Agricultural Sleeper Weeds in Australia
What is the potential threat?

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Summary

This study provides an overview of the threats that sleeper weeds pose to Australian agriculture. Assessments of nine potentially eradicable sleeper weed species were used to characterise this potential threat. Five of the nine species assessed are potentially significant pasture weeds, one is potentially a weed of dryland cropping, one is potentially a weed of pastures and dryland crops, one is a potential weed of irrigated areas and one is a potential weed of pastures and horticulture. The area of agricultural landuse at high risk of potential weed spread for these species ranges from 100,000 hectares to greater than 40 million hectares (which is approximately 10% of the total agricultural land in Australia).

The value of the industries potentially affected by each of these nine sleeper weeds (in the areas of high probability of spread) range from $40 million worth of grazing in northern Queensland to greater than $4.8 billion worth of grazing and cropping industries across the southern States. It was beyond the scope of this study to estimate the potential economic losses to agricultural industries if these weeds are not eradicated, but if each weed only caused losses of 1% (a highly conservative estimate) in the areas where they could reasonably be expected to spread, then the total losses would likely be in the order of $100 million annually.
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Introduction

The aim of this study is to present a preliminary case for the importance of addressing the eradication of naturalised (exotic) plant species that are currently limited in their distribution (making eradication feasible) but which have the potential to become significant weeds of Australian agriculture (sleeper weeds).

For the purpose of this study, sleeper weeds are defined as “…invasive plants that have naturalised in a region but not yet increased their population size exponentially.” (Groves 2000) (see below for further information on the definition of sleeper weeds). Sleeper weeds are not always recognised as a significant problem even though the potential threat they pose to industry, people or the environment may be extreme.

This report provides an indicative assessment of the probable agricultural impacts of nine sleeper weeds if they were to spread to their full potential range. These nine species (Table 1), were identified as potentially eradicable, naturalised weeds in Australia in a Bureau of Rural Sciences (BRS) commissioned report, produced by the Cooperative Research Centre for Australian Weed Management (Groves et al. 2002).

Table 1. Nine potentially eradicable, naturalised weed species which demonstrate some risk to Australian agriculture, adapted from Groves et al. (2002).

<table>
<thead>
<tr>
<th>Common name(s)</th>
<th>Genus</th>
<th>Species</th>
<th>State location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pannicle jointvetch</td>
<td>Aeschynomene</td>
<td>paniculata</td>
<td>Qld</td>
</tr>
<tr>
<td>NA</td>
<td>Blainvillea</td>
<td>gayana</td>
<td>Qld</td>
</tr>
<tr>
<td>NA</td>
<td>Brillantaisia</td>
<td>lamium</td>
<td>Qld</td>
</tr>
<tr>
<td>Whitestem distaff thistle / Glaucous star thistle</td>
<td>Carthamus</td>
<td>leucocaulos</td>
<td>WA</td>
</tr>
<tr>
<td>Common crupina / Bearded creeper</td>
<td>Crupina</td>
<td>vulgaris</td>
<td>SA</td>
</tr>
<tr>
<td>Nutsedge / Esaka</td>
<td>Cyperus</td>
<td>teneristolon</td>
<td>NSW</td>
</tr>
<tr>
<td>Orange hawkweed</td>
<td>Hieracium</td>
<td>aurantiolobulon</td>
<td>Tas, Vic</td>
</tr>
<tr>
<td>Golden lungwort / Wall hawkweed</td>
<td>Hieracium</td>
<td>murorum</td>
<td>NSW</td>
</tr>
<tr>
<td>Taurian thistle / Scotch thistle</td>
<td>Onopordum</td>
<td>tauricum</td>
<td>Vic</td>
</tr>
</tbody>
</table>

The nine weeds selected each have characteristics which make them a threat to Australian agricultural industries. For example, most of these weeds are known to crowd out useful
species, six of the species are unpalatable or toxic to livestock and two species have spines which inhibit grazing and harm livestock.

Pest management is often reactive, with resources (money and time) being focused on controlling species which are perceived to have major impacts on cropping and grazing systems in Australia (Csurhes and Edwards 1998; Groves 1999; Groves 2000). Prominent weeds, such as the Weeds of National Significance (WONS) (Thorp and Lynch 2000), are known to reduce the value of production, and their costs to the community can be relatively easy to calculate compared with the benefits of control (Groves 2000).

