Nature conservation in the Western Australian wheatbelt

Max Abensperg-Traun
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Growing concern about the survival of flora and fauna in the Western Australian wheatbelt prompted CSIRO scientists to start a long-term study to monitor trends in populations. Max Abensperg-Traun and his colleagues report on their findings so far.

Over the past 10 to 15 years various factors have led to increased community-based concern about the survival of native plants and animals in the wheatbelt. The most important factor has been habitat loss through clearing, and the decline in the quality of remaining woodlands and heathlands because of the effects of increasing soil salinity and livestock-grazing. In combination, these factors have resulted in the gradual disappearance of many native plant and animal species, birds and small mammals in particular.

In the mid-1980s, CSIRO's Division of Wildlife and Ecology began a long-term study to identify the factors that have helped to shape the current abundance and diversity (the numbers of species) of native plants and animals in Western Australia's central wheatbelt. This research continues and is centred on an area of 1680 square kilometres to the north of Kellerberrin (Figure 1). Based on our research in gimpet (Eucalyptus salubris) woodland remnants, we can report some of our findings on the effects of sheep-grazing on native plants and animals.

TOP: Most remnants of gimpet (Eucalyptus salubris) woodland in the central wheatbelt are small, isolated and highly degraded, supporting only a small number and diversity of most native plants and some animals.

Figure 1. Location of the study area near Kellerberrin in the central wheatbelt.
Plants

Grazing effects on native plants have been considerable, with the most intensively grazed remnants having lost over 85 per cent of their native plant species (Table). In several remnants, we found that gimlet is the only surviving native plant, while in other remnants some understorey species survive in very small numbers. Presumably these plants are more resistant to trampling, are unpalatable or are beyond the reach of sheep. Understorey species surviving include the spiny wattle (Acacia erinacea), ‘wait-a-while’ (Acacia colletiioides), a melaleuca (Melaleuca lateriflora), and a perennial herb, grey copper burr (Sclerolaena diacantha).

Moderate and high grazing intensity is also associated with much higher seasonal weed growth of barley grass (Hordeum leporinum), ryegrass (Lolium rigidum), capeweed (Arctotheca calendula), and the ice plant (Mesembryanthemum spp.). In relatively undisturbed remnants, an average of only 2 per cent of the soil surface is covered by weeds but in intensively grazed remnants the average weed cover is 70 per cent, with many remnants having more than 90 per cent weed cover. The tree canopy, plant litter and the cover of lichen also declined markedly at moderate and high grazing levels (Table).

Litter and lichen are important stabilisers of the soil surface, helping to reduce soil erosion and soil compaction. They enhance soil moisture retention and nutrient cycling (lichen are nitrogen fixers), and litter provides important feeding and shelter sites for many invertebrates.

Litter invertebrates, such as cockroaches, slaters and termites, are the staple diet of some small native mammals like echidnas and dunnarts, as well as many lizards and predaceous invertebrates such as scorpions, spiders and many beetles.

Intensively grazed sites have fewer and larger trees, which suggests a low survival of young seedlings. A decline of the tree canopy and shrub cover alters conditions such as temperature and humidity in the leaf litter to which particular organisms have adapted over long periods of time. Because biological activity is greatest at the soil surface level, changes in the microclimate can have a severe impact on plant and animal communities.

Birds

Birds are a major component of native vertebrates in our study area, and we recorded 37 species within the gimlet remnants. Birds are a good example that changes in environmental conditions brought

Sheep-grazing effects on plants in remnants of gimlet woodland (Eucalyptus salubris) across low, moderate and high grazing intensities based on faecal pellet counts (values are means across study sites)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sheep-grazing intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>low</td>
</tr>
<tr>
<td>Number of native plant species</td>
<td>24</td>
</tr>
<tr>
<td>% weed cover</td>
<td>21</td>
</tr>
<tr>
<td>% lichen crust cover</td>
<td>25</td>
</tr>
<tr>
<td>% shrub cover</td>
<td>10</td>
</tr>
<tr>
<td>% tree canopy cover</td>
<td>31</td>
</tr>
<tr>
<td>Litter cover</td>
<td>5.4</td>
</tr>
<tr>
<td>Number of live trees (all species)</td>
<td>141</td>
</tr>
<tr>
<td>Trunk diameter at breast height (cm) of live trees</td>
<td>61</td>
</tr>
</tbody>
</table>
about by livestock-activity in remnants may be bad for some species but good for others.

