Chapter 1. Introduction

1.1. Background

Agriculture has had an enormous impact on the world's ecosystems. Natural habitats on arable land have been reduced by more than 50% by clearing for cropping or permanent pasture (Green et al. 2005), and much of the remaining natural habitats have been altered by livestock grazing (Groombridge & Jenkins 2002). Habitat destruction and modification for agriculture is one of the greatest global threats to biodiversity (Foley et al. 2005), yet global food demand is projected to double by 2050 (Tilman et al. 2011). Rapid rates of clearing to establish new industrial agricultural practices are mostly confined to developing countries in tropical and subtropical regions (Vandermeer & Perfecto 2007), though in areas where the extent of agricultural expansion is relatively complete, biodiversity loss continues through agricultural intensification (Donald 2004) and the continuing impacts of habitat fragmentation (Fischer & Lindenmayer 2007; Krauss et al. 2010). Nonetheless, agricultural landscapes can also be crucial repositories of biodiversity (Perfecto et al. 2009). A challenge facing humanity is to understand how biodiversity is changed by agricultural practices (Vandermeer 2011), and how biodiversity conservation can be integrated into farming practices and agricultural landscapes (Harvey et al. 2008; Henle et al. 2008; Rands et al. 2010; Phalan et al. 2011).

This thesis presents research into patterns of plant diversity in one agricultural region in eastern Australia—the North-West Slopes of New South Wales (NSW). This chapter introduces the concepts of biodiversity and its conservation, reviews current ecological knowledge of biodiversity patterns in agricultural landscapes—including the wheat–sheep zone of eastern Australia—and identifies knowledge gaps to be addressed by this

research. The chapter concludes with a statement of thesis objectives and an outline of thesis structure.

1.2. Biodiversity

1.2.1. Definition

The term 'biodiversity' has been used to describe many aspects of the living world (Mace 2005), and can mean many things to different people. The term is a contraction of 'biological diversity', and first came into use around 25 years ago (Wilson & Peter 1988). Biodiversity has been defined many times, and has been regarded variously as a concept, a measurable entity, and as a social or political construct (Gatson 1996). It is necessary to be specific about the definition when using the term in a scientific context (Lovejoy 1997). The most prevalent use of the term defines it as the variety of life in all its forms and at all levels of organisation (Hunter & Gibbs 2007). Biodiversity is often considered at three levels: genetic diversity (the genetic information of all species), species diversity (the variety of species on Earth) and ecosystem diversity (the variety of habitats, biotic communities and ecological processes). Biodiversity as a field of study, however, can represent an area of interest—the 'scientific study of the patterns in, and the determinants and consequences of, the variety of life' (Gatson 1998).

1.2.2. Why conserve biodiversity?

The importance of biodiversity to people varies greatly. The case for conserving it ranges from ethical and philosophical viewpoints to strict utilitarianism (New 2006). There are widespread views that humans have a moral and ethical responsibility of stewardship towards the variety of life, to opposing the extinction of species, and to supporting conservation efforts (Callicot 1986), though these arguments cannot be defended on scientific grounds. Other popular arguments for biodiversity conservation

include aesthetic values, or the usefulness of biodiversity for food, medicines and industrial products, including uses not yet discovered (Kunin & Lawton 1996; Díaz et al. 2006).

An additional argument for biodiversity conservation relates to the ecological roles that species play in the world. Humanity relies on other organisms to photosynthesise, form soils, pump water, fix nutrients, transform gases and regulate climate (Ehrlich & Ehrlich 1992). Species also impact on each other through competition, mutualisms and trophic interactions. There is increasing evidence that changes to biodiversity alter ecosystem processes and resilience, and have profound consequences for the services derived from ecosystems (Tilman 1999; Naeem 2002). Nevertheless, our knowledge of the impact of biodiversity loss is incomplete, and conserving biodiversity preserves options for solutions to future environmental problems (Chapin et al. 2000). The urgency of the need to conserve biodiversity is heightened by the concept of extinction debts—a condition in which populations persist in habitats following environmental change, sometimes for an extended period, prior to their extinction (Kuussaari et al. 2009; Krauss et al. 2010). In such cases, current occupancy of habitats overestimates carrying capacity and underestimates species loss due to past environmental change (Hanski & Ovaskainen 2002).

Despite the variety of justifications for conserving biodiversity (or because of it), 150 countries signed the Convention on Biological Diversity (UNCBD 1992), a treaty that pledges to conserve biodiversity, to use it sustainably, and to promote fair and equitable sharing of its benefits. Similarly, *Australia's biodiversity conservation strategy 2010–2030* (Commonwealth of Australia 2010a) details the commitment of the federal and all state and territory governments of Australia to the conservation of biological diversity.

1.2.3. Plant diversity and conservation

At the heart of many biodiversity conservation issues—and the focus of this thesis—is plant diversity and conservation. Plants are fundamental components of many of the Earth's ecosystems, providing physical structures and resources for many other organisms. At any location, plants and vegetation influence local microclimate, hydrology, soil erosion and the types of animals that exist (Hamilton & Hamilton 2006). The loss of plant species inevitably results in the loss of other species. Many of the world's charismatic animals are endangered by habitat loss and degradation, and efforts to save them are exercises in plant conservation (Dietz et al. 1994).

Research has most commonly focussed on plant *species* diversity, though there is increasing evidence of the importance of genetic diversity within plant populations (Wimp et al. 2004). This thesis considers plant species diversity predominantly from a plant conservation perspective. Such a perspective recognises the cultural, aesthetic and intrinsic values of Australia's flora, the potential role of plant diversity in ecosystem functioning and other ecological interactions, as well as the policy of all Australian governments to conserve biodiversity (Commonwealth of Australia 2010).

1.2.4. Australia's biological diversity

The flora of Australia is diverse and unique. Australia is one of 12 megadiverse countries that together harbour up to 70% of the world's species (McNeely et al. 1990). Australia has a particularly high level of endemic species—including around 85% of its approximately 20 000 vascular plant species (Hnatiuk 1990)—which is related to the continent's long evolutionary history of isolation subsequent to its separation from Antarctica beginning in the late Cretaceous (Frakes 1999; Murthy et al. 2011). Increasing aridity since the mid Tertiary resulted in the development of many

sclerophyllous (hard-leaved) species (Attiwill & Wilson 2003) and the evolution of diverse taxa such as the eucalypts (~800 species, Wilson 2003) and acacias (~970 species). The uniqueness of Australia's biodiversity is of global interest and significance.

1.3. Biodiversity patterns in agricultural landscapes

Pre-existing biodiversity is threatened in agricultural landscapes when natural ecosystems are subject to destruction, modification and fragmentation (Foley et al. 2005). The study of biodiversity in agricultural landscapes has presented new challenges for ecologists. A common ecological approach to studying agricultural landscapes has been to adopt landscape models that are conceptual summaries of how species are distributed through space. Most landscape models are based on ecological processes that influence species distribution patterns (Fischer 2004). This section summarises the landscape models commonly used by ecologists to conceptualise and study biodiversity patterns in agricultural landscapes.

1.3.1. Fragmentation models

The modification of landscapes for agriculture results in habitat loss (the reduction of the proportion of a landscape that is composed of habitat, Ewers & Didham 2006) and habitat fragmentation (the division of habitat into smaller, more isolated patches, Lindenmayer & Fischer 2006). The two processes are related, though their distinction is important—their effect on populations can vary in magnitude (Smith et al. 2009), and fragmentation changes the properties of the remaining habitat (Fahrig 2003). Habitat is a species-specific concept. What constitutes habitat loss for one species may not be for another. In this sense, equating habitat loss to the loss of native vegetation can be misleading (Fischer & Lindenmayer 2007). Nevertheless, many species in agricultural

landscapes are restricted to remnant native vegetation patches, and fragmentation has frequently been modelled in terms of remnant vegetation patches (Debinski & Holt 2000). The effects of habitat loss and fragmentation on pre-existing populations and ecosystems have become a prominent research focus in ecology.

The analogy of remnant vegetation in agricultural landscapes to islands in the ocean led to the adoption of Island Biogeography Theory (IBT, MacArthur & Wilson 1967) as the first theoretical framework to explain biodiversity patterns in fragmented landscapes. When applied to fragmented landscapes, IBT proposes that species richness in patches tends towards an equilibrium representing the rate of colonisation of new species from other patches, and the rate of local extinction within the patch (Figure 1.1). Extinction rate is determined largely by patch size, and colonisation rate is determined largely by the proximity of the patch to other patches. Hence, species richness increases with island size and decreases with degree of isolation. IBT is the most widely used model for conceptualising fragmented landscapes (Haila 2002), and is commonly advocated for the design of reserve networks (Diamond 1975; Cabeza & van Teeffelen 2001; Sax & Gaines 2011).

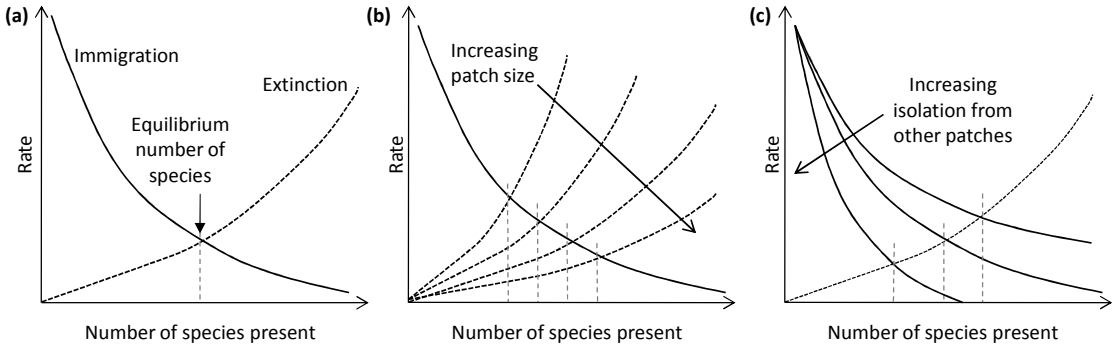

Figure 1.1 The equilibrium theory of island biogeography: (a) the number of species present on an island represents equilibrium between the rate of immigration of new species on to the island and the rate of extinction of previously established species. The equilibrium number of species is predicted to (b) increase with increasing island size, as the rate of extinction decreases, and (c) decrease with increasing isolation from other islands, as the rate of immigration decreases (modified from MacArthur & Wilson 1967; Vandermeer 2011).

The second classical paradigm used to study fragmented landscapes is Metapopulation Theory (MT), conceived by Levins (1969) and elaborated by others (Hanski & Gilpin 1991; McCullough 1996; Hanski & Simberloff 1997). MT is closely related to IBT, as it envisages the same processes of colonisation and extinction at work (Hanski 1991). MT conceptualises the dispersal and recolonisation interactions among subpopulations, and the persistence of the aggregate of subpopulations (i.e. the metapopulation). MT applies only to those species that demonstrate (1) subdivision into many local populations, (2) limited and random dispersal, and (3) relatively frequent local extinction. As this applies to many species whose ranges have been fragmented by human alteration, MT has been applied to many conservation problems in fragmented landscapes (McCullough 1996).

Forman's (1995) Patch–Matrix–Corridor Model was a modification of IBT for terrestrial environments that included corridors, in addition to remnant vegetation patches and the agricultural matrix, in its classification of landscape elements. This

model recognised that landscapes that retain corridors of habitat connecting remnant vegetation patches are more likely to retain species due to greater connectivity and recolonisation between patches.

1.3.2. Incorporating the matrix into agricultural landscape models

In reality, the agricultural matrix—the land surrounding isolated remnants of native vegetation—is not always analogous to an ocean, as assumed in IBT and MT (Haila 2002). The agricultural matrix is rarely hostile to all species. The matrix in many agricultural landscapes can be rich in biodiversity and can influence diversity patterns and the persistence of populations (Perfecto & Vandermeer 2002; Ries et al. 2004; Hendrickx et al. 2007; Franklin & Lindenmayer 2009).

To overcome the limitations of the binary classification of habitat and non-habitat of IBT and MT, McIntyre & Hobbs (1999) proposed an alternative model for conceptualising human-modified landscapes. Their Variegation Model recognises that landscapes can vary in their extent of modification, and defines a continuum of modification states that includes variegated landscapes as an intermediate state between intact and fragmented landscapes. In variegated landscapes, the original habitat is variously modified rather than largely destroyed. They highlighted many regions that fit this description. This approach considers the degree of habitat modification of different parts of the landscape and the extent to which different species are precluded from variously modified habitat states. The variegation model has proved useful for classifying and describing agricultural landscapes, and for overcoming the pitfalls of applying other fragmentation models to these landscapes.

Fischer et al. (2004) conceptualised landscapes as overlaid species-specific habitat contour maps. Their model acknowledges that different species respond differently to

the same environmental variables, and hence habitat suitability is modelled in relation to environmental gradients rather than human-defined patches and patch boundaries. While this model is more complex and unlikely to be directly applied to landscapes for large numbers of species, it is useful for conceptualising the complexity of habitat suitability, particularly in variegated landscapes, where variously modified habitat may extend the effective size of habitat for some species.

The Mosaic Concept, proposed by Duelli (1997), is a landscape model designed specifically for studying biodiversity in agricultural landscapes. The model again uses human-defined habitat types, but views agricultural landscapes as a mosaic of discrete land use types that result from human modification of natural habitat. This model assumes that patches of the same land use type generally have relatively homogeneous living conditions for plant species resulting from previous human land use decisions and interaction of these with the physical environment (Lunt & Spooner 2005; Simmering et al. 2006). According to Duelli (1997), biodiversity in an agricultural landscape is most determined by habitat variability (the number of land use types per unit area), habitat heterogeneity (structural and compositional variability within habitats) and the proportions of each land use type in the landscape. This model is useful for determining how landscape diversity is generated by the various land use types in agricultural landscapes.

While studies based on the above models have often superseded studies based on fragmentation models, the relevance and importance of fragmentation models for particular groups of species are still largely unknown. To evaluate the relevance of fragmentation models we need to know, firstly, how fragmented species are in the

landscape, and secondly, do populations in fragments act as metapopulations via colonisations and extinctions?

1.4. Effect of agricultural intensity on biodiversity

One of the key questions concerning the role of the matrix in conserving landscape biodiversity is: what effect does agricultural intensity have on biodiversity (Vandermeer 2011)? Two hypotheses describe the extremes of possible relationships between biodiversity and agricultural intensity (Figure 1.2). The first assumes that biodiversity follows a negative exponential trend with intensification, so that even agriculture at low intensity results in dramatic decreases in biodiversity. The alternative hypothesis states that biodiversity is relatively tolerant to low or moderate agricultural intensities, and only declines markedly under high agricultural intensity. The nature of this relationship has not been determined for most agricultural landscapes (Vandermeer 2011), or for most taxa, though greater understanding could improve our ability to manage landscapes for conservation.

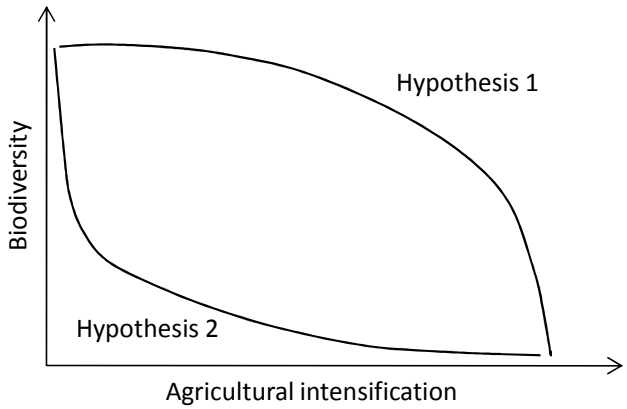

Figure 1.2 Two hypotheses about the relationship between agricultural management intensity and biodiversity (adapted from Green et al. 2005).

