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Weeds: a curse for native plants in farm woodlands

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WEEDS
a curse for native plants in farm woodlands

Weeds have a major impact on native Australian plants, particularly in the tropical north and the agricultural regions of southern Australia. Max Abensperg-Traun, and his colleagues from the CSIRO Division of Wildlife and Ecology, explain the effects of weed invasion on the diversity of native herbaceous plants in farm woodlands in the central wheatbelt of south-west Western Australia.

At its simplest, a weed can be defined as an exotic (non-Australian) plant that grows where it is not wanted. When in flower, weeds can be just as visually striking as native plants. The vast expanses of yellow capeweed (Arctotheca calendula) and purple Paterson’s curse, or salvation Jane (Echium plantagineum) in wheatbelt paddocks are well-known examples. They sometimes provide valuable fodder for livestock.

Broadly speaking, there are two types of weed invasion of native vegetation. There is the single-species invasion, often associated with the tropical north, like the rubber vine (Cryptostegia grandiflora) and mimosa (Mimosa pigra), among many others. These invasions can be visually spectacular and are often subject to very public efforts of containment, with varying degrees of success. An example from the south-west is the bridal creeper (Myrhapsyllium asparagoides).

This contrasts with the less spectacular, insidious, multi-species invasion (mostly annual grasses and herbs) in mediterranean regions of agricultural southern Australia where invasion effects on native plants are just as severe as in the tropics.

Effective management or containment and prevention of further weed invasion requires an understanding of the biological characteristics of exotic plants, and the invasion processes involved. Before we progress to our case study in the Western Australian wheatbelt, it is worth briefly reviewing the factors that enhance weed invasion in native bushland.

Weeds have the edge over native plants

The list of characteristics that give weed species an edge over most native plants is long and we summarise only the most important. Native plants are ideally suited to their natural habitat and soils with low nutrients, unpredictable rainfall and periodic disturbances such as fires. Weeds thrive only in situations where...
these conditions have been altered. In contrast to native plants, weeds usually generate much larger numbers of seeds which are long-lived and have no special requirements for germination. Seedlings grow fast and set seeds quickly, and they often have special adaptations for effective dispersal over both short and long distances.

The invasion process is particularly successful where two factors co-occur. The first is where nutrient levels have been artificially raised, such as through the influx of agricultural fertilisers (nitrogen, phosphorus) along remnant edges and road-verges, and through defecation by livestock. Secondly, invasion is enhanced where the soil crust has been disturbed, either through hoof action by sheep and cattle, or through burrowing and scratching by rabbits. Both situations have the effect of releasing further nutrients from the soil which are much more rapidly taken advantage of by weeds than by native plants.

Most native Australian plants have evolved under low-nutrient conditions and artificially raised nutrient levels may be toxic to some native species. For example, it is now well known that in the presence of higher nutrient levels, many eucalypts grow faster but die sooner. In addition, few native plants can tolerate grazing by livestock, while many weeds either recover well from, or avoid, regular grazing by stock. Examples of ‘avoidance’ include succulents such as the ice-plant (Mesembryanthemum spp.) that are very salty and not eaten.

Once weeds are established, they often rapidly colonise adjacent areas of native vegetation, literally swamping native plants and so reducing their access to light, moisture and nutrients and, ultimately, killing existing natives and preventing their regeneration.

Not all native vegetation types are equally susceptible to invasion by weeds. In the Western Australian wheatbelt, heath and shrublands are much more resilient to weed invasion than are York gum (Eucalyptus loxophleba)-jam (Acacia acuminata) and eucalypt woodlands. And wheatbelt wandoow or white-gum woodlands (Eucalyptus capillosa) are more resilient to invasion than are these York gum-jam woodlands.

Eucalypt woodlands are now poorly represented in the wheatbelt because they grow on relatively nutrient-rich soils which were cleared in preference to heath and shrublands on the sandy, nutrient-poorer soils. Many eucalypt remnants are in paddocks, they are small, heavily grazed by livestock and invaded by a diverse range of weed species from the adjacent agricultural land.

In the wheatbelt, eucalypt woodlands have generated considerable concern on the part of both farmers and scientists because of their important role in farm and catchment hydrology (see Journal of Agriculture WA, 37(1), 1996, Degradation of native vegetation), and their poor conservation status (grazed, weed-infested, lack of regeneration), with remnant trees being mostly old and senescent. These remnants have been and continue to be the subject of research into the factors responsible for their poor levels of regeneration, and for the most effective methods of their rehabilitation.

