



Weed management priorities in the Great Western Woodlands in a climate change context

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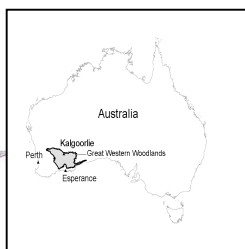
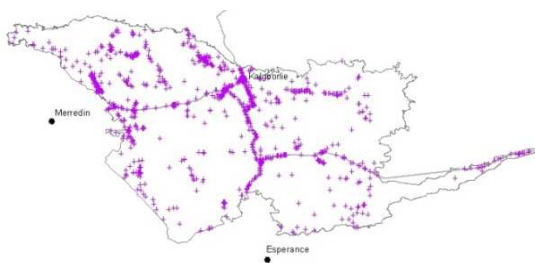
Background

Weeds have wide-ranging impacts on native ecosystems and biodiversity. As weeds are generally expensive or impossible to control once established, preventative management is critical. Efforts to minimize invasions have traditionally focussed on either 'species-led' or 'asset-led' approaches. Species-led approaches aim to prevent or minimize invasions by identifying and managing 'priority' weeds; those that have the highest risks of invasion and impact. Asset-led approaches aim to minimize invasions within selected biodiversity or cultural assets such as nature reserves.

We considered species- and asset-led approaches to preventative weed management in the world's largest extant Mediterranean-climate woodland; the Great Western Woodlands (GWW). While the GWW is relatively undisturbed compared with the adjacent Western Australian wheatbelt, parts of it are under pastoral lease, and other activities that may exacerbate plant invasions are increasing, particularly tourism, mining and minerals exploration.

Our species-led approach considered all known alien plants from the GWW, with all species assigned to one of eight classes based on their invasion potential in a changing climate and current management feasibility (Fig. 1). We identified priority weeds as those expected to be increasingly problematic under the influence of climate change, and have current distributions that allow feasible regional containment or eradication. The GWW is expected to become warmer with less winter rain, so we predicted that species preferring wetter and/or strongly Mediterranean climates would become less significant in future. Species tolerating hotter, more arid conditions, potentially with more summer-dominant rainfall, were expected to become more important.

Our asset-led approach used site-based flora surveys from the GWW to identify drivers of weed invasion, and hence to identify processes that might be managed to limit invasions.



Distribution of alien plant records in the Great Western Woodlands (left), showing high occurrence of weeds along major roads where regular disturbance favours weed spread and where survey and collection effort is high. Prickly pear (*Opuntia* spp.) (right) is a high priority for species-led alien plant management (Table 1). Prickly pear has mostly spread from horticultural plantings, such as in this example which likely originated from disposal of garden waste in the bush.

Findings

Species-led approach

- 206 alien plant taxa were recorded from the GWW. Overall, the alien flora of the GWW is dominated by herb and grass growth forms and annual/biennial life cycles
- Most (64.4%) alien plant taxa in the GWW are associated with wetter winter-rainfall dominated climate (*Widespread mesic*, *Coastal mesic* and *Urban mesic* categories) and are expected to perform poorly under projected climate change.
- 23.3% of alien plant taxa occurred in *Widely dispersed* and *Widespread transitional-zone* classes. These taxa are extremely difficult, if not impossible, to manage at a regional scale.
- 12.2% of alien plant taxa in three classes (*Horticultural transitional-zone*, *GWW transitional-zone* and *Summer-rain arid*) are predicted to perform similarly to present, or more strongly,

under projected climate change, and have current distributions suggesting regional containment or eradication is feasible. In comparison to the total weed flora, perennials are strongly represented among the latter species (Fig. 1; Table 1).

Asset-led approach

- Weeds occurred at ~33% of 1120 systematic flora survey sites, with low-stature annual grasses and annual herbs most widespread (e.g. *Pentameris*, *Vulpia*)
- Disturbance (closer proximity to towns, buildings and water points), climate (marginally greater winter rainfall) and soil (occurrence on calcareous loams and earths on greenstone soil, and on meta-igneous mafic bedrock) factors were all strong predictors of weed presence.