The biodiversity–intensity relationship assumes that agricultural yield is directly related to intensity. This is not always the case, and the *x*-axis of the biodiversity–intensity

relationship could also be conceptualised as yield, farm profit, or any value that is in conflict with biodiversity. Similarly, the measure of biodiversity used on the *y*-axis requires careful consideration. As many potential farming systems could apply in a given region, each with complex relationships to biodiversity, the reality of the biodiversity–intensity relationship is inevitably more complex than represented by Figure 1.2. This relationship has value in that it prompts us to consider the sensitivity of different species in the landscape to agriculture. However, the relationship could also form the basis of empirical evaluations, in which the biodiversity measures being investigated are clearly defined, and observed over a particular gradient of agricultural intensities, as has been done by Flohre et al. (2011).

The nature of the biodiversity–intensification relationship in different agricultural regions has often been used to provide support for one of two proposed conservation strategies for human-dominated landscapes (Balmford et al. 2003; Green et al. 2005; Fischer et al. 2008): (1) land sparing, in which increased intensification and yields on parts of the farm can free up land for conservation management on other parts of the farm, and (2) wildlife-friendly farming, which involves extensive, but lower intensity production that incorporates biodiversity conservation within the farming system. Generally, wildlife-friendly farming is thought to be the more appropriate biodiversity conservation strategy where Hypothesis 1 (Figure 1.2.) is true, while land sparing is more appropriate where Hypothesis 2 is true. However, many authors have argued that while land sparing may be a potential means of conservation, it is unlikely in reality. Matson & Vitousek (2006) suggested that intensification begets extensive land use, and successful intensive land use provides the economic incentive for more intensive farming, rather than maintaining total landscape yields and sparing land for

conservation. They also argue that the many effects of intensive farming on vegetation and wildlife beyond farming areas are not taken into account in most evaluations.

Perfecto & Vandermeer (2010) have argued that the land sparing vs. wildlife-friendly farming debate is neither useful for optimising production outcomes or successfully conserving biodiversity. They argue that current conventional agriculture involves much overconsumption and waste. On a caloric, per capita basis, global food demands require less intensification than many estimates suggest, and addressing socioeconomic inequities will improve options for wildlife-friendly farming and on-farm biodiversity conservation (Vandermeer & Perfecto 2007).

1.5. The wheat–sheep zone of eastern Australia

The study region for this research into plant diversity in agricultural landscapes—the North-West Slopes of NSW—forms part of the wheat–sheep zone of eastern Australia (Figure 1.3a). The extent of this zone coincides with Australia's woodlands and open woodlands (Figure 1.3b), which are characterised by extensive tree clearing and landscape modification, livestock grazing and fertilisation. Research on the effects of these processes is substantial (McIntyre & Lavorel 1994a; Prober & Thiele 1995; Yates & Hobbs 1997a; Kirkpatrick 1999; McIntyre et al. 2002; Landsberg et al. 2003; Dorrough & Ash 2004; Lunt & Spooner 2005; Dorrough et al. 2007), though due to their complexity, many of the effects of land use are still poorly understood. One impediment to the ecological understanding of these systems is that the findings in one region of the wheat–sheep zone do not always translate to other regions due to the complex interactions between climate, productivity, the degree of landscape modification, and other agricultural management practices, both past and present (McIntyre & Martin 2001; McIntyre et al. 2003; Lunt & Spooner 2005; Dorrough et al.

2006). Consensus on the influences of agricultural management practices will require recognition and understanding of these differences. Despite the differences between agricultural regions, our understanding of ecosystem dynamics in any particular region of the wheat–sheep zone is largely based on research conducted in other parts of the zone. With this in mind, this section briefly reviews the impacts of agriculture on grassy ecosystems in the wheat–sheep zone, with particular reference to the effects on plant diversity.

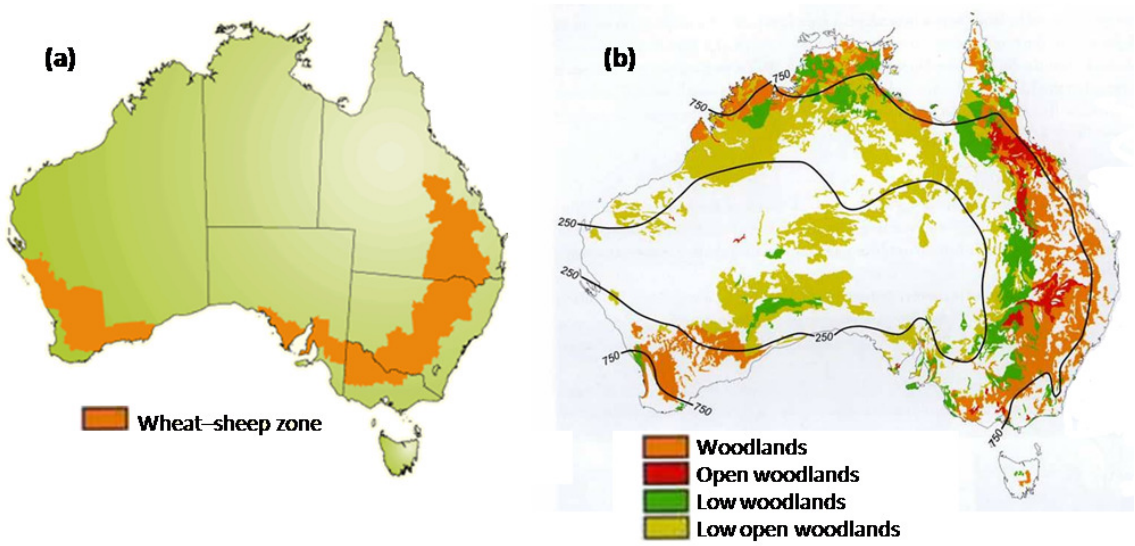

Figure 1.3 (a) Wheat–sheep zone of eastern Australia and south-west Western Australia (ARNA 2007); (b) woodlands of Australia, showing the 250 mm and 750 mm annual rainfall isohyets. Source: Lindenmayer et al. (2005), redrawn from Johnson (2003).

1.5.1. Management history

The Australian continent has a long history of management by indigenous Australians. The time of arrival of the first humans on the continent was around 50 000 years ago (Summerhayes et al. 2010; Rasmussen et al. 2011). There is evidence that many Australian landscapes are the ecological outcomes of management activities of the Aboriginal people (Kohen 1995). The history and role of fire in Australia long pre-dates the arrival of Aboriginal people, but Aboriginal burning regimes have been argued to

have strongly influenced – and possibly determined – the composition of vegetation in eastern Australia (Bowman 1998; Gammage 2011a, b).

Despite this long history of management, it was the introduction of agricultural practices by Europeans from 1788 that brought about extensive and rapid ecological changes in south-eastern Australia. The dispossession of Aboriginal people from their lands by Europeans, and the associated suppression of Aboriginal burning regimes, had a large influence on the distribution and structure of some vegetation types, and possibly the intensity of fires (Bowman 1998; Bowman & Davies 2003).

Following European occupation, grassy woodlands and grasslands quickly became an important pastoral resource (Yates & Hobbs 1997b). The introduction of livestock had an enourmous impact on the groundstorey vegetation of the wheat–sheep belt (Yates & Hobbs 1997a). Australian ecosystems have not evolved with hard-hooved ungulate herbivores (Mack & Thompson 1982), and the introduction of cattle and sheep had a major impact on soils, resulting in loss of biological soil crusts, reduced soil water infiltration rates and increased soil surface erosion, resulting in a loss of ecosystem function (Noble & Tongway 1983; Wilson 1990; Yates & Hobbs 1997a; Kirkpatrick 1999; Prober et al. 2002; Gale & Haworth 2005). In addition to the influence of ungulate hooves, changes in total grazing pressure, herbivore densities and the differing foraging behaviour of sheep and cattle compared to native herbivores have influenced understorey composition. In the wheat–sheep zone, livestock grazing is believed to have caused the decline or local extinction of many grazing-sensitive native plants (Lunt et al. 2007a). Other changes associated with livestock grazing in these systems include a decline in the diversity of native forb species (Trémont & McIntyre 1994), a shift toward cool-season growth (Moore 1970), and an increasing dominance of annual

plants (Pettit et al. 1995; Prober & Thiele 1995). The absence of soil seed banks of native forbs makes many of these changes irreversible in the absence of human-mediated restoration measures (Lunt 1997; Morgan 1998a).

In addition to the effects of changed grazing regimes, clearing and fragmentation have also had a large influence on native vegetation. In what is now the wheat–sheep zone, tree thinning by felling and ringbarking to increase productivity in the grassy layer was extensive (McDougall & Kirkpatrick 1994). Denser eucalypt woodlands with shrubby understoreys were less productive, and hence were less extensively cleared (Johnson 2003). Clearing was primarily focussed on the woodlands dominated by box eucalypts, which previously covered over 10 million ha across south-eastern Australia (Beadle 1981). Over 90% of these woodlands have been cleared, and are now largely restricted to remnants of varying size, quality and isolation (McIntyre 1994; McIntyre & Lavorel 1994b; Prober & Thiele 1995).

The extent of landscape modification varies across the wheat–sheep zone, from variegated landscapes to highly fragmented landscapes, depending on the predominant agricultural land uses. Fragmentation of these communities has led to reduced species diversity through insularisation and altered ecosystem processes (see Yates & Hobbs 1997a for a review of the past and continuing impacts of fragmentation on eucalypt woodlands). The vegetation of the cleared areas varies from completely transformed crops to derived native grasslands and savannas dominated by native grasses and in which many native plant species survive. In some regions, commercially grazed pastures contain a high richness of native species, including rare species (Gilfedder & Kirkpatrick 1994; McIntyre & Lavorel 1994b; Chilcott et al. 1997).

The use of fertiliser in native vegetation is also associated with the transformation of the wheat–sheep zone (Dorrough et al. 2006). Many native species have coevolved with nutrient-poor soils (Beadle 1954). Losses of endangered plants and declines in species richness have been linked to increases in phosphorus (P) and nitrogen (N). In some areas, fertiliser application rates have increased over time in response to agricultural intensification and declining productivity of soils (Passioura 2002). These nutrients can accumulate in native vegetation and be transported across the landscape by livestock (Taylor & Hedges 1984; Taylor et al. 1987; Duncan et al. 2008) and by wind and erosion (Leys & McTainsh 1994; Morgan 1998b). In many cases, the relative influence of the confounded impacts of clearing, grazing and fertiliser on native vegetation have not been disentangled (but see Dorrough et al. 2006).

Another major continuing threat to plant diversity in the wheat–sheep zone is invasions of exotic species, in particular exotic grasses and herbs (McIntyre & Lavorel 1994b). Small vegetation remnants in agricultural landscapes are particularly susceptible to invasions due to high exposure to invasive propagules (Adair 1995) and a high edge-to-area ratio (Panetta & Hopkins 1991). Exotic species abundance has been shown to increase with grazing intensity (Pettit et al. 1995; Dorrough et al. 2007), soil disturbance (McIntyre & Lavorel 1994b) and nutrient enrichment (Morgan 1998b; Allcock 2002), and invasions are generally associated with declines in native species richness (Yates & Hobbs 1997a; Clarke 2003).

1.5.2. North-West Slopes of NSW

The vegetation of the North-West Slopes of NSW (the study region) is reviewed in detail in Chapter 2, including a comparison of several features such as the climate and extent of landscape modification with other regions in the wheat–sheep zone.

1.6. Thesis objectives and aims

The main objective of this research was to examine patterns of species distribution across farms grazing sheep and cattle in the study region, and to determine the value of various land uses in agricultural landscapes to plant diversity conservation. Traditionally, ecologists and conservation biologists have focussed on the distribution and abundance of different taxa in remnants of intact or semi-natural native vegetation in agricultural landscapes, with fewer studies addressing the role of anthropogenic land uses, such as pastures, in contributing to landscape diversity (Bennett et al. 2006). This research addresses this knowledge gap, with a particular focus on the plant diversity of derived native pastures grazed for livestock production. In doing so, I test the nature of the biodiversity – agricultural intensification relationship—that is, what is the relationship of plant diversity to agricultural intensity in the region? Specific aims were to: (1) document the diversity, phenology and ecology of native perennial pastures, (2) investigate the biophysical and management determinants of vegetation composition in the study region, (3) provide plant conservation recommendations for the North-West Slopes of NSW, and (4) evaluate the likely economic impact on farmers of implementing different plant conservation strategies. Such research is essential if effective conservation measures and policies are to be developed and implemented in agricultural landscapes.

1.7. Thesis structure

This thesis consists of five research papers (Chapters 2–6) addressing plant diversity in the study region, plus a synthesis chapter (Chapter 7) summarising the findings and recommendations. The following paragraphs introduce each of the chapters, and explain how the sequence of chapters, and the research questions they address, are designed to

build on the knowledge of plant diversity and its conservation in agricultural landscapes. Each research paper will be submitted for publication in the scientific literature, and hence has been written as a stand-alone contribution. However, some introductory material common to two or more papers has been removed to avoid excessive repetition. References to other chapters in the thesis are cited by chapter number.

Chapter 2 describes the North-West Slopes of NSW, and analyses a database of existing vegetation survey data to characterise the native vegetation of the region. This chapter includes an analysis of the occurrence, frequency and conservation status of understorey plant species in the region, and the patterns in native vegetation composition that are relevant to farmland plant diversity. It highlights some important conservation challenges, and sets the scene for the subsequent research.

Chapter 3 addresses botanical and ecological knowledge gaps regarding plant diversity in native pastures. The study documents the seasonal variation in species composition of native pastures in the region, as well as the short-term (2.5-year) response of native pasture to the exclusion of grazing by livestock. The results of this study are pivotal to the design, data collection and interpretation of the subsequent studies in the project, and also provide useful reference material for the design and interpretation of future research into plant diversity in both native pastures and agricultural landscapes.

Chapter 4 is a case study of a single farm and some of the land immediately adjacent to it in the surrounding agricultural landscape. It reports the vegetation composition of the different land uses. Two landscape ecological models are applied to evaluate how landscape diversity is generated across the various land uses, at different spatial scales.

This chapter demonstrates the importance of spatial scale to the evaluation of conservation value of native pastures at the farm scale.

In Chapter 5, the scale of the analysis broadens from the farm to the region. Vegetation was surveyed and biophysical and management data were compiled to determine the key determinants of vegetation composition for on-farm vegetation. Sample-based rarefaction curves and habitat specificity indices were used to determine the landscape and regional-scale effects of agricultural land uses on landscape plant diversity.

Chapter 6 uses a scenario and model farm approach to determine the likely opportunity costs of implementing plant conservation management on farms grazed by sheep in the region. The scenarios are based on landscape ecology and woodland restoration principles, and the conservation management recommendations from Chapter 5.

Chapter 7 synthesises the findings of Chapters 2–6, details conclusions regarding plant diversity patterns in the study region, and summarises the management recommendations arising from these studies.

STATEMENT OF AUTHORS' CONTRIBUTION

We, the PhD candidate and the candidate's Principal Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated in the *Statement of Originality*.

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Type of work	**Page number/s**
Text	19–44
Tables and figures	22–40

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Type of work	Page number/s
Text	47–70
Tables and figures	52–64

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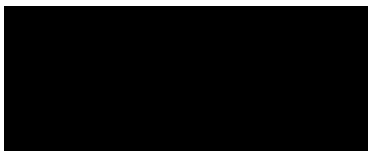

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Text	73–96
Tables and figures	77–90

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However, many native grass and herb species are restricted to the now limited extent of woodlands not grazed by livestock. These habitats make a high contribution to regional plant diversity.