Sleeper weeds are an important and often overlooked category of invasive plants. They form “…an unknown but probably numerically large proportion of the introduced flora of Australia…” (Groves 1999) and assessment of their potential detrimental effects on our environment and industries could be very beneficial. Early intervention (eradication or control) may prove to be highly cost effective in the medium and long-term (Simberloff 1997; Groves 2000).

This study examines nine species as examples of the potential threats that sleeper weeds may pose to Australian agriculture. These nine species are not an exhaustive list; as sleeper weeds potentially encompass many species. Detailed analyses of desirability and feasibility of eradication, including assessment of cost–benefit’s, similar to the analysis of Siam weed by Adamson et al. (2000), may need to be undertaken, prior to embarking on any eradication campaign. Such analyses were beyond the scope of this project.
Sleeper weeds

There are a number of definitions used to describe ‘sleeper weeds’, ranging from extremely broad to very specific (usually restricted to species which have a population growth habit including a period of dormancy followed by a period of exponential growth and spread) (Crooks and Soule 1996). The definition used in this study comes from Groves (2000) who defines sleeper weeds as “…invasive plants that have naturalised in a region but not yet increased their population size exponentially.”

The common phases of population increase for an invading species are presented in Figure 1. The period when a sleeper weed shows a low rate of increase in population size is often considered to be a period of naturalisation when the species adapts to its new environment (Mack et al. 2000). In this case, the period between ‘naturalisation’ and ‘exponential increase’ is where sleeper weeds fit.

![Figure 1. Phases in the population increase of an invasive organism, modified from Williams (1997).](image)

Although this study focuses on sleeper weeds which threaten agriculture, much of the information presented is relevant to potential impacts on the natural environment. There have been other studies which demonstrate such potential environmental risks (Csurhes and Edwards 1998; Groves et al. 2000).

The justification for committing resources to eradicating or controlling sleeper weeds lies primarily in the cost–benefits achieved by addressing the potential problem early, rather than waiting until the weeds become significant problems requiring expensive and long-term control. Figures 2 and 3 show examples of the relative costs associated with eradicating or controlling weeds at various stages of population growth. In Figure 2 sleeper weeds would lie somewhere between A and B, which demonstrates that recent incursions
(A) would be the cheapest weed problem to address, closely followed by sleeper weeds, whilst widespread weeds such as WONS (C) are the most expensive. Not all plants which establish naturalised populations become invasive weeds (Mack et al. 2000; Richardson et al. 2000; Kolar and Lodge 2001). Identifying future invaders and predicting their likely geographic range and potential impacts can tell us a great deal about the value of attempting early eradication or containment to prevent future invasions (Rejmanek and Richardson 1996; Reichard and Hamilton 1997).

Figure 2. Costs of undertaking an eradication program on a recent incursion (A) relative to those for control at either an early (B) or late (C) phase of a plant invasion, from Williams (1997).

![Figure 2](image)

Figure 3. Total potential impact of Siam weed through time, from Adamson et al. (2000). This figure demonstrates the total potential costs per year for both production losses and management costs. Therefore without an eradication campaign it was estimated that costs due to weed management and production losses may be as high as $14.4 million by 2044. It was estimated that the eradication program was expected to cost approximately $2 million over 16 years of operation (including 6 rears of monitoring) in order to eradicate Siam weed in the Tully region of North Queensland.

![Figure 3](image)
Methods

Weed selection

Each of the nine potentially eradicable weed species analysed, were identified by Groves et al. (2001) using the following criteria:

- naturalised in Australia;
- non-native species;
- present at three or less locations in Australia;
- known to pose major problems to agriculture; and
- not currently being targeted for eradication.

Analyses

This section describes the methods used to calculate approximate commodity values (based on 1996 data) for the area at risk of weed spread for each of the nine sleeper weeds. Figure 4 provides an overview of the analysis process, including the eight major steps (A – H) undertaken.

Figure 4. Flow diagram of the process undertaken for each weed species, to determine potential distribution and approximate commodity values in the area at high risk of weed spread.
Potential distribution

Step **A** in the analysis process (Figure 4) was to determine the potential distribution of each species, if they were to spread to their full extent. There are a number of modelling techniques available for the prediction of suitable habitat for plants and/or animals. For this study the CLIMEX model (Sutherst *et al.* 1999) was chosen for the following three reasons:

- CLIMEX has been used successfully in many studies for the task of predicting potential distributions (Adamson *et al.* 2000; Kriticos 1997; Scott and Wykes 1997; Scott and Yeoh 1999; Sutherst *et al.* 1999; Yonow and Sutherst 1998)
- CLIMEX uses a growth index and climatic stresses to govern the climatic niche for a species, which is a robust and proven technique (Kriticos and Randall 2001; Sutherst *et al.* 1999)
- An overview of tools for analysing potential weed distributions by Kriticos and Randall (2001) demonstrated that CLIMEX is one of the most comprehensive, easy to use and reliable models available.