Here we compare levels of weed invasion, and their effects on the diversity of native herbaceous plants, in wandoow (E. capillosa) and gimlet (E. salubris) woodland remnants. Wandoow generally occurs on the slopes immediately below break-aways on the Booraan land-surface unit. Soils supporting wandoow range from acidic to alkaline, and are typically duplex soils of shallow grey sandy clay, with occasional granitic outcroppings or with varying amounts of lateritic gravel of the eroded surface. Gimlet is found downslope of wandoow (on the Merredin and Belka land-surface units) on the alluvial plain with heavy red, brown or grey clayey soils where subsoils are frequently saline.

The situations that we examined are typical for the central wheatbelt. We had six study sites of each woodland type on small remnants with a long history of livestock-grazing, and another six sites of each in road-verge woodlands. These results were compared with undisturbed woodlands within large remnants.
on private land and nature reserves. (See Journal of Agriculture WA 36(3), 1995 for further details of our research in the wheatbelt).

**Total weed cover**
Levels of weed invasion in undisturbed gimlet and wandoowoodlands were very low, less than 5 per cent weed cover (Figure 1), contrasting markedly with the same woodlands in disturbed situations. Compared with grazed wandoowoodland (25 per cent weed cover), average weed cover of gimlet woodlands was three times higher (78 per cent weed cover). Road-verges were less invaded than were grazed sites for both woodland types but, again, gimlet verges had much higher invasion levels (42 per cent weed cover) than verges with wandoowoodland (19 per cent weed cover) (Figure 1).

**Diversity, geographic origin and species abundance of weeds**
We identified a total of 35 weed species from 29 genera and 12 families (a complete list of species can be obtained from the senior author). They originated from Europe (13 species), southern Africa (12 species) and the Mediterranean region (10 species).

Overall, numbers of weed species were similar across all gimlet (28 species) and wandoowoodland sites (27 species). However, diversity of weed species tended to increase from undisturbed to grazed sites, with the greatest numbers of different weed species in road-verge situations, irrespective of woodland type (Table 1).

There were both differences and similarities in the relative importance of individual weed species between the woodland and disturbance types (Table 2). Species that were common to both types of woodland include barley grass (*Hordeum leporinum*), ryegrass (*Lolium perenne*), and Indian hedge mustard (*Sisymbrium orientale*). The ice plant (*Mesembryanthemum crystallinum*) was more common in gimlet than in wandoowoodland, while ursinia (*Ursinia anthemoides*) was common in wandoowoodland but absent from gimlet (Table 2).

Only wild oats (*Avena fatua*) was not recorded in any of the grazed sites for both types of woodland, but was most common in both gimlet and wandoowoodland sites. Barley grass and Indian hedge mustard were most common in grazed situations (Table 2).

**Diversity of native herbaceous plants**
We recorded a total of 91 native species from 66 genera and 27 families. We examined the direct relationship between native plant diversity and weed cover, and the proportion of native species lost from disturbed sites.

Figure 2 demonstrates that for both gimlet and wandoowoodland, the diversity of herbaceous native understory plants stands in a direct (linear) relationship with the extent of weed invasion. The higher the weed cover the lower the diversity of native plants, and vice versa.

Expressed as a percentage of the total native species that we identified in undisturbed woodland

**Table 1. Total numbers of weed species recorded for woodland types**

<table>
<thead>
<tr>
<th>Species Type</th>
<th>Gimlet E. salubris</th>
<th>Wandoo E. capillosa</th>
</tr>
</thead>
<tbody>
<tr>
<td>All sites (18 sites)</td>
<td>28</td>
<td>27</td>
</tr>
<tr>
<td>Undisturbed woodlands (6 sites)</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Grazed woodlands (6 sites)</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Road-verge woodlands (6 sites)</td>
<td>26</td>
<td>22</td>
</tr>
</tbody>
</table>

Figure 3. Percentage of native herbaceous plant species that were recorded in undisturbed but not in grazed or road-verge gimlet (Eucalyptus salubris) and wandoo/white-gum (E. capillosa) woodlands.
High diversity of native herbs in undisturbed wandoor.

food for native herbivores. Our earlier studies (see Journal of Agriculture WA 36(3), 1995) have shown that the most weed-infested gimlet remnants supported by far the greatest number of beetle species, probably because artificially enhanced foliage nutrient levels in such farm woodlands support a greater abundance and diversity of leaf-eating and predatory beetles.

However, negative impacts far outweigh positive influences on the native biota. In addition to preventing regeneration of native trees and shrubs, the loss of these deep-rooting perennials will have several other flow-on effects.

First, there will be higher recharge rates of saline groundwater, with consequent higher levels of soil salinity, reducing agricultural productivity (see Journal of Agriculture WA, 37(1), 1996, Degradation of native vegetation).