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Text	99–133
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STATEMENT OF AUTHORS' CONTRIBUTION

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Chapter 7. Synthesis and conclusions

7.1. Introduction

Biodiversity is under threat in the world's agricultural landscapes due to the modification and destruction of natural habitat, and the continuing impacts of habitat fragmentation (Tilman et al. 2001; Foley et al. 2005). Globally, there are increasing calls by conservationists to integrate biodiversity conservation and production systems (Harvey et al. 2008; Perfecto & Vandermeer 2008). However, the gap in understanding of ecological interactions and diversity patterns in agricultural landscapes must first be addressed (Vandermeer 2011). This study addressed this knowledge gap for the North-West Slopes of NSW by determining the plant conservation value of vegetation on sheep farms grazed by both sheep and cattle. In particular, the study aimed to: (1) provide new information on the diversity, phenology and ecology of native perennial pastures; (2) investigate the biophysical and management determinants of grassy vegetation composition in the region; (3) provide region-specific plant conservation recommendations, and (4) evaluate the likely economic impact of implementing different plant conservation strategies.

This chapter summarises and explores the implications of the research findings presented in this thesis. The objectives are to: (1) synthesise the main findings of the research; (2) highlight the major theoretical advances of the work; (3) summarise the main management recommendations, and (4) highlight and discuss future research implications.

7.2. Summary of main findings

In Chapter 2, a large dataset of existing vegetation surveys was analysed. This highlighted some key conservation issues in the study region. Canonical Correspondence Analysis (CCA) revealed that native vegetation composition in the study region was controlled by two major gradients: a climate gradient and a slope – soil depth gradient. Furthermore, the study demonstrated that the location of the region's conservation reserves was predominantly in hilly terrain at higher altitude, with few reserves in gently sloping areas at lower elevation. Hence, as farmland occupies the majority of low sloping, fertile land, plant conservation in the region will require either widespread uptake of on-farm conservation initiatives, or for a large number of farms to be bought and added to the reserve system. To allow for the conservation of plant diversity at the regional scale, agricultural lands must successfully integrate biodiversity conservation, or a suite of reserves will be needed in areas of low relief. These findings provided context and direction for studies of groundstorey plant conservation reported in subsequent chapters.

In Chapter 3, vegetation composition in paired grazed and ungrazed plots was monitored in native pastures over 2.5 years, in which time composition varied greatly with season and interannual rainfall. Spring surveys in non-drought years recorded the highest number of species at each site, but even the periods of maximum species density (SD) revealed only 60–72% of the species recorded at each site over the 2.5 years. Nevertheless, compositional differences were much greater among sites than seasons—that is, seasonal and interannual variability was not as influential in determining composition as the factors that determine spatial differences (such as biophysical variability and management). Exclusion of livestock grazing did not influence

composition over 2.5 years, but within-site species turnover should be considered when using one-off vegetation survey data to address research questions in plant ecology and conservation.

In Chapter 4, the mosaic concept (Duelli 1997) was applied to a single case study farm to observe how different land uses contributed to landscape plant diversity. Additive partitioning was used to observe how landscape richness was partitioned across four spatial scales (quadrat, patch, land use and landscape) for five land uses in the landscape (grazed and ungrazed woodlands, native pastures, roadsides and sown crops). Grazed and ungrazed woodlands had similar species richness to native pastures at the quadrat and patch scale, but both had greater dissimilarity between patches than pastures. Hence, woodlands were more species rich at the landscape scale. A habitat specificity measure (gamma diversity contribution, GDC) was employed to identify patches contributing high numbers of infrequent species to landscape diversity. GDC was significantly greater for ungrazed woodland patches than all other land uses, showing that these sites contributed a higher effective number of species to landscape diversity. Native pastures, sown forage crops and grazed woodlands made low contributions to landscape diversity, suggesting that synergies were unlikely to exist between pastoral practices and plant diversity conservation in this region. The study showed that those parts of the farm that were not grazed by livestock were important for understorey plant diversity at the landscape scale.

In Chapter 5, 127 sites were surveyed across four land use categories—previously cultivated native pastures, never-cultivated native pastures, grazed woodlands and ungrazed woodlands—to test the influence of land management and biophysical variables on vegetation. Livestock grazing, fertiliser application and tree cover were not

well correlated with total species densities (i.e. total species richness per unit area), but were correlated with native and exotic species densities. CCA showed that vegetation composition was strongly correlated with agricultural intensity (covarying gradients of decreasing tree cover and time-since-cultivation, and increasing amount and duration of fertiliser use and grazing intensity). Climate was secondary to agricultural intensity in explaining farmland plant composition. This contrasted with the native vegetation surveys analysed in Chapter 2, where climate best explained compositional patterns.

The rates of species accumulation across woodlands and pastures observed at the landscape scale in Chapter 4 were accentuated at the regional scale in Chapter 5. Regional species rarefaction curves showed that ungrazed woodlands accumulated the most species across the region, and native pastures accumulated the least, reflecting a high degree of compositional homogeneity in native pastures. The contribution of sites to regional diversity was negatively correlated with land use intensity: mean GDC was significantly higher in ungrazed woodlands than in other land uses. This suggested that both grazing and clearing may be influential in the homogenisation of pasture composition. Overall, this study showed that pastoral management had a consistent influence on vegetation composition that was not conducive to the conservation of a large proportion of native vascular plant species in the region. Native pastures with no cultivation history were comprised of a larger proportion of the regional native species than pastures that had been previously cultivated, and unfertilised pastures showed greater floristic affinity with the woodland understorey vegetation. For the suite of species that persist in them, native pastures provide extensive habitat that ensures large, viable populations that are well connected in the landscape. Nevertheless, woodland

vegetation that was not grazed by livestock made the largest contribution to regional plant diversity, despite its limited extent in the landscape.

In Chapter 6, a modelling approach was used to determine the opportunity costs of setting aside woodland on farms to be managed for conservation without livestock grazing. Although management options such as increasing fertiliser use on other native pastures or sowing an additional area of forage oats could partially offset the opportunity costs of set-aside land, these options were not a convincing means of on-farm conservation for two reasons. First, a high proportion of the opportunity costs were associated with the capital required to establish and maintain set-asides (initial fencing and on-going weed control), so that offsets through intensification represented a small proportion of the total cost compared with the option of simply reducing flock size to account for lost grazing area. Second, detrimental environmental and biodiversity outcomes associated with intensification options were not factored into the analysis. The potential for these disadvantages to be large was incongruent with conservation management objectives, and did not warrant their selection over management options with no adverse environmental impacts. The cost of on-farm conservation management was substantial (opportunity costs of \$173 ha^{-1} yr^{-1} for reducing flock size and managing a 25-ha set-aside woodland). Incentives and stewardship payments of \$100–200 ha^{-1} yr^{-1} will be required if conservation management through set-aside land is to be widely adopted, unless cost-sharing arrangements for capital expenditure can be made, or suitable existing fences are in place.

7.3. Main contributions of this study

7.3.1. Contribution to scientific theory and practice

This study has contributed to scientific theory and practice by: (1) providing evidence of the importance of farm vegetation to plant conservation; (2) increasing the knowledge of seasonality and interannual variability in native pasture composition; (3) providing new information about the partitioning of landscape diversity across different land uses in an agricultural landscape; (4) identifying the biophysical and management determinants of grassy vegetation composition in the study region; (5) demonstrating the regional homogeneity of grassy vegetation in grazed and treeless native pastures; (6) identifying areas that contribute high numbers of unique plant species to the regional species pool, and (7) providing a basis for the investigation of the ecological processes that create landscape diversity patterns.

The analyses of existing vegetation survey data (Chapter 2) contributed to the knowledge of conservation issues in the study region. Other authors (Hosking & James 1998) have highlighted that existing reserves in the region do not adequately represent the range of regional vegetation communities, a finding commonly reported in other regions (Pressey et al. 1993; Pressey 1994; Fischer et al. 2010). The current study supported the findings of these authors by: (1) providing evidence for the importance of strategic and representative reserve creation, and (2) highlighting the importance of farmland in biodiversity conservation, due to its occurrence on land of high conservation priority—gently sloping, fertile areas.

Chapter 3 added substantially to the knowledge of seasonal and interannual variability in the species composition of native pastures in the region. Prior to this study, knowledge of these patterns was based on: (1) seasonal vegetation monitoring from a

study by Burrows (2004) from a different vegetation type and different climate; (2) a study by Williams (1979) of the region's native pastures that included winter and spring repeat surveys only, and (3) observations of seasonal ground cover and herbage mass of the dominant grasses in native pastures in several studies (Lodge 1981; Lodge & Whalley 1981; Lodge et al. 2003). The current study was the first to provide detailed data on seasonal variation of total plant species composition of native pastures, across years of varying rainfall. Most vegetation research is based on a single survey conducted at each survey site, without knowledge or consideration of the proportion of site species diversity not captured by a single survey. These data improve our ability to estimate the proportion of site species richness not recorded by single vegetation surveys, and to compare surveys conducted in different seasons or years. The study challenged the assumption of many plant demographic studies that almost all species present in a vegetation community are detected in a single survey.

The extensive survey of the case study farm based on the mosaic concept (Duelli 1997) contributed new insights into how plant diversity is partitioned across different land uses and spatial scales in an agricultural landscape. In Europe, this approach has allowed a better understanding of diversity patterns in agricultural landscapes (Wagner et al. 2000; Duelli & Obrist 2003; Simmering et al. 2006), but it has not been applied in Australia. The approach recognises that one land use type might be more species rich than another at the patch scale, but less species rich at the landscape scale. This study contributed knowledge of landscape patterns that have major conservation significance but have received little attention in Australian plant diversity studies in agricultural landscapes. The study considered only a single landscape, but revealed the landscape-

scale diversity of several land uses, highlighting the potential for such analyses to further understanding of diversity patterns in farmland.

Chapter 5 identified the determinants of species density of total, native and exotic species in the region's grassy vegetation. The determinants of site-scale density across environment and management gradients in grassy vegetation have been the subject of much research in other parts of the southern and eastern Australian wheat–sheep zone, including the Northern Tablelands of NSW (McIntyre & Lavorel 1994b; Clarke 2003), the Monaro Tablelands of NSW (Dorrough et al. 2004a), the Tasmanian midlands (Kirkpatrick et al. 2005) and subtropical south-east Queensland (McIntyre et al. 2003). However, this was the first such study on the North-West Slopes of NSW. Strong differences were evident between regions in the effects of grazing, clearing and fertiliser application on groundstorey species densities (McIntyre et al. 2002; Dorrough et al. 2004a). Hence, this study was important for determining how the relationships on the North-West Slopes of NSW differ from those in other regions.

Chapter 5 also demonstrated the regional homogeneity of grassy vegetation in grazed and treeless native pastures. These findings have major implications for how grazing is viewed as a process acting at landscape and regional scales. While several other studies have observed the effects of grazing at broad landscape scales (Landsberg et al. 2002; McIntyre et al. 2002; Dorrough et al. 2007), this study revealed a homogenising effect of grazing and clearing on grassy vegetation more clearly than other Australian studies. This may be partly because grazing does not have the same influence in other regions (e.g. McIntyre et al. 2002). Nonetheless, the broad-scale effects of grazing remain untested in most agricultural landscapes in south-eastern Australia, and this study highlighted their importance for plant conservation.

The analyses of GDC contributed information about landscape diversity patterns that differed from the diversity patterns observed by additive partitioning and species accumulation curves. Habitat specificity indices such as GDC consider which species a site holds, rather than simply how many species, and hence provided information about the uniqueness of the flora of particular sites, which is not evident from species numbers and abundances alone. No other studies of plant diversity in Australia have used specificity indices in an agricultural context. The information provided by GDC can: (1) identify diversity patterns of conservation significance; (2) help identify ecological processes that create these patterns, and (3) prioritise vegetation patches in the landscape for reservation or conservation management.

7.4. Management recommendations

Conservation efforts at the ecological community level need to be focussed on those communities that are underrepresented in the reserve system due to their occurrence on low sloping, fertile land—in particular, Box Gum Grassy Woodlands (BGGW), which are listed as critically endangered under the Commonwealth EPBC Act 1999, and have been cleared from an estimated 94% of their pre-1750 distribution on the North-West Slopes of NSW (NPWS 2000). Specifically:

- landholders should consider any BGGW remnant for conservation management, and
- this vegetation should be prioritised for additional stewardship payments by the Namoi and Border Rivers – Gwydir Catchment Management Authorities and for land acquisitions by the federal government and non-government organisations. The federal government, through their BGGW Environmental Stewardship Project (BGGW ESP) and Multiple Ecological Communities project, should

continue to prioritise conservation in these communities, and provide further rounds of funding for additional stewardship contracts.

Furthermore, BGGW vegetation on fertile land of low slope (i.e. land of high agricultural capability) is of particularly high conservation value and should be prioritised for conservation management. This will require the:

- conservation and protection of existing high quality remnant vegetation, particularly the region's Travelling Stock Routes on low sloping ground, which provide some of the highest quality remnants of BGGW. The future management of these TSRs is currently being debated;
- restoration of remnant vegetation that has been degraded by livestock grazing, and
- regeneration of woodland in areas of native pasture that have remained free of fertilisation and cultivation.

These recommendations can be seen as an overarching goal for all stakeholders (landholders, policy makers, catchment management authorities, etc.). However, socioeconomic and political factors related to the production nature of the landscape for which this recommendation is intended are likely to constrain its realisation, unless viable farm practices involving reduced stocking rate are adopted.

These management recommendations differ from those stemming from other research in several important ways. For instance, Fischer et al. (2009) suggested that the next generation of conservation initiatives should consider a suite of measures in addition to the traditional land-sparing conservation management. They surmised that there was 'overwhelming evidence that high grazing pressure is substantially more damaging to plants than low grazing pressure', and as such proposed that lowering stocking rates and

implementing cell grazing may provide broad-scale biodiversity benefits. While I agree that these initiatives warrant research, of which there is currently little (Dorrough et al. 2004b), the results of this thesis suggest that both high and low grazing pressures may fail to provide high conservation value habitat for plant conservation, and so support for alternative grazing regimes as a conservation strategy may be premature, unless the grazing regime includes not grazing some of the farm.

These management recommendations also differ from a global trend in ecological theory and biodiversity conservation in agricultural landscapes. Authors such as Perfecto et al. (2009) and Vandermeer & Perfecto (2007) argue that the quality of the agricultural matrix is far more important to biodiversity conservation than the extent and quality of conservation reserves. They proposed a return to traditional agro-ecological landscapes, or the implementation of alternative agro-ecological techniques, to create high quality agricultural matrices. I agree that systems in which species are not confined to remnants and not subject to fragmentation and isolation are much preferable to 'island–sea' landscapes. However, these ideas were developed mostly from research in Mesoamerica and South America—areas with a longer history of agro-ecological management practices, and an evolutionary history of grazing by ungulates. In south-eastern Australia, the equivalent agro-ecological alternatives are less well defined. although grazing systems such as cell grazing (Earl & Jones 1996; Richards & Lawrence 2009) aim to improve the quality of the agricultural matrix, but have yet to demonstrate positive plant conservation outcomes empirically. These practices are still based on livestock grazing, and results from this thesis suggest that they may not be as effective at conserving the regional plant species pool as increasing the network of woodland habitats not grazed by livestock.

The studies in this thesis provided empirical evidence (which has previously been lacking: Dorrough 2010) that the approach of the BGGW ESP (a government scheme that provides stewardship payments to landholders for managing set-aside land for conservation outcomes) may be a suitable option for conserving the regional plant species pool. As there is no generally agreed grazing regime to incorporate biodiversity conservation with production in temperate Australia (and very little empirical evidence to recommend any regime), the BGGW ESP is successful in the current socioeconomic and political climate and can potentially deliver positive conservation outcomes. However, there may be management alternatives that increase farm profit at lower stocking rates or flock sizes, due to lower variable costs of production and higher quality product. Such alternatives could have greater synergies with farm conservation and could allow more cost-effective conservation gains.