Three sets of information were required for each species before modelling could begin:

- Overseas distribution (including native and introduced ranges)
- Plant characteristics (which include as much information as possible on species phenology)
- Australian distribution (this was not crucial for modelling, but was useful for verification and model refinement).

For each species the information varied in its detail and usefulness. The background research for each species was limited, mostly relying on internet searches and communication with Australian experts. This was due to strict time and funding constraints. More detailed research on species niche requirements would allow greater precision in the modelling of potential distributions, and provide a better basis for detailed cost-benefit analyses. The CLIMEX modelling technique described by Sutherst *et al.* (1999) involves constraining growth parameters and the use of climatic stresses to produce a climatic envelope which most closely matches the overseas distribution. Available phenological and some detailed distribution information were also used to set model parameters.
Modeled potential distributions from CLIMEX for the nine sleeper weeds in Australia were imported into a Geographic Information System (GIS) (in this case, ArcView) to create maps of potential distributions. These maps were then sent to a number of experts around Australia for their comments. In most cases, refinements to the model parameters were undertaken and new distributions were modeled in CLIMEX.

The output from CLIMEX is an Ecoclimatic index (a value between 0 and 100), which provides an overall measure of favorability of the location or year for permanent occupation by the target species, it is calculated by subtracting climatic stresses from a growth index (Sutherst et al. 1999). Even though this is a robust modelling technique, there are a number of factors which have the potential to add uncertainty to the results. They include: soils, climate variability, landuse types, vectors for spread and inter-species competition. To map the potential distribution of individual species, the Ecoclimatic index was classified as shown in Table 2. The Ecoclimatic index ranges shown in Table 2 were derived via expert opinion and previously documented studies (Adamson et al. 2000; Kriticos 1997; Sutherst et al. 1999).

### Table 2. Classes used to represent potential distribution likelihood and there corresponding ecoclimatic index range.

<table>
<thead>
<tr>
<th>Potential distribution suitability class</th>
<th>Ecoclimatic index</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>30 – 100</td>
</tr>
<tr>
<td>Moderate</td>
<td>5 – 30</td>
</tr>
<tr>
<td>Low</td>
<td>&gt;0 – 5</td>
</tr>
</tbody>
</table>

Determining commodity values for the region at risk

Step **B** (Figure 4) (all landuse at risk of weeds spread) involved the use of GIS to associate landuse information, from the National Land and Water Resources Audit (NLWRA) landuse dataset ([www.nlwra.gov.au](http://www.nlwra.gov.au)) with the area at high risk of weed spread (which equates to the modeled ‘high suitability’ class). The NLWRA landuse data provides a reasonable representation of landuse for all of Australia at a resolution of one kilometer square pixels. The high risk, potential distribution class was used as a geographically conservative estimate of potential impact and the basis for analysing the region ‘at risk’ for two reasons. First, the most likely extent of spread (predicted by the model) is used so as not to exaggerate potential impact. Secondly, the opinion of most ‘expert’ reviewers of
each distribution map was that, the high risk class most closely represented the likely area of spread and therefore it is less certain whether each of the weed species would actually spread into parts of the moderate zone. The result from this step is a landuse map for the region corresponding to high risk of weed spread.

The analysis of potential impact on agriculture required information on commodity values in the affected regions. For the purpose of this study it was necessary to find easily accessible, nation–wide data for a number of broad commodity groups. The Australian Bureau of Statistics (ABS) Integrated Regional Database (IRDB) was chosen as the source for commodity data. The finest resolution at which data can be accessed from the IRDB is Statistical Local Areas (SLAs) (ABS 2001). An SLA is an administrative land unit, SLAs range in size from less than 100 hectares in cities (a suburb) to large regions in regional Australia, greater than 50 million hectares, in most cases, size is closely correlated to population density.

Step C (SLAs corresponding to area at high risk) required the association of SLAs with the region at high risk of weed spread. Similar to step B, SLAs which corresponded to the region of high risk were subsetted and kept as a separate GIS coverage.

