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Finding Animals Amongst the Weeds: an Audit System

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Introduction

Numerous plants have been introduced into Australia, many of which have naturalised and emerged as pest plants – or *weeds*. In recent years, the negative impacts of weeds have been highlighted with threats to natural environments and primary production (Environment Australia, 1999: 7; Randall, 1996). Introduced plants compete with and displace native plants and animals and alter floristic and structural composition of vegetation (Edwards, 1998: 86; Humphries et al., 1991: 30). Weeds further affect food resources, nesting sites and refuge cover for native fauna (Brown et al., 1991: 150). In addition, vegetation clearance has occurred in conjunction with the proliferation of weeds to alter ecosystem functions (Humphries et al., 1991: 24; Walker and Smith, 1997; Williams and West, 2000: 429-30). Within this 'contemporary' ecology, however, the role of weeds is not always negative (Bass, 1999: 14; Date et al., 1991; Safford and Jones, 1998).

Research has demonstrated that various native animals interact with weeds in a variety of ways (see, for example, Loyn and French, 1991; Brown et al., 1991). For example, some animals utilise weeds as a food and breeding resource or as general habitat. However, knowledge of animal-weed relationships is limited and the findings have rarely been applied or incorporated into weed management practices. In addition, in management cases where such relationships have been recognised (for example, Turner, 2000) there exists no framework to resolve the resultant conundrums.

This paper addresses these deficiencies through documenting animal-weed interactions and introducing a mechanism – an animal-weed audit – whereby interactions between native animals and weeds can be recognised and accounted for in weed management. (For a comprehensive discussion and copies of the audit see Lawrie, 2000.) At the completion of the audit, 'managers' should be able to determine whether any animals are interacting with the target weed species, what these interactions are, and what management options exist.

Animal-weed interactions

Animals and weeds interact in diverse ways and for different reasons. Loyn and French (1991) and Brown et al. (1991) highlight a number of cases where animals have benefited from utilising weeds. Other studies also detail animal-weed interactions, however, in more indirect ways through research focused on different objectives. For example, seed dispersal research has predominately focused on the role of animals (dispersal agents) in weed ecology. However, the weeds' importance to the animals' ecology is often overlooked, yet may be of vital importance.

An important step in developing a system to manage animal-weed interactions is the documentation of known interactions. This section, therefore, presents a review of animal-weed interactions in Australia. Firstly, bird-weed relationships are examined, followed by a discussion of mammal-weed interactions. From this literature review, key animal-weed interactions are identified.

Role of weeds in the ecology of birds

A significant number of birds have been documented or observed utilising introduced plants in Australia. The interactions identified in this review are summarised in Table 1.

A total of 225 bird species (212 native and 13 introduced) were recorded as variously interacting with 482 weed species. By far the most common interaction was the utilisation of weeds as a food source – nearly 90% of the bird species recorded fed on at least one of the 468 weed species. In some cases weeds made up a significant proportion of birds' diets, such as the Central Western Red-Tailed Black Cockatoo (*Calyptorhynchus banksii samueli*) which feeds predominantly on Doublegee (*Emex australis*) (Mawson and Johnstone, 1997).

The next most common interaction after 'food source', in terms of numbers of bird species, was general habitat – a 'category' which includes all records of bird and weed relationships where no particular interaction was noted. Numerous

Table 1: Summary of bird-weed interactions

	Number of Birds Utilising Weeds			Number of Weed Species Utilised
	Native birds	Introduced birds	Total	
TOTAL	212	13	225	482
Interaction Type				
Habitat (non-specific)	41	4	45	10
Food source	185	13	198	468
Feeding substrate	9	-	9	2
Feeding under canopy	1	-	1	1
Nesting site	33	2	35	36
Perching site	17	-	17	4
Vocalising	10	-	10	2
Roosting	6	1	7	4
Predator protection	7	1	8	3
Corridor movement	3	-	3	1

birds (35) were also identified as nesting or breeding amongst weed species. Other relationships identified include birds perching, vocalising (singing) and roosting on/in weeds. It is clear from Table 1 that birds are utilising a significant number of weeds for a variety of purposes. To emphasise the importance of weed species to the ecology of birds the following elaborates on an example.