The management recommendation of stock exclusion from woodland patches for groundstorey plant conservation has synergies with other taxonomic groups. For example, declining woodland bird species are more likely to inhabit large patches of trees (Seddon et al. 2003) and often respond negatively to grazing (Martin & McIntyre 2007). The exclusion of domestic grazing can also increase the abundance of small native mammals (Read & Cunningham 2010). Also, tree regeneration can improve substantially when stock are excluded (Spooner & Briggs 2008).

Increasing the extent of BGGW is the primary management recommendation. However, for the suite of species that persist in them, native pastures provide extensive habitat that ensures large, viable populations that are well connected in the landscape. This is a preferable agricultural matrix to agricultural regions in which the matrix is either crops or pastures dominated by annual cool-season, exotic grasses. Since native pastures that

have not been previously cultivated support a greater number of the region's native plant species, these pastures should not be considered for intensification of pastoral activities, such as cultivation for forage crops.

7.5. Further research

7.5.1. Plant diversity in the wheat–sheep zone

The scope of this research was to identify landscape diversity patterns and evaluate the role of native pastures in the conservation of groundstorey plant diversity on the North-West Slopes of NSW. A major conclusion was that many species are restricted to ungrazed woodland patches that are infrequent in the landscape, indicating that these are spatially arranged in patches in a matrix of unsuitable habitat akin to the island–sea model of island biogeography theory (IBT, MacArthur & Wilson 1967). These species may also form metapopulations and behave as predicted by metapopulation theory (MT, Levins 1969; Hanski & Gilpin 1991). As such, further research questions remain: are the predictions of IBT and MT realised for the suite of species that are restricted to woodland habitats? Is the configuration of these ungrazed woodland patches important for species persistence? Ecological knowledge of the suite of woodland-restricted, grazing-sensitive species that are most likely to represent the extinction debt in this regional ecosystem is also required. Patches that are reproductively connected for some species can be isolated for others. Seed rain studies may reveal the dispersal ability of many woodland-restricted herbaceous species and demonstrate the likely connectivity of patches. Patches of remnant vegetation that have previously been comprehensively surveyed for species incidence may also provide an opportunity for revisitation studies (e.g. Sutton & Morgan 2009) that could reveal colonisation rates of species restricted to such habitats, to test for functional connectivity between fragments.

Research questions regarding the potential to restore native pastures and heavily grazed grassy woodland to high quality grassy woodland habitat are vital to the development of conservation strategies in the wheat–sheep zone. While the protection of high quality patches is a high priority for plant conservation, improving the connectivity of these patches in the landscape may also be vital in ensuring the viability of many species. This will require successful restoration and regeneration of high conservation value habitat, though many questions remain regarding how to achieve this: when grazing is removed, under what circumstances, and over what temporal scales will degraded woodlands provide suitable habitat for grazing-sensitive species? What degree of active management, such as weed control, is needed to ensure positive conservation outcomes? Monitoring the outcomes of existing conservation efforts and research on alternative conservation management techniques is needed, and research in south-eastern Australia has begun to answer some of these questions (Smallbone et al. 2007; Spooner & Briggs 2008; Lindenmayer et al. 2010; McIntyre et al. 2010).

The ecological processes that determine landscape diversity patterns require further research. The landscape methods used in this thesis, such as additive partitioning, species accumulation curves and habitat specificity measures, helped to identify the landscape-scale patterns evident in the study region. The knowledge of such patterns may enable ecologists to more readily identify the processes that are responsible for them (Gering et al. 2003). The present study highlighted landscape-scale patterns and hypothesised which ecological processes caused them. However, these hypotheses require experimental verification. For example, a replicated grassland experiment with a variety of disturbance treatments in large experimental plots (≥1 ha) could help to reveal the mechanisms by which grazing increases the homogeneity of grassy vegetation. Such

research could also improve our ability to develop management strategies that successfully maintain heterogeneity, and extend the applicability and theoretical advances made from the observation of broad-scale diversity patterns.

In agreement with Whalley (2005), further research is needed to provide objective evidence of the biodiversity outcomes of alternate grassland management systems, such as cell grazing implemented by some livestock producers (e.g. Wright & Wright 2000). This research must incorporate the issues of spatial scale highlighted in this thesis—local-scale comparisons of species richness between management techniques will be insufficient to substantiate claims of improved conservation value. In particular, the effects of grazing systems such as cell grazing on broad-scale plant diversity patterns requires further research: does providing extra watering points and creating smaller paddock sizes to increase the degree of utilisation of pastures by livestock increase or decrease the homogeneity of native pastures? My results suggest that such management may create low heterogeneity grassland environments with low accumulation of species across broad spatial scales.

A review of grazing impacts (Lunt et al. 2007a) provided a decision tree to predict the effects of livestock grazing on the conservation values of native vegetation. Though broad-scale ecological processes were factored into the decision tree, consideration of the impact of grazing on plant diversity was limited to species richness effects at small spatial scales. Future research should aim to develop a similar tool for predicting the broad-scale impacts of grazing and agricultural intensification on conservation values, including the interactions among grazing management, climate, soil type and fertility. It is likely that many opportunities exist to re-analyse large survey datasets that have previously been used to identify site-scale diversity patterns, to test hypotheses

regarding landscape scale diversity patterns across different land uses. Analytical methods such as habitat specificity indices (including GDC), additive partitioning and sample-based rarefaction (such as Mao Tao and Coleman) can potentially be applied to existing survey datasets that have been well-stratified across environmental gradients of interest to reveal important information for biodiversity conservation that has not yet been revealed by site-scale analyses.

7.6. Conclusions

Biodiversity conservation in agricultural landscapes may face many political and socioeconomic challenges; however, robust ecological research is a prerequisite for designing sustainable agricultural landscapes, influencing land use policy and management decisions, and ultimately avoiding species losses. This research has provided new insight into the conservation of plant diversity in farmland on the North-West Slopes of NSW, in particular regarding the homogeneous composition of native pastures across broad spatial scales, and the importance of observing management and land use influences at multiple spatial scales. The study challenges ecologists and conservation biologists to strive to understand the ecological mechanisms and interactions underlying the diversity patterns of different groups of taxa in agricultural landscapes around the world.

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APPENDIX 1

Species list for all taxa represented in metadataset

Origin (O): N = native; E = exotic. Life form (LF): C = climber or creeper; F = forb; G = grass; Gl = grass-like; LS = low shrub; P = parasite, Pt = pteridophyte; TS = tall shrub; T = tree. Life cycle (LC): AN = annual; PE = perennial; PA = perennial bulb with annual shoots; SP = short-lived perennial.

Species	O	LF	LC
PTERIDOPHYTES			
ADIANTACEAE			
Adiantum atroviride	N	Pt	PE
Adiantum formosum	N	Pt	PE
Adiantum hispidulum	N	Pt	PE
Cheilanthes austrotenuifolia	N	Pt	PE
Cheilanthes distans	N	Pt	PE
Cheilanthes sieberi	N	Pt	PE
Pellaea calidirupium	N	Pt	PE
Pellaea falcata	N	Pt	PE
Pellaea nana	N	Pt	PE
Pellaea paradoxa	N	Pt	PE
ASPLENIACEAE			
Asplenium flabellifolium	N	Pt	PE
Asplenium trichomanes	N	Pt	PE
Pleurosorus subglandulosus	N	Pt	PE
AZOLLACEAE			
Azolla filiculoides	N	Pt	PE
BLECHNACEAE			
Blechnum cartilagineum	N	Pt	PE
Blechnum minus	N	Pt	PE
Blechnum nudum	N	Pt	PE
Doodia aspera	N	Pt	PE
Doodia australis	N	Pt	PE
Doodia caudata	N	Pt	PE
CYATHEACEAE			
Cyathea australis	N	Pt	PE
DENNSTAEDTIACEAE			
Histiopteris incisa	N	Pt	PE
Hypolepis glandulifera	N	Pt	PE
Pteridium esculentum	N	Pt	PE
DICKSONIACEAE			
Calochlaena dubia	N	Pt	PE
Dicksonia antarctica	N	Pt	PE
DRYOPTERIDACEAE			
Lastreopsis decomposita	N	Pt	PE
Lastreopsis microsora subsp. microsora	N	Pt	PE
Polystichum fallax	N	Pt	PE
MARSILEACEAE			
Marsilea drummondii	N	Pt	AN
Marsilea hirsuta	N	Pt	AN
OPHIOGLOSSACEAE			
Ophioglossum lusitanicum	N	Pt	PE
POLYPODIACEAE			
Pyrrosia confluens var. confluens	N	Pt	PE
Pyrrosia rupestris	N	Pt	PE
PTERIDACEAE			
Pteris tremula	N	Pt	PE
THELYPTERIDACEAE			
Christella dentata	N	Pt	PE

Species	O	LF	LC
CYCAD			
ZAMIACEAE			
Macrozamia concinna	N	TS	PE
Macrozamia glaucophylla	N	TS	PE
Macrozamia heteromera	N	TS	PE
Macrozamia stenomera	N	LS	PE
CONIFER			
CUPRESSACEAE			
Callitris columellaris	N	T	PE
Callitris endlicheri	N	T	PE
MONOCOTYLEDON			
ALLIACEAE			
Nothoscordum borbonicum	E	GL	PA
AMARYLLIDACEAE			
Crinum flaccidum	N	GL	PA
ANTHERICACEAE			
Arthropodium fimbriatum	N	Gl	PA
Arthropodium milleflorum	N	Gl	PA
Arthropodium sp. A	N	Gl	PA
Arthropodium sp. B	N	Gl	PA
Arthropodium strictum	N	Gl	PA
Caesia parviflora	N	Gl	PA
Laxmannia compacta	N	Gl	PA
Laxmannia gracilis	N	Gl	PA
Thysanotus tuberosus	N	GL	PA
Tricoryne elatior	N	GL	PA
ASPARAGACEAE			
Asparagus aethiopicus	E	C	PA
Asparagus asparagoides	E	C	PA
Asparagus officinalis	E	F	PA
ASPHODELACEAE			
Asphodelus fistulosus	E	Gl	SP
Bulbine bulbosa	N	Gl	PE
Bulbine semibarbata	N	GL	AN
COLCHICACEAE			
Wurmbea biglandulosa	N	GL	PA
Wurmbea dioica subsp. dioica	N	GL	PA
COMMELINACEAE			
Commelina cyanea	N	F	PE
Murdannia graminea	N	GL	PA
Tradescantia fluminensis	E	F	PE
CRASSULACEAE			
Kalanchoe sexangularis	E	LS	PE
CYPERACEAE			
Bulbostylis densa	N	GL	AN
Carex appressa	N	GL	PE
Carex breviculmis	N	GL	PE
Carex gaudichaudiana	N	GL	PE
Carex incomitata	N	GL	PE
Carex inversa	N	GL	PE
Carex longebrachiata	N	GL	PE
Caustis flexuosa	N	GL	PE

Species	O	LF	LC
Cyperus bifax	N	GL	PE
Cyperus brevifolius	E	GL	PE
Cyperus difformis	N	GL	AN
Cyperus eragrostis	E	GL	PE
Cyperus exaltatus	N	GL	PE
Cyperus fulvus	N	GL	PE
Cyperus gracilis	N	GL	PE
Cyperus gunnii subsp. gunnii	N	GL	PE
Cyperus lucidus	N	GL	PE
Cyperus papyrus	E	GL	PE
Cyperus sanguinolentus	N	GL	SP
Cyperus sphaeroideus	N	GL	PE
Cyperus subulatus	N	GL	PE
Cyperus vaginatus	N	GL	PE
Eleocharis acuta	N	GL	PE
Eleocharis cylindrostachys	N	GL	PE
Eleocharis pallens	N	GL	PE
Eleocharis plana	N	GL	PE
Eleocharis pusilla	N	GL	PE
Fimbristylis dichotoma	N	GL	PE
Gahnia aspera	N	GL	PE
Isolepis habra	N	GL	PE
Isolepis inundata	N	GL	PE
Isolepis subtilissima	N	GL	PE
Lepidosperma laterale	N	GL	PE
Schoenoplectus mucronatus	N	GL	PE
Schoenoplectus validus	N	GL	PE
Schoenus apogon	N	GL	PE
Scirpus polystachyus	N	GL	PE
Scleria mackaviensis	N	GL	PE
HYDROCHARITACEAE			
Vallisneria nana	N	Gl	AN
HYPOXIDACEAE			
Hypoxis exilis	N	F	PE
Hypoxis hygrometrica var. villosisepala	N	GL	PA
IRIDACEAE			
Libertia paniculata	N	GL	PE
Patersonia sericea	N	GL	PE
JUNCACEAE			
Juncus articulatus	E	GL	PE
Juncus australis	N	GL	PE
Juncus bufonius	E	GL	AN
Juncus continuus	N	GL	PE
Juncus filicaulis	N	GL	PE
Juncus firmus	N	GL	PE
Juncus fockei	N	GL	PE
Juncus homalocaulis	N	GL	PE
Juncus ochrocoleus	N	GL	PE
Juncus pauciflorus	N	GL	PE
Juncus planifolius	N	GL	AN
Juncus prismatocarpus	N	GL	PE
Juncus radula	N	GL	PE
Juncus remotiflorus	N	GL	PE
Juncus sarophorus	N	GL	PE
Juncus subsecundus	N	GL	PE
Juncus usitatus	N	GL	PE
Juncus vaginatus	N	GL	PE
Luzula densiflora	N	GL	PE
Luzula flaccida	N	GL	PE
Luzula meridionalis	N	GL	PE
LOMANDRACEAE			
Lomandra confertifolia	N	GL	PE
LUZURIAGACEAE			
Eustrephus latifolius	N	C	PE
Geitonoplesium cymosum	N	C	PE
ORCHIDACEAE			
Acianthus collinus	N	GL	PA

Species	O	LF	LC
ORCHIDACEAE			
Caladenia capillata	N	GL	PA
Caladenia carnea	N	GL	PA
Caladenia fuscata	N	GL	PA
Caladenia gracilis	N	GL	PA
Calochilus campestris	N	GL	PA
Calochilus robertsonii	N	GL	PA
Cryptostylis leptochila	N	GL	PA
Cyanicula caerulea	N	GL	PA
Cymbidium canaliculatum	N	GL	PA
Cyrtostylis reniformis	N	GL	PA
Dipodium punctatum	N	GL	PA
Dipodium roseum	N	GL	PA
Dipodium variegatum	N	GL	PA
Eriochilus cucullatus	N	GL	PA
Microtis parviflora	N	GL	PA
Microtis unifolia	N	GL	PA
Orthoceras strictum	N	GL	PA
Pterostylis arenicola	N	GL	PA
Pterostylis coccina	N	GL	PA
Pterostylis curta	N	GL	PA
Pterostylis longicurva	N	GL	PA
Pterostylis mutica	N	GL	PA
Pterostylis parviflora	N	GL	PA
Pterostylis praetermissa	N	GL	PA
Pterostylis setifera	N	GL	PA
Pterostylis species B	N	GL	PA
PHORMIACEAE			
Dianella 'admixta'	N	GL	PE
Dianella caerulea var. caerulea	N	GL	PE
Dianella caerulea var. cinerascens	N	GL	PE
Dianella longifolia var. longifolia	N	GL	PE
Dianella longifolia var. stenophylla	N	GL	PE
Dianella revoluta var. revoluta	N	GL	PE
Dianella revoluta var. vinosa	N	GL	PE
Stypandra glauca	N	GL	PE
POACEAE			
Aira cupaniana	E	G	AN
Amphibromus nervosus	N	G	PE
Ancistrachne uncinulata	N	G	PE
Anthoxanthum odoratum	E	G	PE
Aristida acuta	N	G	PE
Aristida benthamii	N	G	PE
Aristida calycina var. calycina	N	G	PE
Aristida calycina var. praealta	N	G	PE
Aristida caput-medusae	N	G	PE
Aristida echinata	N	G	PE
Aristida gracilipes	N	G	PE
Aristida jerichoensis var. jerichoensis	N	G	PE
Aristida jerichoensis var. subspinulifera	N	G	PE
Aristida latifolia	N	G	PE
Aristida leichhardtiana	N	G	PE
Aristida leptopoda	N	G	PE
Aristida personata	N	G	PE
Aristida psammophila	N	G	PE
Aristida queenslandica var. queenslandica	N	G	PE
Aristida ramosa	N	G	PE
Aristida vagans	N	G	PE
Arundinella nepalensis	N	G	PE
Austrodanthonia bipartita	N	G	PE
Austrodanthonia caespitosa	N	G	PE
Austrodanthonia eriantha	N	G	PE
Austrodanthonia fulva	N	G	PE
Austrodanthonia laevis	N	G	PE
Austrodanthonia monticola	N	G	PE
Austrodanthonia penicillata	N	G	PE