Step D (area of specific landuse at high risk) involved taking the output from step B and extracting landuses identified as being at risk from the specific weed species (for example, grazing industries are at risk from the thistle, *Onopordum tauricum*). The total area of specific landuse at high risk of weed spread was then calculated (in square kilometers).

Step E (total area of specific landuse for the high risk SLAs) required analysis of the total area (square kilometers) of specific landuse corresponding to the SLAs extracted in step C. Step F (proportion of specific landuse at high risk of weed spread for SLAs), was calculated by dividing the results of step D by step E.

Step G (total commodity values for the SLA region) required the extraction of commodity data (corresponding to a specific landuse) for the SLAs identified in step C. The total commodity value was summed for all of the identified SLAs at high risk. In order to calculate the final value of commodities at high risk of weed spread, step H (commodity value in 1996 for the area at high risk of weed spread), the proportion of landuse (at risk) for the SLAs (step F) was multiplied by the total commodity value for the SLAs (step G).
Results

Three sets of results were produced for each of the nine species:
- potential distributions
- commodity values for the region at risk
- weediness characteristics (threat to agriculture).

These outputs are not intended to be definitive and in a number of instances further research and analysis may be required to confirm these results, particularly if a full assessment of the benefits of eradicating individual species is required. The nine analyses are intended to illustrate the importance of addressing agricultural sleeper weeds in Australia.

The current location/s of each of the nine sleeper weeds assessed in this study are shown in Figure 5. Pictures of each of the nine species are provided in Appendix A.

![Figure 5. Approximate distribution/s of the nine potentially eradicable agricultural sleeper weeds, identified by Groves et al. (2001).](image)

Maps of the approximate current overseas distribution for each of the nine species are shown in Appendix B. The red areas in these maps identify the regions used to assist in setting climatic parameters for the CLIMEX model. In a number of cases these maps are indicative only and the actual distribution may be restricted to limited areas within these regions and may also include other regions in the world.
Table 3 provides an overview of the three key outcomes for each weed species from the analyses shown in Figure 4. These outcomes are:

- Map of potential distribution
- Calculation of the area of specific landuse at high risk of weed spread (based on 1996 landuse data)
- Approximate commodity value of the area of specific landuse at high risk of weed spread. These commodity values represent overall production values for the area at risk and do not represent the economic impact that a weed species may have. Further information on the outcomes from individual analysis steps for each species is available in Appendix C.
Table 3. Three main outcomes from the analyses undertaken for each species: map of potential distribution, area of specific landuse at risk of weed spread and approximate commodity value of the area at risk of weed spread.

<table>
<thead>
<tr>
<th>Species</th>
<th>Potential distribution in Australia</th>
<th>1996 landuse (commodities)*</th>
<th>Area of 1996 landuse at high risk of weed spread (km²)**</th>
<th>Approximate 1996 commodity value for landuse in the area at high risk of weed spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pannicle jointvetch</td>
<td><img src="image" alt="Map of Pannicle jointvetch" /></td>
<td>Grazing (cattle)</td>
<td>45,997</td>
<td>$41 million</td>
</tr>
<tr>
<td>Aeschynomone paniculata</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blainvillea gayana</td>
<td><img src="image" alt="Map of Blainvillea gayana" /></td>
<td>Grazing (cattle)</td>
<td>181,804</td>
<td>$125 million</td>
</tr>
<tr>
<td>Brillantaisia lamium</td>
<td><img src="image" alt="Map of Brillantaisia lamium" /></td>
<td>Irrigated cropping</td>
<td>906</td>
<td>$685 million</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(sugar cane, sunflowers,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>cotton &amp; coffee)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Irrigated &amp; non-irrigated</td>
<td>102</td>
<td>$220 million</td>
</tr>
<tr>
<td></td>
<td></td>
<td>horticulture (fruit &amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>vegetables)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Landuse’s identified as being at threat if the weed species were to spread have been selected based on information about overseas infestations or via expert opinion. The commodities in brackets refer to the ABS commodity values used to represent the specific landuse.