In northern New South Wales, subtropical and temperate rainforest originally covered an estimated 75,000 hectares. However, by 1900 the area referred to as the 'Big Scrub' was reduced to some 300 hectares (Biodiversity Unit, 1995: 8). Across this fragmented landscape, the introduced species Camphor Laurel (*Cinnamomum camphora*) serves important ecological functions (Date et al., 1991). Specifically, *C. camphora* has been identified as an important winter food source for the Topknot (*Lopholaimus aniarcticus*) (Ford, 1986: 61) and White-headed Pigeons (*Columba leucomela*), particularly across lower elevations where native fruits are scarce.

Cinnamomum camphora also enables the movement of a number of rainforest pigeons between fragments of the 'Big Scrub'. Patches of *C. camphora* act as 'stepping stones', providing *L. aniarcticus* and *C. leucomela* with an important food source and a perching and roosting resource between rainforest remnants (Date et al., 1991: 245). The significance of *C. camphora* to the ecology of rainforest pigeons is emphasised by Date et al., (1991: 245):

> "The importance of exotics to the short term survival of fruit pigeons in north eastern New South Wales should not be underestimated. Patches of *C. camphora* and other fruit bearing exotic species should be retained, until substantial links of native vegetation have been re-established."

Clearly, the corridor functions provided by *C. camphora* are significant with regards to the ecology of several rainforest pigeons. This example is just one of many that highlight the importance of weeds to the ecology and conservation of Australia's bird species. However, it is not only birds that are becoming increasingly reliant on weeds for survival. Recent studies have highlighted that several mammal species utilise weeds for a variety of important purposes.

Role of weeds in the ecology of mammals

Native vegetation clearance has had a devastating effect on Australia's mammal population (Short, 1998; Wilson and Friend, 1999; Morton, 1990). Many small mammals, such as Bandicoots and Bilbies, are under increasing threat and have been forced to seek alternative food and habitat sources following recent environmental changes (Kemper, 1990; Southgate, 1990). In conducting this review, a small but important group of mammals was identified as interacting with weeds, and this is summarised in Table 2.

Table 2: Summary of mammal-weed interactions

	Number of Mammals Utilising Weeds			Number of Weed Species Utilised
	Native Mammals	Introduced Mammals	Total	
TOTAL	38	5	43	55
Interaction Type				
Habitat (non-specific)	27	5	32	24
Food source	19	2	21	39
Corridor Movement	1	-	1	3
Shelter	4	1	5	5
Protection from predators	2	-	2	3
Nesting/breeding	2	-	2	3

In total, 43 mammals (38 native and 5 introduced) were recorded interacting with 55 weed species. The most common interaction involved weeds being utilised as general (non-specific) habitat – a category used here to document weed-mammal relationships such as the place where mammals live/sleep, raise their young or return to feed, and so forth. Food-resource interactions accounted for the highest number of weeds utilised. A total of 21 mammals were documented/observed as incorporating some 39 weed species in their diets. Other interactions relating to specific habitat qualities included mammals breeding and sheltering within weedy areas. Thus, it is apparent that a wide variety of mammals utilise weeds for a number of important purposes. These alternative resources may be significant to the persistence and conservation of many mammals across the current degraded and fragmented Australian landscapes. A good example of a small mammal's reliance on weeds involves the case of the Southern Brown Bandicoot (*Isoodon obesulus*).

That bandicoot has had its range severely reduced and is only known to occur in abundance in a few places on the Australian mainland (Rees and Paull, 2000: 539). Surveys in the Adelaide Hills, South Australia, have found *I. obesulus* within areas infested by Blackberry (*Rubus fruticosis*), Gorse (*Ulex europaeus*) and Montpellier Broom (*Genista monspessulana*) (Paull, 1993; Regel et al., 1996). These weeds provide dense undergrowth for resting and breeding purposes (Paull, 1993; 1995). In addition, predation on *I. obesulus,* particularly by the European Fox (*Vulpes vulpes*), has been negatively correlated with Blackberry presence/absence. Clearly, within these altered ecological systems weeds contribute to the short-term survival of *I. obesulus*, which has been decimated by habitat clearance and increased predation.