Species	O	LF	LC
POACEAE			
Austrodanthonia pilosa	N	G	PE
Austrodanthonia racemosa var. obtusata	N	G	PE
Austrodanthonia racemosa var. racemosa	N	G	PE
Austrodanthonia richardsonii	N	G	PE
Austrodanthonia setacea	N	G	PE
Austrodanthonia tenuior	N	G	PE
Austrostipa aristiglumis	N	G	PE
Austrostipa densiflora	N	G	PE
Austrostipa nitida	N	G	PE
Austrostipa nodosa	N	G	PE
Austrostipa ramosissima	N	G	PE
Austrostipa rudis subsp. nervosa	N	G	PE
Austrostipa rudis subsp. rudis	N	G	PE
Austrostipa scabra subsp. falcata	N	G	PE
Austrostipa scabra subsp. scabra	N	G	PE
Austrostipa setacea	N	G	PE
Austrostipa tuckeri	N	G	PE
Austrostipa verticillata	N	G	PE
Avena barbata	E	G	AN
Avena fatua	E	G	AN
Avena sterilis subsp. ludoviciana	E	G	AN
Axonopus fissifolius	E	G	PE
Bothriochloa biloba	N	G	PE
Bothriochloa bladhii subsp. bladhii	N	G	PE
Bothriochloa decipiens	N	G	PE
Bothriochloa ewartiana	N	G	PE
Bothriochloa macra	N	G	PE
Briza maxima	E	G	AN
Briza minor	E	G	AN
Bromus alopecuros	E	G	AN
Bromus brevis	E	G	AN
Bromus catharticus	E	G	SP
Bromus diandrus	E	G	AN
Bromus hordeaceus	E	G	AN
Bromus secalinus	E	G	AN
Bromus tectorum	E	G	AN
Capillipedium parviflorum	N	G	PE
Capillipedium spicigerum	N	G	PE
Catapodium rigidum	E	G	AN
Cenchrus caliculatus	N	G	PE
Chloris gayana	E	G	PE
Chloris truncata	N	G	PE
Chloris ventricosa	N	G	PE
Chloris virgata	E	G	SP
Cleistochloa rigida	N	G	PE
Cymbopogon obtectus	N	G	PE
Cymbopogon refractus	N	G	PE
Cynodon dactylon	N	G	PE
Cynodon incompletus	N	G	PE
Dactylis glomerata	E	G	PE
Dactyloctenium aegyptium	N	G	PE
Dactyloctenium radulans	N	G	PE
Desmazeria rigida	N	G	PE
Deyeuxia gunniana	N	G	PE
Dichanthium sericeum	N	G	PE
Dichanthium setosum	N	G	PE
Dichelachne crinita	N	G	PE
Dichelachne inaequiglumis	N	G	PE
Dichelachne micrantha	N	G	PE
Dichelachne rara	N	G	PE
Dichelachne sieberiana	N	G	PE
Digitaria ammophila	N	G	PE
Digitaria breviglumis	N	G	PE
Digitaria brownii	N	G	PE
Digitaria ciliaris	E	G	AN

Species	O	LF	LC
POACEAE			
Digitaria diffusa	N	G	PE
Digitaria divaricatissima	N	G	PE
Digitaria hubbardii	N	G	PE
Digitaria hystrichoides	N	G	PE
Digitaria parviflora	N	G	PE
Digitaria ramularis	N	G	PE
Echinochloa colona	N	G	AN
Echinochloa crusgalli	E	G	AN
Echinopogon caespitosus	N	G	PE
Echinopogon cheelii	N	G	PE
Echinopogon intermedius	N	G	PE
Echinopogon mckiei	N	G	PE
Echinopogon nutans	N	G	PE
Echinopogon ovatus	N	G	PE
Eleusine tristachya	E	G	SP
Elymus scaber var. plurinervis	N	G	PE
Elymus scaber var. scaber	N	G	PE
Enneapogon gracilis	N	G	PE
Enneapogon lindleyanus	N	G	PE
Enneapogon nigricans	N	G	PE
Enteropogon acicularis	N	G	PE
Enteropogon ramosus	N	G	PE
Entolasia stricta	N	G	PE
Eragrostis benthamii	N	G	PE
Eragrostis brownii	N	G	PE
Eragrostis cilianensis	E	G	AN
Eragrostis curvula	E	G	PE
Eragrostis elongata	N	G	SP
Eragrostis lacunaria	N	G	PE
Eragrostis leptocarpa	N	G	PE
Eragrostis leptostachya	N	G	PE
Eragrostis megalosperma	N	G	PE
Eragrostis molybdea	N	G	PE
Eragrostis parviflora	N	G	AN
Eragrostis trachycarpa	N	G	PE
Eriochloa australiensis	N	G	AN
Eriochloa crebra	N	G	PE
Eriochloa procera	N	G	SP
Eriochloa pseudoacrotricha	N	G	SP
Eulalia aurea	N	G	PE
Festuca asperula	N	G	PE
Festuca elatior	E	G	PE
Heteropogon contortus	N	G	PE
Holcus lanatus	E	G	PE
Homopholis belsonii	N	G	PE
Homopholis proluta	N	G	PE
Hordeum geniculatum	E	G	AN
Hordeum glaucum	E	G	AN
Hordeum leporinum	E	G	AN
Hyparrhenia hirta	E	G	PE
Imperata cylindrica var. major	N	G	PE
Joycea pallida	N	G	PE
Lachnagrostis filiformis	N	G	AN
Lamarckia aurea	E	G	AN
Leptochloa decipens subsp. decipens	N	G	PE
Leptochloa divaricatissima	N	G	PE
Lolium perenne	E	G	SP
Lolium rigidum	E	G	AN
Microlaena stipoides	N	G	PE
Notodanthonia longifolia	N	G	PE
Oplismenus aemulus	N	G	PE
Oplismenus imbecillis	N	G	PE
Panicum capillare var. capillare	E	G	AN
Panicum decompositum	N	G	PE
Panicum effusum	N	G	PE
Panicum gilvum	E	G	AN
Panicum laevinode	N	G	PE

Species	O	LF	LC
POACEAE			
Panicum miliaceum	E	G	AN
Panicum paludosum	N	G	PE
Panicum queenslandicum var. acuminatum	N	G	PE
Panicum queenslandicum var. queenslandicum	N	G	PE
Panicum simile	N	G	PE
Paspalidium aversum	N	G	PE
Paspalidium gausum	N	G	PE
Paspalidium gracile	N	G	PE
Paspalum dilatatum	E	G	PE
Paspalum distichum	N	G	PE
Pennisetum alopecuroides	N	G	PE
Pennisetum clandestinum	E	G	PE
Phalaris aquatica	E	G	PE
Phalaris minor	E	G	AN
Phalaris paradoxa	E	G	AN
Phragmites australis	N	G	PE
Poa annua	E	G	AN
Poa fax	N	G	AN
Poa labillardierei var. labillardierei	N	G	PE
Poa queenslandica	N	G	PE
Poa sieberiana var. hirtella	N	G	PE
Poa sieberiana var. sieberiana	N	G	PE
Polypogon monspeliensis	E	G	AN
Rostraria cristata	E	G	AN
Rytidosperma vickeryae	N	G	PE
Sarga leiocladum	E	G	PE
Secale cereale	E	G	AN
Setaria constricta	E	G	PE
Setaria criniformе	E	G	PE
Setaria distans	E	G	PE
Setaria gracilis	E	G	PE
Setaria jubiflorum	E	G	PE
Setaria paspalidioides	E	G	PE
Setaria pumila	E	G	AN
Setaria verticillata	E	G	AN
Sorghum bicolor	E	G	SP
Sorghum halepense	E	G	PE
Sporobolus caroli	N	G	SP
Sporobolus creber	N	G	PE
Sporobolus elongatus	N	G	PE
Themeda avenacea	N	G	PE
Themeda triandra	N	G	PE
Tragopogon porrifolius	E	G	SP
Tragus australianus	N	G	AN
Triodia mitchellii	N	G	PE
Triodia scariosa	N	G	PE
Tripogon loliiformis	N	G	SP
Urochloa advena	E	G	PE
Urochloa panicoides	E	G	AN
Vulpia bromoides	E	G	AN
Vulpia muralis	E	G	AN
Vulpia myuros forma megalura	E	G	AN
Walwhalleya subxerophila	N	G	PE
RESTIONACEAE			
Baloskion stenocoleum	N	GL	PE
STYLIDIACEAE			
Stylidium graminifolium	N	GL	PE
TYPHACEAE			
Typha domingensis	N	GL	PE
Typha orientalis	N	GL	PE
XANTHORRHOEACEAE			
Lomandra filiformis subsp. coriacea	N	GL	PE
Lomandra filiformis subsp. filiformis	N	GL	PE
Lomandra filiformis subsp. flavior	N	GL	PE
Lomandra leucocephala	N	GL	PE

Species	O	LF	LC
XANTHORRHOEACEAE			
Lomandra longifolia	N	GL	PE
Lomandra multiflora subsp. multiflora	N	GL	PE
Lomandra patens	N	GL	PE
Xanthorrhoea acaulis	N	TS	PE
Xanthorrhoea glauca subsp. angustifolia	N	TS	PE
Xanthorrhoea glauca subsp. glauca	N	TS	PE
Xanthorrhoea johnsonii	N	TS	PE
DICOTYLEDON			
ACANTHACEAE			
Brunoniella australis	N	F	PE
Brunoniella pumilio	N	F	PE
Pseuderanthemum variabile	N	F	PE
Rostellularia adscendens subsp. adscendens	N	F	PE
AIZOACEAE			
Glinus lotoides	N	F	AN
Tetragonia tetragonioides	N	F	AN
Zaleya galericulata	N	F	SP
ALISMATACEAE			
Damasonium minus	N	F	SP
AMARANTHACEAE			
Alternanthera denticulata	N	F	AN
Alternanthera pungens	E	F	SP
Alternanthera species A	N	F	PE
Amaranthus hybridus	E	F	AN
Amaranthus macrocarpus var. macrocarpus	N	F	AN
Amaranthus mitchellii	N	F	AN
Amaranthus powellii	E	F	AN
Amaranthus viridis	E	F	AN
Gomphrena celosioides	N	F	AN
Nyssanthes diffusa	N	F	SP
Nyssanthes erecta	N	F	AN
AMYGDALACEAE			
Prunus cerasus	E	T	PE
ANACARDIACEAE			
Schinus molle var. areira	E	T	PE
APIACEAE			
Actinotus helianthi	N	F	AN
Ammi majus	E	F	SP
Centella asiatica	N	F	PE
Conium maculatum	E	F	SP
Cyclospermum leptophyllum	E	F	AN
Daucus carota	E	F	AN
Daucus glochidiatus	N	F	AN
Eryngium ovinum	N	F	SP
Foeniculum vulgare	E	F	SP
Hydrocotyle acutiloba	E	F	PE
Hydrocotyle laxiflora	N	F	PE
Hydrocotyle peduncularis	N	F	PE
Hydrocotyle tripartita	N	F	PE
Oreomyrrhis ciliata	N	F	PE
Oreomyrrhis eriopoda	N	F	PE
Platysace lanceolata	N	LS	PE
Trachymene incisa	N	F	PE
Xanthosia spp.	N	TS	PE
APOCYNACEAE			
Alstonia constricta	N	TS	PE
Carissa ovata	N	LS	PE
Parsonsia eucalyptophylla	N	C	PE
Parsonsia lanceolata	N	C	PE
ARALIACEAE			
Astrotricha longifolia	N	TS	PE
Hedera helix	E	C	PE
Polyscias sambucifolia	N	TS	PE

Species	O	LF	LC
ASCLEPIADACEAE			
Gomphocarpus fruticosus	E	F	PE
Marsdenia viridiflora subsp. viridiflora	N	C	PE
Oxypetalum coeruleum	E	LS	PE
Rhyncharrhena linearis	N	C	PE
Tylophora paniculata	N	C	PE
ASTERACEAE			
Actinobole uliginosum	N	F	AN
Ammobium alatum	N	F	PE
Arctotheca calendula	E	F	AN
Aster subulatus	E	F	SP
Bidens pilosa	E	F	AN
Bidens subalternans	E	F	AN
Brachyscome aculeata	N	F	PE
Brachyscome angustifolia var. angustifolia	N	F	PE
Brachyscome angustifolia var. heterophylla	N	F	PE
Brachyscome ciliaris	N	F	PE
Brachyscome curvicarpa	N	F	AN
Brachyscome dentata	N	F	PE
Brachyscome dissectifolia	N	F	PE
Brachyscome diversifolia var. dissecta	N	F	PE
Brachyscome gracilis	N	F	AN
Brachyscome melanocarpa	N	F	PE
Brachyscome microcarpa	N	F	PE
Brachyscome multifida	N	F	AN
Brachyscome nova-anglica	N	F	AN
Brachyscome procumbens	N	F	PE
Brachyscome smithwhitei	N	F	PE
Brachyscome spathulata	N	F	PE
Brachyscome stuartii	N	F	PE
Calocephalus citreus	N	F	PE
Calotis anthemoides	N	F	PE
Calotis cuneifolia	N	F	PE
Calotis dentex	N	F	PE
Calotis hispidula	N	F	AN
Calotis lappulacea	N	F	PE
Carduus tenuiflorus	E	F	AN
Carthamus lanatus	E	F	AN
Cassinia arcuata	N	LS	PE
Cassinia compacta	N	LS	PE
Cassinia laevis	N	LS	PE
Cassinia leptocephala	N	LS	PE
Cassinia quinquefaria	N	LS	PE
Cassinia species B	N	LS	PE
Cassinia species D	N	LS	PE
Cassinia tegulata	N	LS	PE
Cassinia theodori	N	LS	PE
Centaurea calcitrapa	E	F	SP
Centaurea melitensis	E	F	AN
Centaurea solstitialis	E	F	SP
Centipeda minima var. minima	N	F	AN
Chondrilla juncea	E	F	PE
Chrysocephalum apiculatum	N	F	PE
Chrysocephalum semipapposum	N	F	PE
Cichorium intybus	E	F	PE
Cirsium vulgare	E	F	SP
Conyza bonariensis	E	F	AN
Conyza parva	E	F	AN
Conyza sumatrensis	E	F	AN
Cosmos bipinnatus	E	F	AN
Craspedia canens	N	F	SP
Craspedia variabilis	N	F	SP
Crepis capillaris	E	F	SP
Cymbonotus lawsonianus	N	F	PE