Second, loss of trees and shrubs will cause higher exposure of the soil surface to wind and water, leading to increased rates of topsoil erosion, the most valuable part of the soil for the establishment of native plants.

Third, weed invasion increases the fire risk in these woodlands. Although native vegetation is resilient to the effects of fire, a tree

Conservation implications

Two important points have emerged from this study. Firstly, weed invasion by itself causes local extinctions of native herbaceous plants (road- verge type woodlands). Secondly, weed invasion is enhanced under livestock-grazed conditions, and the combined effects of grazing and weed invasion causes considerably higher local plant extinctions.

The implications of weed invasion of farm woodlands go far beyond their immediate effects on native plants. Invasion can have both negative and positive effects on other components of the native ecosystem. Positive effects may include an increase in the availability of plants (weeds) as

Table 2. Invasion levels of the most common weed species in gimlet (Eucalyptus salubris) and wandoor (E. capillosa) woodlands.

<table>
<thead>
<tr>
<th>WEED SPECIES</th>
<th>GIMLET WOODLAND</th>
<th>WANDOO WOODLAND</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Undisturbed</td>
<td>Grazed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capeweed</td>
<td>low</td>
<td>moderate</td>
</tr>
<tr>
<td>Wild oats</td>
<td>low</td>
<td>none</td>
</tr>
<tr>
<td>Red brome</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Barley grass</td>
<td>none</td>
<td>high</td>
</tr>
<tr>
<td>Flatweed</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Ryegrass</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Iceplant</td>
<td>low</td>
<td>moderate</td>
</tr>
<tr>
<td>Indian hedge mustard</td>
<td>none</td>
<td>high</td>
</tr>
<tr>
<td>Ursinia</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Rat’s tail fescue</td>
<td>low</td>
<td>high</td>
</tr>
</tbody>
</table>

low

high

moderate

low
or shrub that is stressed (weeds, grazing) will often die instead of recovering. As seedling establishment is rare in a weedy area, this can lead to a further decline in native plant diversity. Natural recolonisation of these remnants by native species is uncommon owing to their isolation from seed sources, the apparent lack of seed production in remnants and the difficulty in seedling establishment. In these circumstances, replanting is often the only method of regeneration.

Fourth, a decline in native plant diversity associated with increased levels of weed invasion, and trampling and grazing by stock, has been associated with a significant decline in the abundance and diversity of lizards, scorpions and termites in the gimlet woodlands of the wheatbelt.

Fifth, a number of studies now indicate that the loss of native plant and animal species (biodiversity) can adversely affect ecosystem processes such as nutrient- and energy-cycling, soil formation and plant pollination. This, in turn, may reduce the long-term stability of these ecosystems and may ultimately cause the demise of many, if not most of the native woodlands on farms.

The demise of woodland remnants on farms would be tragic. The retention and restoration of woodland remnants, in part through sheep exclusion, weed control and revegetation, would go some way towards the interrelated goals of sustainable agriculture (especially a reduction in soil salinity) and nature conservation (improving habitat for native plants and animals).

Are there guidelines?
Native woodland remnants on farms play a very important role for soil hydrology and nature conservation at several scales: the local remnant, the individual farm, the catchment and region. The extent to which native plant species are lost from such remnants is alarming for practical reasons (e.g. sustainable agriculture) as well as for the concept that native plant communities and the native animal fauna dependent on them deserve preservation in their own right.

So what to do?

While sheep can be excluded from remnants by fencing, the problem of weeds in remnant bush is a much more difficult task. Weed
control is an essential component of any attempt to regenerate native bush or to revegetate other areas. The only effective way of controlling weeds over big enough areas is by chemical control. A variety of chemicals are available which will control broad-leaved or grass weeds, as well as pre-emergence herbicides which appear to have minimal impact on native species if used correctly. However, the effectiveness of spraying depends in large part on the timing in relation to weather (before and after).

A one-off spraying will be unlikely to succeed unless it is followed by the rapid re-establishment of a native cover. Once that native cover is in place, weeds will be suppressed. Otherwise, repeated sprayings will be necessary. In severe cases, where weeds dominate the above-ground plant cover as well as the soil seed bank, the cost-benefit ratio may well be prohibitive. At the end of the day, the decision to spray or not to spray rests with the individual farmers.

The easiest way to deal with weeds is to prevent their establishment in the first place. This simply means not disturbing bush with an intact cover of native trees and understorey species. Such intact pieces of bush are the sole survivors of the native bush as it once was, and their retention should be given high priority.

Further reading

Road-verge wandoo woodland.

Road-verge gimlet woodland.


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