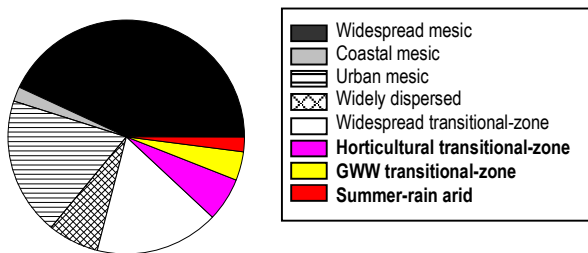


Fig. 1. Alien flora of the GWW were assigned to one of eight classes based on their invasion potential in a changing climate and current management feasibility. Alien plants associated with wetter and/or more Mediterranean climates were further subdivided into *Widespread mesic* (e.g. *Arctotheca calendula*), *Coastal* (and salt lake) *mesic* (e.g. *Carpobrotus aequilaterus*) or *Urban mesic* (e.g. *Asparagus officinalis*) categories based on distribution patterns. *Widely dispersed* taxa have wide climate tolerance, are extremely widely distributed and readily dispersed (e.g. *Sonchus oleraceus*). *Transitional-zone* taxa are associated with dry Mediterranean to arid non-seasonal climates, further subdivided into *Widespread transitional-zone* (e.g. *Carrichtera annua*), *Horticultural transitional-zone* (spreading from gardens e.g. *Schinus molle*) or *GWW transitional-zone* (GWW-centric distribution e.g. *Oncosiphon suffruticosum*) based on distribution and patterns of spread. *Summer-rain arid* weeds (e.g. *Cenchrus ciliaris*; bottom photo) are associated with arid climates.

Table 1. Priority weed species for species-led management in the GWW, based on future climate tolerance and current distribution (see Fig. 1). Life cycle: P = perennial; A = annual. Growth form: G = grass; H = herb; S = shrub; T = tree; C = climber.

Weed category	Life cycle	Growth form
Horticultural transitional-zone		
<i>Agave americana</i>	P	H
<i>Bryophyllum</i> sp.	P	H
<i>Cylindropuntia fulgida</i> var. <i>mamillata</i>	P	S
<i>Cylindropuntia</i> sp.	P	S
<i>Galenia pubescens</i> var. <i>pubescens</i>	P	H
<i>Gazania linearis</i>	P	H
<i>Opuntia</i> sp.	P	S
<i>Orbea variegata</i>	P	H
<i>Pennisetum setaceum</i>	P	G
<i>Portulacaria afra</i>	P	S
<i>Schinus molle</i> var. <i>areira</i>	P	T
<i>Tamarix</i> sp.	P	T
GWW transitional-zone		
<i>Alyssum linifolium</i>	A	H
<i>Galium spurium</i>	A	H
<i>Heliotropium supinum</i>	A	H
<i>Herniaria cinerea</i>	A	H
<i>Oligocarpus calendulaceus</i>	A	H
<i>Oncosiphon suffruticosum</i>	A	H
<i>Proboscidea louisianica</i>	A	H
<i>Salvia reflexa</i>	A	H
Summer-rain arid		
<i>Acetosa vesicaria</i>	A	H
<i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>	A	H
<i>Cenchrus ciliaris</i>	P	G
<i>Citrullus colocynthis</i>	P	C

Management Implications

- The species-led approach identified a group of relatively few taxa that are likely to be favoured by projected future climate and are currently of restricted distribution in the GWW and hence could feasibly be eradicated or contained on a regional scale (Table 1). An example is Buffel grass (*Cenchrus ciliaris*); a 'summer-rain arid' weed currently restricted to roadsides in the GWW but with potentially greater occurrence in the future due to an increase in climatic suitability in the region. Buffel grass invasion would be highly impactful through synergistic increases in vegetation flammability.
- The asset-led approach identified the following weed management priorities: targeting abandoned and current settlements for localised removal of disjunct weed populations, closing artificial water points on conservation estate, and minimising new settlement creation in locations currently remote from towns.

Further reading: Gosper CR, Prober SM, Yates CJ and Scott JK (2015) Combining asset- and species-led alien plant management priorities in the world's most intact Mediterranean-climate landscape. *Biodiversity and Conservation* 24, 2789-2807.

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GREAT WESTERN WOODLANDS