Species	O	LF	LC
ASTERACEAE			
Eclipta platyglossa	N	F	AN
Euchiton gymnocephalus	N	F	PE
Euchiton involucratus	N	F	PE
Euchiton sphaericus	N	F	SP
Gamochaeta americana	E	F	AN
Gamochaeta calviceps	E	F	AN
Gamochaeta spicata	E	F	PE
Glossogyne tannensis	N	F	PE
Hedypnois rhagadioloides subsp. cretica	E	F	AN
Helichrysum scorpioides	N	F	PE
Hypochaeris glabra	E	F	AN
Hypochaeris microcephala var. albiflora	E	F	PE
Hypochaeris radicata	E	F	PE
Ixiolaena leptolepis	N	F	PE
Ixiolaena tomentosa	N	F	PE
Lactuca saligna	E	F	SP
Lactuca serriola	E	F	SP
Lagenophora gracilis	N	F	PE
Lagenophora stipitata	N	F	PE
Leptorhynchos panaetioides	N	F	PE
Leptorhynchos squamatus	N	F	PE
Leucochrysum albicans	N	F	PE
Microseris lanceolata	N	F	PA
Minuria leptophylla	N	F	PE
Minuria scoparia	N	F	PE
Olearia canescens	N	LS	PE
Olearia elliptica	N	LS	PE
Olearia microphylla	N	LS	PE
Olearia myrsinoides	N	LS	PE
Olearia ramosissima	N	LS	PE
Olearia ramulosa	N	LS	PE
Olearia rosmarinifolia	N	LS	PE
Olearia viscidula	N	LS	PE
Ozothamnus adnatus	N	LS	PE
Ozothamnus bidwillii	N	LS	PE
Ozothamnus diosmifolius	N	LS	PE
Ozothamnus obcordatus	N	LS	PE
Picris angustifolia subsp. carolorum-henricorum	N	F	AN
Picris hieracioides	N	F	AN
Podolepis jaceoides	N	F	PE
Podolepis neglecta	N	F	PE
Pseudognaphalium luteo-album	N	F	AN
Pycnosorus globosus	N	F	PE
Rhodanthe anthemoides	N	F	PE
Schkuhria pinnata var. abrotanoides	E	F	AN
Senecio australis	N	F	PE
Senecio bathurstianus	N	F	PE
Senecio daltonii	N	F	PE
Senecio diaschides	N	F	PE
Senecio gunnii	N	F	PE
Senecio hispidulus	N	F	PE
Senecio macranthus	N	F	PE
Senecio madagascariensis	E	F	SP
Senecio minimus	N	F	PE
Senecio prenanthoides	N	F	PE
Senecio quadridentatus	N	F	PE
Senecio spanomerus	N	F	PE
Senecio tenuiflorus	N	F	PE
Sigesbeckia australiensis	N	F	AN
Sigesbeckia orientalis subsp. orientalis	N	F	AN
Silybum marianum	E	F	SP
Solenogyne bellioides	N	F	PE
Solenogyne dominii	N	F	PE

Species	O	LF	LC
ASTERACEAE			
Solenogyne gunnii	N	F	PE
Soliva anthemifolia	E	F	AN
Sonchus asper subsp. glaucescens	E	F	AN
Sonchus oleraceus	E	F	AN
Stuartina hamata	N	F	AN
Tagetes minuta	E	F	AN
Taraxacum officinale	E	F	PE
Triptilodiscus pygmaeus	N	F	AN
Verbesina encelioides subsp. encelioides	E	F	AN
Vernonia cinerea	N	F	AN
Vittadinia cervicularis var. cervicularis	N	F	PE
Vittadinia cervicularis var. subcervicularis	N	F	PE
Vittadinia condyloides	N	F	PE
Vittadinia cuneata var. cuneata	N	F	PE
Vittadinia cuneata var. hirsuta	N	F	PE
Vittadinia dissecta	N	F	PE
Vittadinia hispidula var. hispidula	N	F	PE
Vittadinia muelleri	N	F	PE
Vittadinia pterochaeta	N	F	PE
Vittadinia pustulata	N	F	PE
Vittadinia sulcata	N	F	AN
Xanthium spinosum	E	F	AN
Xanthium strumarium	E	F	AN
Xerochrysum bracteatum	N	F	PE
Xerochrysum viscosum	N	F	PE
Zinnia peruviana	E	F	AN
BIGNONIACEAE			
Pandorea pandorana subsp. austrocaledonica	N	C	PE
Pandorea pandorana subsp. pandorana	N	C	PE
BORAGINACEAE			
Austrocynoglossum latifolium	N	F	PE
Buglossoides arvensis	E	F	AN
Cynoglossum australe	N	F	PE
Cynoglossum suaveolens	N	F	PE
Echium plantagineum	E	F	AN
Echium vulgare	E	F	AN
Ehretia membranifolia	N	TS	PE
Halgania brachyrhyncha	N	LS	PE
Myosotis laxa subsp. caespitosa	E	F	AN
BRASSICACEAE			
Brassica nigra	E	F	AN
Brassica oleracea	E	F	PE
Brassica rapa subsp. campestris	E	F	AN
Capsella bursa-pastoris	E	F	AN
Cardamine hirsuta	E	F	AN
Cardamine paucijuga	N	F	AN
Coronopus didymus	E	F	SP
Hirschfeldia incana	E	F	SP
Lepidium africanum	E	F	SP
Lepidium pseudohyssopifolium	N	F	SP
Rapistrum rugosum	E	F	SP
Rorippa laciniata	N	F	PE
Sisymbrium erysimoides	E	F	SP
Sisymbrium irio	E	F	SP
Sisymbrium officinale	E	F	SP
CACTACEAE			
Opuntia aurantiaca	E	F	PE
Opuntia stricta	E	F	PE
CAMPANULACEAE			
Wahlenbergia communis	N	F	PE
Wahlenbergia fluminalis	N	F	PE
Wahlenbergia gracilenta	N	F	PE

Species	O	LF	LC
CAMPANULACEAE			
Wahlenbergia gracilis	N	F	PE
Wahlenbergia graniticola	N	F	PE
Wahlenbergia luteola	N	F	PE
Wahlenbergia planiflora subsp. longipila	N	F	PE
Wahlenbergia planiflora subsp. planiflora	N	F	PE
Wahlenbergia stricta subsp. alterna	N	F	PE
Wahlenbergia stricta subsp. stricta	N	F	PE
CANNABACEAE			
Cannabis sativa	N	F	PE
CAPPARACEAE			
Capparis mitchellii	N	T	PE
CAPRIFOLIACEAE			
Lonicera japonica	E	C	PE
CARYOPHYLLACEAE			
Arenaria leptoclados	E	F	AN
Arenaria serpyllifolia	E	F	AN
Cerastium glomeratum	E	F	AN
Gypsophila tubulosa	E	F	AN
Moenchia erecta	E	F	AN
Paronychia brasiliana	E	F	PE
Petrorhagia dubia	E	F	AN
Petrorhagia nanteuilii	E	F	AN
Polycarpaea corymbosa var. minor	N	F	AN
Polycarpon tetraphyllum	E	F	AN
Sagina apetala	E	F	AN
Scleranthus biflorus	N	F	PE
Scleranthus diander	N	F	PE
Scleranthus pungens	N	F	PE
Silene dioica	E	F	PE
Silene gallica	E	F	AN
Spergularia rubra	E	F	SP
Stellaria angustifolia	N	F	PE
Stellaria flaccida	N	F	PE
Stellaria media	E	F	SP
Stellaria multiflora	N	F	AN
Stellaria pallida	E	F	AN
Stellaria pungens	N	F	PE
CASUARINACEAE			
Allocasuarina littoralis	N	T	PE
Allocasuarina luehmannii	N	T	PE
Allocasuarina torulosa	N	T	PE
Casuarina cunninghamiana subsp. cunninghamiana	N	T	PE
CELASTRACEAE			
Celastrus australis	N	C	PE
Maytenus bilocularis	N	T	PE
Maytenus cunninghamii	N	TS	PE
Maytenus silvestris	N	TS	PE
CHENOPODIACEAE			
Atriplex semibaccata	N	F	PE
Atriplex spinibractea	N	F	PE
Atriplex suberecta	N	F	PE
Chenopodium album	E	F	AN
Chenopodium ambrosioides	E	LS	PE
Chenopodium auricomum	N	F	PE
Chenopodium carinatum	N	F	AN
Chenopodium desertorum subsp. desertorum	N	F	PE
Chenopodium melanocarpum	N	F	AN
Chenopodium murale	E	F	AN
Chenopodium pumilio	N	F	AN
Einadia hastata	N	F	PE
Einadia nutans subsp. linifolia	N	F	PE
Einadia nutans subsp. nutans	N	F	PE
Einadia polygonoides	N	F	PE

Species	O	LF	LC
CHENOPODIACEAE			
Einadia trigonos subsp. leiocarpa	N	F	PE
Einadia trigonos subsp. stellulata	N	F	PE
Enchylaena tomentosa	N	LS	PE
Maireana aphylla	N	LS	PE
Maireana brevifolia	N	LS	PE
Maireana enchylaenoides	N	F	PE
Maireana microcarpa	N	LS	PE
Maireana microphylla	N	LS	PE
Rhagodia parabolica	N	LS	PE
Salsola tragus	N	F	SP
Sclerolaena birchii	N	F	PE
Sclerolaena divaricata	N	LS	PE
Sclerolaena muricata var. muricata	N	F	PE
Sclerolaena muricata var. semiglabra	N	F	PE
Sclerolaena muricata var. villosa	N	F	PE
CHLOANTHACEAE			
Spartothamnella juncea	N	LS	PE
CLUSIACEAE			
Hypericum gramineum	N	F	PE
Hypericum japonicum	N	F	PE
Hypericum perforatum	E	F	PE
CONVOLVULACEAE			
Calystegia marginata	N	C	PE
Convolvulus arvensis	E	C	PE
Convolvulus erubescens	N	F	PE
Convolvulus remotus	N	F	PE
Cuscuta campestris	E	P	PE
Dichondra repens	N	F	PE
Dichondra species A	N	Gl	PA
Evolvulus alsinoides var. decumbens	N	F	PE
Evolvulus alsinoides var. villosicalyx	N	F	PE
CRASSULACEAE			
Crassula sieberiana	N	F	AN
CUCURBITACEAE			
Citrullus lanatus	E	F	AN
Cucumis myriocarpus subsp. leptodermis	E	F	AN
DILLENIACEAE			
Hibbertia acicularis	N	LS	PE
Hibbertia dentata	N	C	PE
Hibbertia hermanniifolia	N	LS	PE
Hibbertia linearis	N	LS	PE
Hibbertia obtusifolia	N	LS	PE
Hibbertia riparia	N	LS	PE
Hibbertia rufa	N	LS	PE
Hibbertia serpyllifolia	N	LS	PE
DROSERACEAE			
Drosera auriculata	N	F	AN
Drosera peltata	N	F	PE
ELATINACEAE			
Elatine gratioloides	N	F	AN
EPACRIDACEAE			
Acrotriche serrulata	N	LS	PE
Brachyloma daphnoides	N	LS	PE
Epacris pulchella	N	LS	PE
Leucopogon attenuatus	N	LS	PE
Leucopogon lanceolatus	N	LS	PE
Leucopogon microphyllus	N	LS	PE
Leucopogon muticus	N	LS	PE
Leucopogon neo-anglicus	N	LS	PE
Leucopogon virgatus	N	LS	PE
Lissanthe strigosa subsp. strigosa	N	LS	PE
Lissanthe strigosa subsp. subulata	N	LS	PE
Melichrus erubescens	N	LS	PE
Melichrus urceolatus	N	LS	PE
Monotoca scoparia	N	LS	PE
Ericaceae			

Species	O	LF	LC
EPACRIDACEAE			
Acrothamnus hookeri	N	LS	PE
EUPHORBIACEAE			
Adriana urticoides	N	TS	PE
Bertya mollissima	N	LS	PE
Bertya oleifolia	N	LS	PE
Beyeria viscosa	N	LS	PE
Breynia cernua	N	LS	PE
Breynia oblongifolia	N	LS	PE
Chamaesyce australis	N	F	PE
Chamaesyce dallachyana	N	F	PE
Chamaesyce drummondii	N	F	PE
Chamaesyce species A	N	F	PE
Claoxylon australe	N	TS	PE
Croton phebalioides	N	LS	PE
Euphorbia eremophila	N	F	SP
Euphorbia lathyrus	E	F	SP
Euphorbia peplus	E	F	AN
Homalanthus populifolius	N	TS	PE
Phyllanthus carpentariae	N	LS	PE
Phyllanthus gunnii	N	LS	PE
Phyllanthus subcrenulatus	N	LS	PE
Phyllanthus virgatus	N	F	SP
Poranthera microphylla	N	F	AN
FABACEAE			
Acacia blakei subsp. diphylla	N	T	PE
Acacia brownii	N	LS	PE
Acacia buxifolia	N	TS	PE
Acacia caesiella	N	TS	PE
Acacia cheelii	N	TS	PE
Acacia dealbata	N	T	PE
Acacia deanei	N	T	PE
Acacia decora	N	LS	PE
Acacia doratoxylon	N	T	PE
Acacia falcata	N	T	PE
Acacia falciformis	N	TS	PE
Acacia gladiiformis	N	TS	PE
Acacia harpophylla	N	T	PE
Acacia homalophylla	N	TS	PE
Acacia implexa	N	T	PE
Acacia leiocalyx subsp. leiocalyx	N	T	PE
Acacia leptoclada	N	TS	PE
Acacia maidenii	N	T	PE
Acacia melanoxylon	N	T	PE
Acacia myrtifolia	N	TS	PE
Acacia neriifolia	N	TS	PE
Acacia paradoxa	N	TS	PE
Acacia pendula	N	T	PE
Acacia penninervis	N	T	PE
Acacia pruinosa	N	TS	PE
Acacia rubida	N	TS	PE
Acacia salicina	N	TS	PE
Acacia triptera	N	T	PE
Acacia ulicifolia	N	TS	PE
Acacia venulosa	N	TS	PE
Acacia viscidula	N	LS	PE
Aotus subglauca	N	LS	PE
Bossiaea buxifolia	N	LS	PE
Bossiaea neo-anglica	N	LS	PE
Bossiaea obcordata	N	LS	PE
Bossiaea prostrata	N	LS	PE
Chamaecytisus palmensis	E	T	PE
Crotalaria agatiflora subsp. agatiflora	E	LS	PE
Crotalaria dissitiflora subsp. dissitiflora	N	F	PE
Crotalaria mitchellii subsp. laevis	N	F	PE
Cullen tenax	N	F	PE

Species	O	LF	LC
FABACEAE			
Daviesia acicularis	N	LS	PE
Daviesia genistifolia	N	LS	PE
Daviesia latifolia	N	LS	PE
Daviesia pubigera	N	LS	PE
Daviesia ulicifolia	N	LS	PE
Desmodium brachypodum	N	F	PE
Desmodium gunnii	N	F	PE
Desmodium varians	N	F	PE
Dillwynia phylicoides	N	LS	PE
Dillwynia retorta species complex	N	LS	PE
Dillwynia sericea	N	LS	PE
Gleditsia triacanthos	E	T	PE
Glycine canescens	N	C	PE
Glycine clandestina	N	C	PE
Glycine microphylla	N	C	PE
Glycine stenophita	N	C	PE
Glycine tabacina	N	C	PE
Glycine tomentella	N	C	PE
Gompholobium huegelii	N	LS	PE
Hardenbergia violacea	N	C	PE
Hovea heterophylla	N	LS	PE
Hovea lanceolata	N	LS	PE
Hovea linearis	N	LS	PE
Hovea purpurea	N	LS	PE
Indigofera adesmiifolia	N	LS	PE
Indigofera australis	N	LS	PE
Isotropis foliosa	N	LS	PE
Jacksonia scoparia	N	TS	PE
Kennedia rubicunda	N	C	PE
Lespedeza juncea subsp. sericea	N	LS	PE
Lotus australis	N	F	PE
Lotus cruentus	N	F	PE
Medicago arabica	E	F	AN
Medicago laciniata	E	F	AN
Medicago lupulina	E	F	SP
Medicago minima	E	F	AN
Medicago orbicularis	E	F	AN
Medicago polymorpha	E	F	AN
Medicago sativa	E	F	PE
Medicago truncatula	E	F	AN
Melilotus albus	E	F	SP
Melilotus indicus	E	F	AN
Mirbelia oxylobioides	N	LS	PE
Mirbelia pungens	N	LS	PE
Neptunia gracilis forma gracilis	N	F	PE
Pultenaea campbellii	N	LS	PE
Pultenaea cuneata	N	LS	PE
Pultenaea foliolosa	N	LS	PE
Pultenaea linophylla	N	LS	PE
Pultenaea microphylla	N	LS	PE
Pultenaea myrtoides	N	LS	PE
Pultenaea scabra	N	LS	PE
Pultenaea setulosa	N	LS	PE
Pultenaea spinosa	N	LS	PE
Rhynchosia minima	N	C	PE
Robinia pseudoacacia	E	T	PE
Senna aciphylla	N	LS	PE
Senna artemisioides nothosubsp. coriacea	N	LS	PE
Senna artemisioides subsp. zygophylla	N	LS	PE
Senna barclayana	N	F	PE
Senna baronfieldii	N	LS	PE
Senna clavigera	N	LS	PE
Senna coronilloides	N	LS	PE
Senna occidentalis	E	LS	PE
Sesbania cannabina var. cannabina	N	LS	PE