** The landuse area identified as ‘at risk’ is calculated using one km² landuse data in the distribution region coloured green.
Table 3. Continued

<table>
<thead>
<tr>
<th>Species</th>
<th>Potential distribution in Australia</th>
<th>1996 landuse (commodities)</th>
<th>Area of 1996 landuse at high risk of weed spread (km²)</th>
<th>Approximate 1996 commodity value for landuse in the area at high risk of weed spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whitestem distaff thistle</td>
<td><em>Carthamus leucocaules</em></td>
<td>Grazing (sheep &amp; cattle)</td>
<td>302,555</td>
<td>$1,336 million</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cropping (cereals)</td>
<td>101,080</td>
<td>$3,520 million</td>
</tr>
<tr>
<td>Common crupina</td>
<td><em>Crupina vulgaris</em></td>
<td>Grazing (sheep &amp; cattle)</td>
<td>131,935</td>
<td>$891 million</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cropping (cereals)</td>
<td>1,833</td>
<td>$44 million</td>
</tr>
<tr>
<td>Esaka</td>
<td><em>Cyperus teneristolon</em></td>
<td>Cropping (cereals)</td>
<td>1,833</td>
<td>$44 million</td>
</tr>
</tbody>
</table>
Table 3. Continued

<table>
<thead>
<tr>
<th>Species</th>
<th>Potential distribution in Australia</th>
<th>1996 landuse (commodities)</th>
<th>Area of 1996 landuse at high risk of weed spread (km²)</th>
<th>Approximate 1996 commodity value for landuse in the area at high risk of weed spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange hawkweed <em>Hieracium aurantiacum</em></td>
<td>Grazing (sheep &amp; cattle)</td>
<td>142,901</td>
<td>$959 million</td>
<td></td>
</tr>
<tr>
<td>Golden lungwort <em>Hieracium murorum</em></td>
<td>Grazing (sheep &amp; cattle)</td>
<td>74,435</td>
<td>$514 million</td>
<td></td>
</tr>
<tr>
<td>Taurian thistle <em>Onopordum tauricum</em></td>
<td>Grazing (sheep &amp; cattle)</td>
<td>312,248</td>
<td>$1,453 million</td>
<td></td>
</tr>
</tbody>
</table>
Each of the nine weed species were identified as posing a threat to Australian agricultural industries due to various characteristics. Table 4 provides information that was gathered during this study, about the potential ‘weediness’ of each species with regard to its threat to specific agricultural industries.

Table 4. Characteristics of each weed species which make them a potential threat to Australian agriculture.