Key weed and animal interactions

The literature review presented above identifies and confirms that weeds are utilised by animals in diverse ways. Animals interact with introduced plants in a multiplicity of ways and for a variety of reasons. Some interactions are more significant than others, depending on the animal and the weed in question. It is outside the scope of this paper to develop a means of determining the significance of interactions in such diverse circumstances. This assessment needs to be done at a local scale with local knowledge. In making these assessments, however, it is important to know what interactions are occurring.

In undertaking this review, a number of animal-weed interactions were identified. These are:

- habitat (non-specific)
- food source
- feeding substrate
- feeding under canopy
- nesting/breeding
- shelter
- protection from predators
- roosting
- perching site
- vocalising
- basking
- corridor movement.

While it is likely that other relationships exist between animals and introduced plants, these 'key interactions' provide a basis for developing an audit system to account for animal-weed interactions.

Many of the key interactions summarised above can be observed in the field by looking for evidence that suggests an animal has interacted with a weed. The principal types of field evidence for identifying animal-weed interactions are summarised in Table 3.

Table 3: Principal field evidence of animals

Scats and regurgitated pellets	Depressions
Tracks	Flattened grass
Run-ins and paths	Diggings
Damaged fruit, seeds and foliage	Scratches, scrapings and rubbings
Nests	Fur
Shelters	Snake skins
Eggs (shells)	Bones
Burrows	

As animals move through, feed or breed in, and generally interact with their environments they leave these various traces. These signs can be 'read' or interpreted to identify the animal species. For example, from scats it is often possible to identify the animal as the size, shape, location, contents, smell and colouring of scats can be characteristic of particular species. Some evidence gives little indication of the animal's activities and just points to an animal's presence. Some forms of evidence, however, indicate specific activities or interactions.

The presence of animals and the relationships between plants and animals or weeds can also be directly observed. A number of types of behaviour such as perching, feeding (e.g., foraging, frugivory) and breeding (display, presence of juveniles in nests etc.) can all be viewed in the field. However, on finding evidence of animals interacting with weeds or on making direct observations, managers have rarely had a mechanism to record and assess this information, hence the need for an animal-weed audit.

An animal-weed audit

Recognising the range of interactions and interpreting the forms of evidence animals leave behind is an important first step towards acknowledging animal-weed relationships. Systematically recording such information has to date been difficult. As a consequence potentially important interactions have largely been overlooked. To overcome this problem I have developed a checklist or audit that managers can use to record animal-weed interactions.

The audit provides a systematic method or checklist for surveying weedy sites to identify and record interactions between animals and the target weed(s). The audit is divided into several sections, each focusing on either the target weed species and its biological characteristics or interaction signs managers are likely to find. Detailed instructions guide the user through the audit from the pre-fieldwork stage to the variety of weed management options available.

The audit contains several checklists that are basically data sheets to prompt managers to look in particular places or for other signs that may aid in identifying the animal. An example of a checklist involving looking for evidence of scats is shown in Table 4.

Table 4: Recording and identifying scats

	Animal Scat Type			
Location	*1*	*2*	*3*	*4*
Under weed				
On weed foliage				
Under tree/shrub				
On tree/shrub foliage				
Top of tussock				
Top of rock				
Top of a log				
On/near animal track				
Next to a digging				
Next to a run-in				
Next to shelter/nest				
Next to burrow				
Other				
Scat is from:				
Bird				
Mammal				
Reptile/Amph.				

This particular checklist encourages managers to look under, around and amongst the target weed for scats whilst also looking at the entrance to any burrows or run-ins. Other areas where scats are commonly deposited are also listed as 'prompts'. If managers are able to identify the animal from the scat they must then determine the animal's status – if the animal is endangered, vulnerable, common etc. This is important because an animal's status may influence any weed management activities.

There are a number of other checklists included in the audit, similar in layout to Table 4, that record other types of evidence of interactions such as tracks, run-ins, shelters and feeding signs.

The types of evidence that are accounted for in the audit will generally fall into two basic categories. These are signs of animal-weed interactions and signs of animals using the general environment. In some cases it is possible to piece together multiple signs from an animal to establish an interaction. The significance of these findings will vary considerably, as will the implications for weed management.