Species	O	LF	LC
FABACEAE			
Swainsona behriana	N	F	PE
Swainsona bracteata	N	F	PE
Swainsona galegifolia	N	F	PE
Swainsona luteola	N	F	PE
Swainsona microphylla	N	F	PE
Swainsona monticola	N	F	PE
Swainsona murrayana	N	F	PE
Swainsona parviflora	N	F	PE
Swainsona queenslandica	N	F	PE
Swainsona reticulata	N	F	PE
Templetonia stenophylla	N	LS	PE
Tephrosia brachyodon	N	F	PE
Trifolium angustifolium	E	F	AN
Trifolium arvense	E	F	AN
Trifolium campestre	E	F	AN
Trifolium cernuum	E	F	AN
Trifolium dubium	E	F	AN
Trifolium fragiferum	E	F	AN
Trifolium glomeratum	E	F	AN
Trifolium pratense	E	F	PE
Trifolium repens	E	F	PE
Trifolium subterraneum	E	F	AN
Trifolium tomentosum	E	F	AN
Vicia hirsuta	E	C	AN
Vicia monantha	E	C	AN
Vicia sativa	E	C	AN
Vigna lanceolata var. lanceolata	N	C	PE
Vigna vexillata var. angustifolia	N	C	PE
Zornia dyctiocarpa var. dyctiocarpa	N	F	PE
Zornia floribunda	N	F	PE
FUMARIACEAE			
Fumaria capreolata subsp. capreolata	E	F	AN
GENTIANACEAE			
Centaurium erythraea	E	F	AN
Centaurium tenuiflorum	E	F	AN
Schenkia australis	N	F	AN
GERANIACEAE			
Geranium molle subsp. molle	E	F	SP
Geranium neglectum	N	F	PE
Geranium potentilloides var. potentilloides	N	F	PE
Geranium retrorsum	E	F	PE
Geranium solanderi var. grande	N	F	PE
Geranium solanderi var. solanderi	N	F	PE
Pelargonium inodorum	N	F	AN
GOODENIACEAE			
Brunonia australis	N	F	PE
Dampiera stricta	N	LS	PE
Goodenia bellidifolia subsp. argentea	N	F	PE
Goodenia bellidifolia subsp. bellidifolia	N	F	PE
Goodenia cycloptera	N	F	AN
Goodenia fascicularis	N	F	PE
Goodenia glabra	N	F	PE
Goodenia hederacea	N	F	PE
Goodenia ovata	N	F	PE
Goodenia pinnatifida	N	F	AN
Goodenia rotundifolia	N	F	PE
Scaevola albida	N	LS	PE
Scaevola hookeri	N	F	PE
Velleia paradoxa	N	F	PE
HAEMODORACEAE			
Haemodorum planifolium	N	F	PE
HALORAGACEAE			
Gonocarpus elatus	N	F	PE
Gonocarpus humilis	N	F	PE

Species	O	LF	LC
HALORAGACEAE			
Gonocarpus micranthus	N	F	PE
Gonocarpus tetragynus	N	F	PE
Gonocarpus teucrioides	N	F	PE
Haloragis aspera	N	F	PE
Haloragis glauca forma glauca	N	F	PE
Haloragis heterophylla	N	F	PE
Haloragis serra	N	F	PE
Myriophyllum verrucosum	N	F	PE
IRIDACEAE			
Sisyrinchium exile	E	F	AN
LAMIACEAE			
Ajuga australis	N	F	PE
Lamium amplexicaule	E	F	AN
Marrubium vulgare	E	F	PE
Mentha australis	N	F	PE
Mentha diemenica	N	F	PE
Mentha satureioides	N	F	PE
Plectranthus graveolens	N	F	PE
Plectranthus parviflorus	N	F	PE
Plectranthus suaveolens	N	F	PE
Prostanthera cruciflora	N	LS	PE
Prostanthera lasianthos	N	LS	PE
Prostanthera nivea	N	LS	PE
Prostanthera ovalifolia	N	LS	PE
Prostanthera scutellarioides	N	LS	PE
Prunella vulgaris	E	F	PE
Salvia reflexa	E	F	AN
Salvia verbenaca	E	F	PE
Scutellaria humilis	N	F	PE
Teucrium argutum	N	F	PE
Teucrium species D	N	F	PE
LAURACEAE			
Cassytha pubescens	N	C	PE
LENTIBULARIACEAE			
Utricularia dichotoma	N	F	PE
LINACEAE			
Linum marginale	N	F	PE
LOBELIACEAE			
Isotoma axillaris	N	F	PE
Isotoma fluviatilis	N	F	PE
Lobelia gibbosa	N	F	AN
Lobelia gracilis	N	F	PE
Pratia concolor	N	F	PE
Pratia pedunculata	N	F	PE
Pratia purpurascens	N	F	PE
LOGANIACEAE			
Logania albiflora	N	LS	PE
LORANTHACEAE			
Amyema bifurcatum	N	P	PE
Amyema cambagei	N	P	PE
Amyema linophylla subsp. orientalis	N	P	PE
Amyema longifolia	N	P	PE
Amyema miquelii	N	P	PE
Amyema pendula	N	P	PE
Amyema quandang var. bancroftii	N	P	PE
Amyema quandang var. quandang	N	P	PE
Dendrophthoe glabrescens	N	P	PE
Dendrophthoe vitellina	N	P	PE
Lysiana subfalcata	N	P	PE
Muellerina bidwillii	N	P	PE
Muellerina eucalyptoides	N	P	PE
LYTHRACEAE			
Lythrum hyssopifolia	N	F	AN
Lythrum salicaria	N	F	PE
MALACEAE			
Cotoneaster glaucophyllus	E	TS	PE

Species	O	LF	LC
MALVACEAE			
Abutilon malvifolium	N	LS	PE
Abutilon oxycarpum var. oxycarpum	N	LS	PE
Abutilon oxycarpum var. subsagittatum	N	LS	PE
Abutilon theophrasti	E	F	AN
Abutilon tubulosum	N	LS	PE
Hibiscus sturtii	N	LS	PE
Hibiscus trionum	E	F	SP
Malus pumila	E	T	PE
Malva neglecta	E	F	AN
Malva parviflora	E	F	AN
Malvastrum americanum	E	F	SP
Malvastrum coromandelianum	N	F	AN
Modiola caroliniana	E	F	SP
Pavonia hastata	E	LS	PE
Sida corrugata	N	F	PE
Sida cunninghamii	N	F	PE
Sida filiformis	N	F	PE
Sida rhombifolia	N	F	PE
Sida spinosa	E	LS	PE
Sida subspicata	N	LS	PE
Sida trichopoda	N	F	PE
MELIACEAE			
Melia azedarach	N	T	PE
MENISPERMACEAE			
Stephania japonica	N	C	PE
MORACEAE			
Ficus coronata	N	T	PE
Ficus rubiginosa	N	T	PE
Maclura pomifera	E	T	PE
Morus alba	E	T	PE
MYOPORACEAE			
Eremophila debilis	N	LS	PE
Eremophila mitchellii	N	TS	PE
Eremophila polyclada	N	LS	PE
Myoporum montanum	N	LS	PE
MYRTACEAE			
Acmena smithii	N	T	PE
Angophora floribunda	N	T	PE
Callistemon pityoides	N	TS	PE
Callistemon pungens	N	TS	PE
Callistemon viminalis	N	T	PE
Calytrix tetragona	N	LS	PE
Eucalyptus acaciiformis	N	T	PE
Eucalyptus albens	N	T	PE
Eucalyptus andrewsii	N	T	PE
Eucalyptus banksii	N	T	PE
Eucalyptus blakelyi	N	T	PE
Eucalyptus bridgesiana	N	T	PE
Eucalyptus caleyi subsp. caleyi	N	T	PE
Eucalyptus caleyi subsp. ovendenii	N	T	PE
Eucalyptus caliginosa	N	T	PE
Eucalyptus camaldulensis	N	T	PE
Eucalyptus chloroclada	N	T	PE
Eucalyptus conica	N	T	PE
Eucalyptus crebra	N	T	PE
Eucalyptus dalrympleana	N	T	PE
Eucalyptus dealbata	N	T	PE
Eucalyptus dwyeri	N	T	PE
Eucalyptus elliptica	N	T	PE
Eucalyptus laevopinea	N	T	PE
Eucalyptus macrorhyncha	N	T	PE
Eucalyptus malacoxylon	N	T	PE
Eucalyptus mckieana	N	T	PE
Eucalyptus melanophloia	N	T	PE
Eucalyptus melliodora	N	T	PE
Eucalyptus microcarpa	N	T	PE

Species	O	LF	LC
MYRTACEAE			
Eucalyptus moluccana	N	T	PE
Eucalyptus nobilis	N	T	PE
Eucalyptus nortonii	N	T	PE
Eucalyptus obliqua	N	T	PE
Eucalyptus pauciflora	N	T	PE
Eucalyptus pilligaensis	N	T	PE
Eucalyptus populnea subsp. bimbil	N	T	PE
Eucalyptus prava	N	T	PE
Eucalyptus quinniorum	N	T	PE
Eucalyptus sideroxylon	N	T	PE
Eucalyptus stannicola	N	T	PE
Eucalyptus stellulata	N	T	PE
Eucalyptus subtilior	N	T	PE
Eucalyptus viminalis	N	T	PE
Eucalyptus volcanica	N	T	PE
Eucalyptus youmanii	N	T	PE
Kunzea opposita	N	LS	PE
Kunzea sp. 'Mt Kaputar'	N	LS	PE
Leptospermum brevipes	N	TS	PE
Leptospermum microcarpum	N	T	PE
Leptospermum novae-angliae	N	T	PE
Leptospermum polygalifolium	N	TS	PE
Melaleuca bracteata	N	TS	PE
Micromyrtus sessilis	N	LS	PE
Micromyrtus striata	N	LS	PE
NYCTAGINACEAE			
Boerhavia dominii	N	F	PE
Boerhavia repleta	N	F	PE
OLEACEAE			
Jasminum lineare	N	LS	PE
Jasminum suavissimum	N	LS	PE
Ligustrum lucidum	E	TS	PE
Notelaea microcarpa var. microcarpa	N	T	PE
Notelaea microcarpa var. velutina	N	T	PE
Olea europaea	E	T	PE
ONAGRACEAE			
Epilobium billardiereanum subsp. cinereum	N	F	PE
Epilobium billardiereanum subsp. hydrophilum	N	F	PE
Epilobium hirtigerum	N	F	PE
Ludwigia peploides subsp. montevidensis	N	F	PE
Oenothera rosea	E	LS	PE
OXALIDACEAE			
Oxalis chnoodes	N	F	PE
Oxalis corniculata	N	F	PE
Oxalis thompsoniae	N	F	PE
PAPAVERACEAE			
Argemone ochroleuca subsp. ochroleuca	N	F	AN
PHYTOLACCACEAE			
Phytolacca octandra	E	F	SP
PITTOSPORACEAE			
Billardiera scandens	N	LS	PE
Bursaria longisepala	N	TS	PE
Bursaria spinosa	N	TS	PE
Cheiranthera cyanea var. cyanea	N	LS	PE
Pittosporum angustifolium	N	T	PE
Pittosporum undulatum	N	T	PE
Rhytidosporum diosmoides	N	LS	PE
Rhytidosporum procumbens	N	LS	PE
PLANTAGINACEAE			
Plantago cunninghamii	N	F	PE
Plantago debilis	N	F	SP
Plantago gaudichaudii	N	F	PE

Species	O	LF	LC
PLANTAGINACEAE			
Plantago hispida	N	F	PE
Plantago lanceolata	E	F	SP
Plantago turrifera	N	F	AN
Plantago varia	N	F	PE
POLYGALACEAE			
Comesperma sylvestre	N	LS	PE
Polygala japonica	N	F	PE
POLYGANACEAE			
Fallopia convolvulus	E	F	AN
Rumex brownii	N	F	PE
Rumex crispus	E	F	PE
POLYGONACEAE			
Muehlenbeckia florulenta	N	LS	PE
Muehlenbeckia gracillima	N	C	PE
Muehlenbeckia rhyticarya	N	LS	PE
Persicaria attenuata	N	F	AN
Persicaria decipiens	N	F	AN
Persicaria hydropiper	N	F	AN
Persicaria lapathifolia	N	F	AN
Persicaria prostrata	N	F	PE
Polygonum arenastrum	E	F	SP
Polygonum aviculare	E	F	SP
Polygonum patulum	N	F	AN
Rumex acetosella	E	F	PE
Rumex crystallinus	N	F	AN
Rumex dumosus	N	F	PE
PORTULACACEAE			
Calandrinia eremaea	N	F	AN
Portulaca oleracea	N	F	AN
PRIMULACEAE			
Anagallis arvensis	E	F	SP
PROTEACEAE			
Grevillea floribunda subsp. floribunda	N	LS	PE
Grevillea ramosissima subsp. ramosissima	N	LS	PE
Grevillea triternata	N	LS	PE
Hakea eriantha	N	TS	PE
Hakea laevipes subsp. graniticola	N	TS	PE
Hakea microcarpa	N	TS	PE
Lomatia arborescens	N	T	PE
Persoonia chamaepeuce	N	TS	PE
Persoonia cornifolia	N	TS	PE
Persoonia fastigiata	N	LS	PE
Persoonia sericea	N	LS	PE
Petrophile canescens	N	LS	PE
RANUNCULACEAE			
Clematis aristata	N	C	PE
Clematis glycinoides var. glycinoides	N	C	PE
Clematis glycinoides var. submutica	N	C	PE
Clematis microphylla var. leptophylla	N	C	PE
Clematis microphylla var. microphylla	N	C	PE
Ranunculus lappaceus	N	F	PE
Ranunculus meristus	N	F	PE
Ranunculus pumilio	N	F	AN
Ranunculus sessiliflorus var. pilulifer	N	F	AN
Ranunculus sessiliflorus var. sessiliflorus	N	F	AN
Ranunculus undosus	N	F	PE
RHAMNACEAE			
Alphitonia excelsa	N	T	PE
Cryptandra amara var. amara	N	LS	PE
Cryptandra amara var. floribunda	N	LS	PE
Cryptandra amara var. longiflora	N	LS	PE
Cryptandra propinqua	N	LS	PE
Discaria pubescens	N	LS	PE