<table>
<thead>
<tr>
<th>Species</th>
<th>Weediness information ***</th>
<th>Information source</th>
</tr>
</thead>
</table>
| Pannicle jointvetch            | - Originally introduced as a trial pasture species in northern Queensland, it is now spreading to new areas and has the potential to become a significant environmental and pasture weed.  
- There is evidence that cattle and native animals choose not to eat this plant.  
- Can develop into thickets and therefore exclude useful pasture species. | - R.W. Walker (Pers. Comm. DPI Qld.)                                                |
| Aeschynomene paniculata        |                                                                                          |                                                                                   |
| Blainvillea gayana             | - Known to be a weed of open ground in semi-arid regions in West Africa.  
- Appears to be a problem weed in disturbed areas. | - Pacific Island Ecosystems at Risk: http://www.hear.org/pier3/blgavy.htm  
- C. Chopping (Pers. Comm. Land Protection Officer, Mackay, Qld.)                   |
| Brillantaisia lamium           | - Known to be a problem in orchards, nurseries and along banks of drainage ditches around sugarcane, as well as being an environmental weed.  
- A very prolific, invasive species which produces lots of seeds which are most often spread by water. A number of landholders and others (in Queensland) are very concerned about its potential impact.  
- Prefers moist, tropical areas, both in full sun and partial shade. Forms dense, monospecific stands.  
- May spread via seeds or rooting stem fragments.  
- This plant is recorded as a troublesome weed in West Africa, where it forms dense infestations capable of smothering more desirable plants. | - (Groves et al. 2001)  
- P. Lawler (Pers. Comm. Pest Management Officer, Douglas Shire Council)  
- Pacific Island Ecosystems at Risk: http://www.hear.org/pier3/brlam.htm  
- (QDNR) (info. Brochure)                                                        |
| Whitestem distaff thistle      | - Noxious winter annual.  
- Highly competitive with cereal crops and desirable rangeland species.  
- Because of their spiny nature, distaff thistles can injure the eyes and mouths of livestock forced to graze within dense populations of the weeds. | - Californian noxious weed index: http://pi.cdfa.ca.gov/weedinfo/CARTHAMU2.htm |
| Carthamus leucocaulos          |                                                                                          |                                                                                   |
| Common crupina                 | - Adapted to a wide range of soil and climatic conditions, common crupina can form solid stands, which decrease forage productivity and livestock carrying capacity.  
- Although it is non-toxic, livestock tend to avoid common crupina.  
- Plants adapt to many environmental conditions and are highly competitive for water and nutrients. | - Washington State Noxious Weed Control Board: http://www.wa.gov/agr/weedboard/weed_info/crupina.html  
- Californian noxious weed index: http://pi.cdfa.ca.gov/weedinfo/CRUPINA2.html |
| Crupina vulgaris               |                                                                                          |                                                                                   |
| **Esaka**                      | **- Spreads by stolons, rhizomes and seed.**  
|                               | **- Considered to be a significant weed of crops in the highlands of eastern Africa.** |
| **Cyperus teneristolon**      | **- (Groves et al. 2001)**  
|                               | **- (Terry and Michieka 1987)** |
| **Orange hawkweed**          | **- Found primarily on native meadows, forest openings, permanent pastures, hayfields, roadways, right-of-ways and idle areas in States of the USA where it has naturalised.**  
| **Hieracium aurantiacum**     | **- Once established, it quickly develops into a patch that continues spreading by seed and undersurface lateral roots.**  
|                               | **- Severe infestations will dominate the site with a solid mat of rosettes or seedlings.**  
|                               | **- Plants aggressively compete with pasture species.**  
|                               | **- It is unpalatable to livestock and crowds out more desirable species.**  
|                               | **- It can spread and overtake other small ornamental plants.**  
|                               | **- Considered to be one of the most noxious weeds in the New England states of USA.** |
|                              | **- Integrated weed management, British Columbia:**  
|                               | **http://www.agf.gov.bc.ca/croplife/cropprot/hawkweed.pdf**  
|                               | **- Noxious weed alert, Clallam County:**  
|                               | **http://www.clallam.net/weed/assets/images/orangehawkweed.pdf**  
|                               | **- Washington State Noxious Weed Control Board:**  
|                               | **http://www.wa.gov/agr/weedboard/weed_info/orangehawk.html** |
| **Golden lungwort**          | **- Similar to Orange hawkweed (above).**  
| **Hieracium murorum**        | **- Competitive pasture species which is unpalatable to livestock.** |
|                              | **- (Groves et al. 2001)** |
| **Taurian thistle**          | **- May become an impassable obstacle to livestock on rangelands and pastures.**  
| **Onopordum tauricum**       | **- Severe infestations can form tall, dense, impenetrable stands, especially in fertile soils.**  
|                               | **- Known to reduce productivity and strongly compete with native plants for resources.** |
|                               | **- Colorado weed management association:**  
|                               | **http://www.cwma.org/scotch_thistle.html**  
|                               | **- Californian noxious weed index:**  
|                               | **http://pi.cdfa.ca.gov/weedinfo/ONOPORDU2.html** |

*** Availability of easily accessible information was the main factor determining the quality of results presented. Therefore limited information is not an indicator of low risk.

It was difficult to find information that would allow estimates to be made of approximate economic costs to affected agricultural industries.

The total approximate economic cost of weeds to all agricultural systems in Australia was $3.3 billion in 1995 (Groves 2002). There are a number of similar statistics available which provide broad estimates of costs due to weeds (ARMCANZ 1999; CIE 2001; Groves 2002). An example of economic cost incurred due to a particular weed’s spread was reported by (Grundy 1989) for *Hieracium* species in New Zealand. It was estimated that production losses in grazing areas due to *Hieracium* species could be as high as 15% on improved land and 5% on unimproved land. If the 5% figure is used to estimate
approximate potential loss to production in Australia, due to the two *Hieracium* species, orange hawkweed and golden lungwort, estimated annual losses to grazing industries would be in the order of $48 million and $26 million respectively.

All of the nine sleeper weeds examined were compiled in the GIS to determine the total area at high risk of weed spread, as shown in Figure 6. The total area of land which is covered by high potential of spread for the nine species is 128 million hectares. Similarly, the total area of land which is covered by high or moderate potential of weed spread for the nine species is 292 million hectares (Figure 7), this area is an estimation of the total ‘worst case scenario’ for all nine species.

![Figure 6](image6.png)

*Figure 6. Total area at high risk of weed spread from the nine weed species, including the Australian wheat-belt.*

![Figure 7](image7.png)

*Figure 7. Total area at high or moderate risk of weed spread from the nine weed species, including the Australian wheat-belt.*
Whitestem distaff thistle is potentially the most threatening sleeper weed analysed in this study. The value of agriculture in the region at high risk of this weed’s spread is $1.3 billion for sheep and cattle grazing and $3.5 billion for cereal cropping. The potential area of spread for whitestem distaff thistle encompasses greater than 90% of the wheat-belt in southern Australia (Figure 8). Table 5 shows the area of land (total area and agricultural land area) that may be highly and moderately susceptible to the spread of whitestem distaff thistle. The moderate class is used here as an example of a ‘worst case scenario’ in terms of the potential range of spread for whitestem distaff thistle.