For example, birds that obtain a considerable proportion of their food from farmland could be expected to persist in intensively grazed woodlands largely lacking an understorey. Obvious examples are the galah, Port Lincoln parrot (colouquially known as the ‘28’), magpie lark, pied butcherbird, crested pigeon and willie wagtail which are more common at moderate and high grazing intensities (Figure 2). However, farmland species are not a conservation priority.

In contrast, species which depend on native vegetation, such as the broad-tailed thornbill, varied sitella, grey shrike-thrush and weebill, have become less common and less diverse with increasing levels of grazing intensity (Figures 2 and 3). Such species are of high conservation priority.

Ground-foraging, insect-eating bird species have declined from 40 per cent of the total bird community to 17 per cent in the Kellerberrin district. Many of the remaining species have modified their feeding behaviour by foraging in paddocks (Peter Cale, personal communication).

Figure 3. Relationships between sheep grazing intensity in gimlet woodlands and the diversity of native animals.

**Mammals**

We have not studied the native mammals in gimlet directly but can summarise our understanding of their ecology from studies carried out in other vegetation types (wandoo/salmon gum woodland, heath/shrubland) at Kellerberrin. Of the native mammals present at the time of agricultural development in the district, at least six species survive with varying degrees of success: the western grey kangaroo (*Macropus fuliginosus*), the small common dunnart (*Sminthopsis dolichura*)
and the fat-tailed dunnart (S. crassicaudata), and the echidna (Tachyglossus aculeatus) use gimlet woodlands. Of these, the grey kangaroo, echidna and fat-tailed dunnart appear to be largely unaffected by livestock-induced disturbance, being able to use farmland to varying degrees.

The ash-grey mouse (Pseudomys albocinereus) is largely restricted to heath/shrubland on sandy soils where livestock-effects are low. The euro, easily recognisable by the rusty reddish coat of the male, predominantly inhabits breakaway country such as granite outcrops carrying 'jam' (Acacia acuminata) woodland or tammar (Allocasuarina campestris) shrubland, but also uses farmland for feeding. The abundance and diversity of most of these native mammals in remnant woodlands is likely to be influenced by:

- predation by foxes and cats,
- road deaths,
- food availability, especially during drought, and
- the size and isolation of the vegetation remnant.

**Lizards**

We recorded 19 species in gimlet. Although lizards show an overall decline in their diversity under moderate and high grazing intensities (Figure 3), some species seem to be coping reasonably well. Notable examples include the omnivorous bobtail (Tiliqua rugosa) and species which do not have specific habitat requirements for survival, like the goannas

*TOP LEFT:* As is the case for most lizard species, the biology of Heteronotia binoei is not well known. However, the species was not found in any of the most degraded woodland remnants, and this suggests that high livestock grazing intensity may be an important factor influencing its current distribution.

*LEFT:* The echidna is the only medium-sized native mammal in the wheatbelt that has coped reasonably well with loss of habitat, decline in habitat quality, and predation by exotic predators, the fox and feral cat in particular.
(Varanus gouldii, for example) and the gecko Gehyra variegata.

Species living mostly on trees such as the gecko Oedura reticulata have survived in some of the most intensely-grazed remnants. However, this species was studied in detail by Stephen Sarre from the Australian National University Canberra, and his studies show that the species' survival is closely linked to the density of the smooth-barked gimlet trees.

Given the poor regeneration of eucalypts in remnant woodlands, and the progressive decline of tree density as old trees die, most populations of O. reticulata in small remnants are doomed. The survival of lizards is also influenced by the size of the remnants, particularly for the larger species (goannas, for example) which require larger areas for feeding.

Invertebrates (scorpions, termites, beetles, cockroaches, slaters)

We recorded a total of five scorpion and 28 termite species in the gimlet remnants, and both groups are less abundant and less diverse at moderate and high grazing intensities (Figure 2 and 3). For the scorpions, we speculate that repeated physical destruction by the trampling of their shelters, either their own burrows or those of other species, and the decline of plant litter which is an important feeding place, may have reduced their chances of survival.

Termites have declined more markedly than scorpions. This decline includes species that eat wood in varying stages of decay, as well as the grass and litter harvesters. An average of 15 termite species were found in ungrazed gimlet compared to as few as 6 species in intensively grazed remnants. Their abundance also declined by as much as 70 per cent.

Termites are important in the break-down of plant litter for nutrient cycling, and improving soil aeration by tunnelling. Both these factors enhance nutrient-cycling rates. The long-term effects of losing a large proportion of the soil fauna on native ecosystems is unknown, and recolonisation of small remnants from outside may be difficult because of the high degree of isolation of many remnant woodlands.