Weed removal options

Weed management should always be considered a long term and gradual process. Weed infestations should rarely be cleared entirely in one go or even over a couple of years. This is particularly the case if managers have identified animals interacting with the target weed. Even if managers follow up weed removal with revegetation programmes, there is a lag time before native plants provide similar ecological functions to the removed weeds. Thus, it is important to choose a weed management option that best suits individual situations. When deciding on weed removal strategies it is necessary to consider the spatial, temporal and structural components of the weed and the interacting animal(s): where and what area should weeds be removed from, when and how to remove weeds, and what to plant as replacements.

There are a number of alternative weed management methods. It is common belief that weed management activities predominantly involve killing and removing weeds off site. The 'best' approach will depend on the weed and animal characteristics and the nature of the infestation. The audit encompasses this philosophy by exploring the various options to help find which methods are best suited to certain situations.

To identify suitable weed control methods managers are asked to identify the types of interactions that occur with the target weed. The types of interactions identified can then be applied to a suitable management option. For example, if the interaction was a bird roosting in an Olive (*Olea europaea*) tree then an appropriate management option may be to control the weed through stem injection without removal, thus leaving the structural component of the tree intact. Another method may involve removal of the weed but into piles on site to provide some form of structural continuity for protection. Other options are also detailed in the audit. Methods of employing the various weed management strategies and their appropriateness for various situations are also presented through the audit.

After considering weed removal strategies, managers should have identified where, what area and how they are going to undertake weed removal. The audit then asks managers to consider with which native species it is appropriate to revegetate the site and when to undertake weed removal.

To determine what native species are appropriate, the audit prompts managers to identify what types of attributes the target weed provides (e.g. fruit, seed, palatable foliage, dense habit, etc.). They are also asked to identify the structural component (e.g. shrub, scrambler) of the target weed. The structure and the attributes of the weed can then be used to search for similar indigenous plant species. For example, a prickly shrub such as Gorse (*Ulex europaeus*) may be replaced with Kangaroo Thorn (*Acacia paradoxa*) which has similar attributes. Once suitable native species have been selected then the seasonal timing of weed management activities should also be determined.

The timing of weed management will have a significant impact on animal populations. It is necessary to identify a weed removal time that will minimise any adverse impact on interacting animals. To determine the appropriate time for weed control the audit prompts managers to work through a 'weed management calendar'. The calendar basically asks managers to establish the time frame in which the weed is being utilised and to block out these months on the calendar. By blocking out the months in which the weed provides food and breeding resources, managers are left with the best time for weed removal. The calendar provides a straightforward assessment of when its removal would have the least impact on animals that utilise the target weed.

The audit discusses in detail the spatial, temporal and structural components of weed management to provide a solid foundation for managers to make an informed decision. However, appropriate weed removal strategies will vary greatly depending on local circumstances. Thus, managers must adapt weed management activities based on local knowledge and experience to ensure the continued survival of animal populations with guidance from the audit.

Conclusion

This paper has highlighted the fact that the relationships between animals and plants are dynamic and intricate. The introduction of weeds creates further complexities. For weed management to be effective, it is essential that animal-weed relationships are given appropriate consideration. The audit, summarised in this paper, aims to account for such relationships by observing and systematically recording 'evidence' of animal-weed interactions. Only through undertaking such an approach can weed management be considered holistic – one that considers broader community processes to address the previously unrecognised impacts on native animals that stem from weed removal.

Weed management must not merely be assessed by the relative effectiveness of weed treatment methods, but also by the minimisation of off-target impacts and resultant habitat qualities. As this paper has highlighted, weeds, while having various negative impacts, often provide some ecological roles within contemporary landscapes. Moving from a weedy to a non-weedy environment should not be thought of as just a matter of removing the weed. Establishing the 'desired' vegetation does not necessarily correlate to restoration of suitable habitats. Removing weeds should be considered in many circumstances as removal of habitat, albeit one provided by undesirable plants. Weed management therefore needs to take precautionary, strategic and long-term approaches to make the transition to desirable states – 'non-weedy' environments.

The weed management strategy summarised in this paper provides a formative step in realising such goals. The audit, while pertaining to wider ideological changes, empowers managers to make weed management decisions on a local basis while accounting for contemporary ecological processes. This paper presents the field of weed management with a challenge to engage more actively with concepts of habitat. To think of introduced plants as only negative or at best benign components of landscapes leaves weed management vulnerable – potentially replicating the impacts that have ensued from native vegetation clearance.

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