![Figure 8. high and moderate potential distribution of whitestem distaff thistle, including the Australian wheat-belt.](image)

Table 5. Area of land susceptible to the spread of whitestem distaff thistle in Australia.

<table>
<thead>
<tr>
<th>Landuse</th>
<th>Risk of spread</th>
<th>Area (hectares)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All land (ag. &amp; non-ag.)</td>
<td>High</td>
<td>53.9 million</td>
</tr>
<tr>
<td>Agricultural land (grazing &amp; cropping)</td>
<td>High</td>
<td>40.3 million</td>
</tr>
<tr>
<td>All land (ag. &amp; non-ag.)</td>
<td>High &amp; Moderate</td>
<td>151.9 million</td>
</tr>
<tr>
<td>Agricultural land (grazing &amp; cropping)</td>
<td>High &amp; Moderate</td>
<td>104.9 million</td>
</tr>
</tbody>
</table>

The potential distribution of whitestem distaff thistle was, visually, compared to the potential distributions of the 20 WONS (Thorpe and Lynch 2000) and blackberry was found to have a very similar potential distribution to whitestem distaff thistle. Blackberry is known to presently cover between 5 and 8.8 million hectares of land, traversing all
Australian states and the Australian Capital Territory (MVWS 1999, OCA 2001). It may therefore be inferred that a weed such as whitestem distaff thistle may not need to reach its full extent in order to have a major impact on Australian agriculture.

**Discussion**

This study presents a range of information derived from research and analyses pertaining to nine sleeper weed species in Australia. These results indicate the scale of potential threat each weeds species poses to Australian agriculture, and make it possible to draw conclusions about the importance of addressing the sleeper weed problem in Australia.

This study does not attempt to estimate the actual extent or cost of impacts of the nine sleeper weeds or where such impacts may occur because predicting future ranges for invasive species and their potential impacts is a difficult task and subject to much uncertainty. Generally, the weed experts consulted during this project considered it likely that the nine sleeper weeds assessed could spread throughout the areas of ‘high’ CLIMEX match (Table 3) if they are not controlled. Hence, the results of this study indicate clearly that these nine sleeper weeds pose a threat to agriculture and if this potential is realised they could impose major economic costs on Australian agricultural industries.

As a result of identifying the potential threat posed by sleeper weeds, assessments of desirability and feasibility of species eradication or containment, are highly desirable. An assessment of desirability of eradication would build upon the analyses already undertaken. Developing a clear understanding of individual species potential to adversely impact on agriculture, including, the species ability to spread, further analysis of species characteristics which impact on agriculture and the costs associated with control and lost production post-spread. Analysis of eradication feasibility for individual species would require new components in the study, such as, access to the affected site, longevity of propagules, methods and timing of eradication and cost of an eradication campaign. Once a set of decision tools pertaining to desirability and feasibility of sleeper weed eradication have been agreed to, then prioritisation of eradication candidates may be undertaken.

The analyses undertaken demonstrate that more than 100,000 square kilometers (or 10 million hectares) of grazing land is at risk from the spread of five of the nine weeds species. Although it is unknown whether weed control in the areas at risk would
adequately combat these weeds it may be assumed that some impact would occur if the
weeds spread. The approximate value of agricultural industries in the regions at risk of
weed spread for the nine species, range from $41 million to $3.5 billion.

The example of total losses of $26 to $48 million for *Hieracium aurantiacum* and *H.
muorum*, based on the assumption that production losses would be equivalent to the 5%
levels found in New Zealand, indicate that the potential costs of these species in Australia
are high. No figures could be found for production losses caused by the other seven sleeper
weeds assessed, and as is difficult to accurately estimate the future cost/impact of a sleeper
weed species on agricultural industries, therefore they were not pursued in this study.

The value of the industries potentially affected by the nine sleeper weeds assessed (in the
areas of high probability of spread) range from $40 million worth of grazing in northern
Queensland to greater than $4.8 billion worth of grazing and cropping industries across the
southern States. It was beyond the scope of this study to estimate the potential economic
losses to agricultural industries if these weeds are not eradicated, but if each weed only
caused losses of 1% (a highly conservative estimate) in the areas where they could
reasonably be expected to spread, then the total losses would likely be in the order of $100
million annually.

