance** and **Effort**, the framework can be modified to have greater relevance to either tackling the most important weeds or maximising the number of successful programs.

Using the WoNS list and weeds already identified by the Australian Weeds Committee as suitable for biological control, the research team then prepared a ranked prioritisation list of species suitable for biological control.

There remain some challenges for prioritisation of weeds for which biocontrol agents might be developed. Not least among these are:

- the lack of data available in relation to feasibility of control of many species using non-biological methods, such as herbicides
- the appropriate weightings to be given to the measures used in the framework
- ways in which emergent species such as agricultural 'sleeper' and environmental 'alert' species should be addressed, especially in the face of a changing land uses and human-induced climate change.

Excerpt from the framework for assessing priority as a target for biocontrol

Module 2: Effort required to obtain and host-test biocontrol agents
This section of the framework assesses the effort required to obtain and host-range test biocontrol agents.

Has the weed been/is it a subject of adequately resourced biocontrol program elsewhere?		Difficulty score
a. Yes, successful program	If specific agents are already known and host-range testing has already been conducted overseas, then program is likely to be cheaper	1
b. Yes, unsuccessful program	Some knowledge of agents may help, but law of diminishing returns — if the current known suite of agents is ineffective,finding new ones will be harder	15
c. Current target/too early/insufficient data to assess success elsewhere or variable success elsewhere	Potential for cost savings, but uncertainty factored into score	8
d. No, never	Program will have to bear all costs of survey work and agent testing	20

The next question addresses the ease of working in the native range.

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Recommendations

1. The framework, as a score-based decision-making tool, should be reviewed regularly and revised as more weed biocontrol impact data becomes available. The methods for ranking weed importance (e.g. WoNS, Weed Risk Management Protocol, and current versus incipient weeds such as agricultural 'sleeper' and environmental 'alert' weeds) should be debated and agreed between interested parties.
2. There needs to be more dialogue and engagement with those likely to be affected by the adoption of such a framework to ensure its successful implementation. A pragmatic decision-making process should always accompany the framework when deciding the portfolio of target species for biological control.
3. Research questions should be developed and addressed to improve the predictive power and to reduce the level of uncertainty in the framework.
4. Review of the framework should be simplified by developing a database to capture information about weeds and the assumptions behind the framework.

Despite the qualifications contained in these recommendations, the framework provides a sound and easily usable basis from which to develop a nationally agreed tool to assist in assigning resources to weed biological control research.

Right: Spear thistle (*Cirsium vulgare*) a target species for biocontrol, photo Roger Charlton. Below: Gorse spider mite (*Tetranychus lintearius*); a biological control of gorse, photo Peter Martin.

Full report: Paynter, Q., Hill R., Bellgard, S. & Dawson, M. 2009, *Improving targeting of weed biological control projects in Australia*. A report prepared for Land & Water Australia, by Landcare Research NZ, Auckland. The full report is available from lwa.gov.au/weeds

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