Beetles have benefited from livestock-grazing (Figure 2 and 3). We recorded more than 100 beetle species in the litter layer, and found a four-fold increase in beetle abundance and a two-fold increase in beetle diversity, in the most intensively grazed remnants. We believe this is a result of the increased nutritional quality of the plant foliage resulting from nutrient input from dung, urine and wind-blown fertilisers.

Nutrient-rich foliage causes higher growth rates of beetle larvae and increased reproductive output. This results in larger populations of leaf-eating and plant-sucking beetles which probably attract a larger number and diversity of predatory beetles. Paradoxically, woodland remnants where grazing has been most intense, are likely to support the greatest number of invertebrate species because the beetles are the largest component.

Cockroaches and slaters, decomposers and scavengers of the litter layer, provide an interesting contrast to the other invertebrate groups. They have benefited to some extent by the presence of sheep as their abundance has increased markedly at moderate levels of grazing-intensity (Figure 3). This is an unusual pattern with no apparent explanation, highlighting the variety of responses by native animals following the introduction of stock to woodland remnants.

Where to next?

Reducing grazing levels in remnant woodland is an important first step in addressing local (farm) and regional goals for the long-term survival of native species. But can we do more?

Is it possible to rehabilitate grazed woodland remnants so that they once again resemble their pre-disturbance condition? There are several reasons why natural regeneration alone, at least in the short to medium term, may not see the return of the understorey seen in ungrazed remnants, even where sheep are fenced out.

This is because prolonged livestock activity has created a hostile soil surface environment for seedling establishment. The important factors include soil compaction, reduced water infiltration and hence increased soil aridity, changes in soil surface temperatures and intense competition with weeds for light and moisture. Most native plants have evolved under low nutrient
conditions, and nutrient levels in small remnants may be toxic to some species. A study by CSIRO into the long-term effects of sheep exclusion from remnants on plant regeneration and native animals in the central wheatbelt has begun.

Our observations in the wheatbelt suggest that mature gimlet trees in small remnants often fail to flower and set seeds, further contributing to poor regeneration. This may be due to the poor health of the trees resulting from rising soil salinity and artificially high soil nutrient levels.

There is no evidence that pollinating insects, such as beetles and bees (European bees in the absence of native species), have become less common but we currently lack supporting evidence from the field. The frequency of below average annual rainfall years in the wheatbelt has increased since the mid-1960s. The drought of 1993 and 1994, for example, has been linked to the widespread death of large gimlet trees in the Kellerberrin region, in some instances affecting most trees within remnants of less than 1 ha. Although standing dead and fallen trees can support some native animals, the conservation value of such remnants has been seriously diminished.

The survival of the remnant woodlands depends on promoting natural regeneration. For natural regeneration to occur, the existing trees must set seed; this does not always happen. Unlike some plants such as 'jam' (Acacia acuminata), eucalypt seed does not survive in the soil.

Another possibility is that seeds might be able to reach the remnant from outside. But this is unlikely to occur because a high proportion of gimlet remnants, as well as those of other species such as salmon gum (E. salmonophloia), York gum (E. loxophleba) and wheatbelt wandoo (E. capillosa), may be too isolated from other woodland remnants.

Eucalypt seeds fall within the close proximity of the parent tree and are often eaten immediately by ants. We know that seed predation by ants is one factor among several contributing to low levels of regeneration by salmon gum in the central and eastern wheatbelt.

Interestingly, ants may increase successful seedling establishment by transporting seeds away from the plant for storage in their nests. This effectively reduces competition between the seedling and the parent tree for scarce resources, moisture in particular. But effective seed dispersal by ants probably occurs only for plants with seeds favoured by ants because they have a nutrient-rich appendage known as an elaiosome.

Elaiosomes are characteristic of many native shrubs including acacia, cassia, grevillea and hakea, but not eucalypts. Seeds from native shrubs may lie dormant and viable in the soil for years. Given a return to more favourable conditions (such as sheep exclusion coupled with weed control), shrub regeneration is more likely to occur than that of eucalypts. Most eucalypts also tend to regenerate more successfully after fire, yet fire has been all but excluded from remnant woodlands.

Replanting of existing eucalypt remnants, ensuring that as wide a diversity of local shrub and tree species are used, and subsequently protected from livestock, may be the only long-term option ensuring their persistence, and that of its native animals.

Further reading

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