As specific costs to industry cannot be calculated, the information generated in this study
may be used as a tool for drawing generalised conclusions about the threats posed by some
sleeper weeds in Australia. This study has shown that the importance of addressing sleeper
weeds is significant, due to their potential threat to industries and the environment.

**Future Directions**

The information presented on these nine species demonstrates that each of them pose a
significant threat to at least one agricultural industry and the costs associated with lost
production and control could be very large. These species may also pose a potential threat
to the environment if they were to spread. There is also the potential for many other sleeper
weed species to threaten industries and the environment.

A more in depth assessment of sleeper weeds would allow priorities to be set for targeting
control action against sleeper weeds. Such a study would need to:
• include assessments of many more sleeper weed species
• assess the costs and benefits of eradications, including more in depth assessment of potential harm caused by individual species, such as that conducted for Siam weed (Adamson et al. 2000)
• develop criteria for assessing the feasibility of eradication and assess each species against these criteria.

Such a study could be used to rank sleeper weeds so that species that pose greatest threat and are most amenable to eradication could be identified and targeted for priority action before they spread and the opportunity for eradication is lost. This will help to ensure that the list of WONS does not continue to grow.
Acknowledgements

There are a number of people who the authors would like to thank for their assistance during this project. Firstly thanks to Richard Groves and members of the CRC for Australian weed management whom put together the report (Groves et al. 2002) which provided the basis for this work. Also, thanks to Holly Ainslie for her assistance with the GIS analyses and to Darren Kriticos for his help with the CLIMEX model.

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Thank-you to all these people – without Australia’s amazing weeds network we could not have done this project within the constraints that were set.

References


QDNR (Queensland Department of Natural Resources) [undated] Brillantasia lamium, a new 'potential weed' in the wet tropics. Douglas Shire Council.


Appendix A.
Appendix B.

Figure 1: World distribution of *A. paniculata*

Figure 2: World distribution of *B. gayana*
Figure 3: World distribution of *B. lamium*

Figure 4: World distribution of *C. teneristolon*
Figure 5: World distribution of *C. vulgaris*

Figure 6: World distribution of *H. aurantiacum*
Figure 7: World distribution of *C. leucocaulos*
Figure 8: World distribution of *H. murorum*
Figure 9: World distribution of *O. tauricum*
### Appendix C.

<table>
<thead>
<tr>
<th>Species</th>
<th>Landuse</th>
<th>Area of landuse at high risk of weed incursion (km²)</th>
<th>Total area of landuse (km²) for all SLAs at risk</th>
<th>Percentage of SLA landuse at high risk</th>
<th>Total commodity value for the landuse</th>
<th>Commodity value for the landuse at high risk</th>
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<tr>
<td>A. paniculata</td>
<td>Grazing</td>
<td>45997</td>
<td>200180</td>
<td>23%</td>
<td>$182,538,770</td>
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<td>B. gayana</td>
<td>Grazing</td>
<td>181804</td>
<td>628099</td>
<td>29%</td>
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<td>B. lamium</td>
<td>Irrigated cropping</td>
<td>906</td>
<td>1414</td>
<td>64%</td>
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<td>B. lamium</td>
<td>Irrigated and non-irrig. horticulture</td>
<td>102</td>
<td>229</td>
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<td>302555</td>
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<td>C. leucocaulos</td>
<td>Cropping</td>
<td>101080</td>
<td>135194</td>
<td>75%</td>
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<td>C. vulgaris</td>
<td>Grazing</td>
<td>131935</td>
<td>267000</td>
<td>49%</td>
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<td>$891,473,000</td>
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<td>C. teneristolon</td>
<td>Cropping</td>
<td>1833</td>
<td>4677</td>
<td>39%</td>
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<td>H. aurantiacum</td>
<td>Grazing</td>
<td>142901</td>
<td>215941</td>
<td>66%</td>
<td>$1,449,221,400</td>
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<td>H. aurantiacum</td>
<td>Perennial horticulture</td>
<td>249</td>
<td>376</td>
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<td>H. murorum</td>
<td>Grazing</td>
<td>74435</td>
<td>143645</td>
<td>52%</td>
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<td>O. tauricum</td>
<td>Grazing</td>
<td>312248</td>
<td>502903</td>
<td>62%</td>
<td>$2,341,212,030</td>
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