Species	O	LF	LC
RHAMNACEAE			
Pomaderris angustifolia	N	TS	PE
Pomaderris betulina	N	TS	PE
ROSACEAE			
Acaena agnipila	N	F	PE
Acaena echinata	N	F	PE
Acaena novae-zelandiae	N	F	PE
Acaena ovina	N	F	PE
Rosa rubiginosa	E	LS	PE
Rubus discolor	E	LS	PE
Rubus fruticosus sp. agg.	E	LS	PE
Rubus parvifolius	N	LS	PE
Rubus pyramidalis	E	LS	PE
Rubus rosifolius	N	LS	PE
Rubus ulmifolius	E	LS	PE
Rubus vestitus	E	LS	PE
RUBIACEAE			
Asperula conferta	N	F	PE
Asperula cunninghamii	N	F	PE
Asperula scoparia	N	F	PE
Asperula subulifolia	N	F	PE
Coprosma hirtella	N	LS	PE
Coprosma quadrifida	N	LS	PE
Galium aparine	E	F	AN
Galium binifolium	N	F	AN
Galium ciliare	N	F	PE
Galium gaudichaudii	N	F	PE
Galium migrans	N	F	PE
Galium murale	E	F	AN
Galium propinquum	N	F	AN
Opercularia aspera	N	LS	PE
Opercularia diphylla	N	F	PE
Opercularia hispida	N	F	PE
Pomax umbellata	N	LS	PE
Psydrax odorata	N	T	PE
Psydrax oleifolia	N	T	PE
Sherardia arvensis	E	F	AN
RUTACEAE			
Boronia microphylla	N	LS	PE
Boronia polygalifolia	N	LS	PE
Boronia rubiginosa	N	LS	PE
Correa alba var. alba	N	LS	PE
Correa glabra	N	LS	PE
Correa reflexa	N	LS	PE
Geijera parviflora	N	TS	PE
Melicope micrococca	N	T	PE
Phebalium squamulosum subsp. squamulosum	N	LS	PE
Zieria aspalathoides	N	LS	PE
Zieria cytisoides	N	TS	PE
SALICACEAE			
Populus nigra	E	T	PE
Salix babylonica	E	T	PE
SAMBUCACEAE			
Sambucus australasica	N	LS	PE
Sambucus gaudichaudiana	N	LS	PE
SANTALACEAE			
Exocarpos cupressiformis	N	HP	PE
Exocarpos strictus	N	TS	PE
Leptomeria drupacea	N	TS	PE
Santalum lanceolatum	N	HP	PE
Thesium australe	N	F	PE
SAPINDACEAE			
Alectryon forsythii	N	TS	PE
Alectryon oleifolius	N	T	PE
Alectryon subdentatus forma subdentatus	N	T	PE
Atalaya hemiglauca	N	T	PE

Species	O	LF	LC
SAPINDACEAE			
Cupaniopsis baileyana	N	T	PE
Dodonaea boroniifolia	N	LS	PE
Dodonaea heteromorpha	N	TS	PE
Dodonaea rhombifolia	N	TS	PE
Dodonaea sinuolata	N	LS	PE
Dodonaea triquetra	N	TS	PE
Dodonaea viscosa subsp. angustifolia	N	TS	PE
Dodonaea viscosa subsp. angustissima	N	TS	PE
Dodonaea viscosa subsp. cuneata	N	TS	PE
Dodonaea viscosa subsp. mucronata	N	TS	PE
Dodonaea viscosa subsp. spatulata	N	TS	PE
SCROPHULARIACEAE			
Derwentia arcuata	N	F	PE
Derwentia arenaria	N	F	PE
Derwentia derwentiana	N	F	PE
Derwentia velutina	N	F	PE
Euphrasia collina	N	F	PE
Gratiola pedunculata	N	F	PE
Gratiola peruviana	N	F	PE
Linaria arvensis	E	F	AN
Linaria pelisseriana	E	F	AN
Mimulus gracilis	N	F	PE
Mimulus prostratus	N	F	PE
Mimulus repens	N	F	PE
Misopates orontium	E	F	AN
Verbascum thapsus subsp. thapsus	E	F	SP
Verbascum virgatum	E	F	SP
Veronica anagallis-aquatica	E	F	PE
Veronica arvensis	E	F	AN
Veronica calycina	E	F	AN
Veronica plebeia	N	F	PE
SIMAROUBACEAE			
Ailanthus altissima	E	T	PE
SMILACACEAE			
Smilax australis	N	C	PE
SOLANACEAE			
Capsicum annuum var. glabriusculum	E	LS	PE
Cestrum parqui	E	LS	PE
Datura ferox	E	F	AN
Datura stramonium	E	F	AN
Lycium ferocissimum	E	TS	PE
Nicotiana suaveolens	N	F	PE
Physalis ixocarpa	E	F	AN
Solanum americanum	N	LS	PE
Solanum aviculare	N	TS	PE
Solanum brownii	N	LS	PE
Solanum chenopodioides	E	F	AN
Solanum cinereum	N	F	PE
Solanum ellipticum	N	F	PE
Solanum esuriale	N	F	PE
Solanum ferocissimum	N	LS	PE
Solanum opacum	N	F	AN
Solanum papaverifolium	N	F	PE
Solanum parvifolium	N	LS	PE
Solanum prinophyllum	N	F	SP
Solanum pseudocapsicum	E	LS	PE
Solanum semiarmatum	N	LS	PE
STACKHOUSIACEAE			
Stackhousia monogyna	N	F	PE
Stackhousia muricata	N	F	PE
Stackhousia viminea	N	F	PE
STERCULIACEAE			
Brachychiton populneus subsp. populneus	N	T	PE
Rulingia dasyphylla	N	TS	PE

Species	O	LF	LC
THYMELAEACEAE			
Pimelea curviflora	N	LS	PE
Pimelea curviflora var. divergens	N	LS	PE
Pimelea curviflora var. gracilis	N	LS	PE
Pimelea curviflora var. sericea	N	LS	PE
Pimelea glauca	N	LS	PE
Pimelea latifolia	N	LS	PE
Pimelea linifolia subsp. collina	N	LS	PE
Pimelea linifolia subsp. linifolia	N	LS	PE
Pimelea micrantha	N	LS	PE
Pimelea neo-anglica	N	LS	PE
Pimelea simplex	N	LS	PE
Pimelea stricta	N	LS	PE
Pimelea strigosa	N	LS	PE
ULMACEAE			
Trema tomentosa var. viridis	N	T	PE
URTICACEAE			
Parietaria debilis	N	F	AN
Urtica incisa	N	F	PE
Urtica urens	E	F	AN
VERBENACEAE			
Glandularia aristigera	E	F	PE
Oncinocalyx betchei	N	F	PE
Phyla canescens	E	F	PE
Phyla nodiflora var. nodiflora	E	F	PE

Species	O	LF	LC
VERBENACEAE			
Verbena bonariensis	E	F	PE
Verbena gaudichaudii	E	F	PE
Verbena hispida	E	F	PE
Verbena incompta	E	F	PE
Verbena litoralis	E	F	PE
Verbena officinalis	E	F	PE
Verbena quadrangularis	E	F	PE
Verbena rigida	E	F	PE
VIOLACEAE			
Hybanthus monopetalus	N	F	PE
Melicytus dentatus	N	TS	PE
Viola banksii	N	F	PE
Viola betonicifolia	N	F	PE
Viola caleyana	N	F	PE
VISCACEAE			
Korthalsella rubra subsp. geijericola	N	P	PE
Notothixos cornifolius	N	P	PE
VITACEAE			
Cayratia clematidea	N	C	PE
Clematicissus opaca	N	C	PE
ZYGOPHYLLACEAE			
Tribulus micrococcus	N	F	AN
Tribulus minutus	N	F	AN
Tribulus terrestris	E	F	AN

APPENDIX 2

Species list for taxa represented in seasonal monitoring dataset (Chapter 3)

Plant species incidence data for six grazed pasture sites for 10 monitoring periods over two years from October 2008 to October 2010, showing origin (O, N = native, E = exotic) and Raunkier's life-form classification (R, H = hemicryptophyte, G = geophyte, T = therophyte (annual), Ph = Phanerophyte, C = Chamaephyte). The presence (+) or absence (-) of each species is indicated at each site for each monitoring period, in chronological order.

	O	R	Arlemont	Bareela	Gemma	Marathon	Werona	Wooli
Monocotyledons								
ANTHERICACEAE								
Arthropodium minus	N	H	----------	----------	----------	---------	----------	-++------+
Dichopogon fimbriatus	N	H	----------	----------	----------	---------	----------	-++--+---+
ASPHODELACEAE								
Bulbine bulbosa	N	G	----------	----------	+---------	---------	----------	+---+---+-
CYPERACEAE								
Carex inversa	N	H	++++-+++++	++++++++++	++++++++++	+++++++++	----------	++++++++++
Cyperus gracilis	N	H	-+--------	----------	----------	---------	-+--------	----------
JUNCACEAE								
Juncus subsecundus	N	H	----------	++++++++++	----------	---------	----------	----------
Juncus usitatus	N	H	++++++++++	----------	----------	---------	----------	----------
POACEAE								
Aristida leptopoda	N	H	----------	----------	-+--++-+--	---------	----------	----------
Aristida ramosa	N	H	++++++++++	++++++++++	++++++++++	+++++++++	++++++++++	++++++++++
Austrodanthonia bipartita	N	H	----------	++++++++++	++-+-+-+--	+++++++++	++++++++++	++++++++++
Austrodanthonia caespitosa	N	H	----------	++--++----	----------	---------	++++++++++	----------
Austrodanthonia racemosa	N	H	+++-+--+--	----------	----------	---------	----------	----------
Austrostipa aristiglumis	N	H	----------	----------	++++++++++	---------	----------	----------
Austrostipa scabra	N	H	----------	++--------	----------	+++++++++	++++++++++	++++++++++
Austrostipa setacea	N	H	----------	----------	----------	---------	----------	+++---+---
Austrostipa verticillata	N	H	----------	----------	----------	+++++++++	----------	++++++++++
Avena barbata	E	T	-++++++---	----------	+---------	---------	----------	----------
Bothriochloa macra	N	H	++++++++++	++++++++++	++-+------	+++++++++	++++++++++	++++++++++
Bromus hordeaceus	E	T	+-+-------	++--------	+++--++---	---------	-+++-+----	-++------+
Chloris truncata	N	H	-++---+---	++++++++++	++++++++++	-+++++++++	++++++++++	++++++++++
Chloris ventricosa	N	H	----------	----------	----------	-++-+----	----------	----------
Cynodon dactylon	N	H	++-+++++--	----------	++--------	++----+--	----------	++--------
Dichanthium sericeum	N	H	----------	+++++++-++	++++++++++	---------	++++++++++	----------
Dichelachne micrantha	N	H	-------+--	+++-----+-	----------	---------	----------	----------
Digitaria brownii	N	H	----------	----------	----------	---------	----------	-++-------
Digitaria divaricatissima	N	H	----------	----------	----------	---------	-------+--	----------
Eleusine tristachya	E	T	++----+++-	+++++-++--	----------	---------	----------	----------
Elymus scaber	N	H	+++---+---	-++-+-----	----------	---------	----------	------+---
Enneapogon gracilis	N	H	----------	----------	----------	-++++++-+-	------+---	----------
Enteropogon acicularis	N	H	----------	----------	----------	+++++++++	----------	++++++++++
Eragrostis cilianensis	E	T	----------	----------	----------	+------+-	----------	--++---++-
Eragrostis leptostachya	N	H	++++++++++	++++++++++	----------	+++++-+++	+++++-++++	++++++++++
Hordeum leporinum	E	T	-+--------	----------	++--------	+++--+--+	----------	++---+---+
Lolium perenne	E	H	-++-----++	-+-------+	++---+--++	+++-----+	++++++++++	----++--++
Microlaena stipoides	N	H	-+-+-+----	----------	----------	---------	----------	----------
Panicum effusum	N	H	-+++++-++-	-+++--+---	-+++------	-++------	++++++++++	-+++------
Paspalum dilatatum	E	H	--++++++++	--++------	----------	---------	----------	----------

Rostraria cristata	E	T	----------	----------	----------	---------	-+++-+---+	++---+---+
Sporobolus creber	N	H	++++++++++	++++++++++	----------	++++---+-	++++++++++	-+-+---+--
Tragus australianus	N	T	----------	----------	----------	---------	--++---+--	--+-------
Urochloa panicoides	E	T	++--------	----------	----------	++-+--+++	++--------	----------
Vulpia myuros	E	T	+++--+----	++--------	+---------	---------	+++--+---+	++-------+
Dicotyledons								
AMARANTHACEAE								
Alternanthera nana	N	T	----------	--++--++--	----------	---------	----------	----------
Alternanthera pungens	E	H	----------	----------	----------	+--------	----------	----------
Amaranthus macrocarpus	E	T	----------	----------	--+-------	---------	----------	----------
Amaranthus retroflexus	E	T	----------	----------	----------	++-------	----------	--+-------
APIACEAE								
Cyclospermum leptophyllum	E	T	--+------+	-++-------	--++-+---+	---------	--+--+----	----------
Daucus glochidiatus	N	T	+---------	-+++++---+	++----+-++	-++---+--	-+++++---+	-+------++
Hydrocotyle laxiflora	N	H	----------	-++------+	----------	---------	----------	----------
ASTERACEAE								
Bidens subalternans	E	T	----------	----------	----------	+-++-----	----------	----------
Calotis lappulacea	N	H	----------	----------	----------	-+++++++-	++++--++--	++++++++++
Carthamus lanatus	E	T	++++++++++	+++-++++++	++++++++++	--------+	+++++++-+-	++++++++++
Chrysocephalum apiculatum	N	H	----------	--++++++++	----------	---------	----------	----------
Cirsium vulgare	E	T	-++++--+-+	-+++++++++	+++++-----	--++-----	++--------	----------
Conyza bonariensis	E	H	----------	--+++-++--	--++------	-++++---+	--++------	--++------
Conyza sumatrensis	E	H	--+++----+	----------	----------	---------	----------	----------
Cotula australis	N	T	--------+	-++--+---+	----------	----+--++	-+-------+	----++---+
Cymbonotus lawsonianus	N	H	----------	++++++++++	+-+------+	---------	++--+++-++	+++--+---+
Euchiton involucratus	N	H	----------	+++++++-++	-+++-+---+	-+++----+	-+++-----+	--+-------
Glossocardia bidens	N	H	----------	--+-------	----------	+--------	----------	----------
Hedypnois rhagadioloides subsp. cretica	E	T	----------	------+---	-+---+--++	---------	-++--+--++	--------+
Hypochaeris microcephela	E	H	----------	-+---++--+	----------	---------	----------	----------
Hypochaeris radicata	E	H	+++--+-+-+	-++-+-+--+	++--+----+	-+--+--++	++--+----+	++--++---+
Lactuca serriola	E	T	----------	--++--+--+	--+------+	--+------	----------	----------
Onopordum acanthium subsp. acanthium	E	T	+---------	----------	----------	---------	----------	----------
Schkuhria pinnata var. abrotanoides	E	T	----------	----------	----------	+++++----	----------	----------
Silybum marianum	E	T	----------	----------	++----+-++	-+--+--++	----------	++-------+
Solenogyne bellioides	N	H	----------	------+---	----------	---------	----------	----+-----
Sonchus oleraceus	E	T	----------	--+------+	+-+--+---+	+++-+---+	----------	--------++
Stuartina hamata	N	T	----------	----------	----------	---------	----------	-+-------+
Taraxacum officinale	E	H	----------	++--+-----	----------	-+--+----	-+--------	-++-------
Triptilodiscus pygmaeus	N	T	----------	----------	----------	---------	----------	-+-------+
Vittadinia muelleri	N	H	----------	----------	-+-+------	---------	+++++++--+	-+++++-+--
Vittadinia sulcata	N	T	----------	----------	----------	-+++++++-	++---+-+++	----------
Xanthium spinosum	E	T	+---------	++++------	++----+++-	---------	----------	--+----+--
BRASSICACEAE								
Capsella bursa-pastoris	E	H	----------	++---+---+	-+---+---+	-+--+---+	----------	-----+---+
Lepidium africanum	E	H	----------	++++++++++	----------	+++++--+-	--++------	-++++-----
Sisymbrium irio	E	T	----------	----------	--------+	-+------+	----------	----------
Sisymbrium officinale	E	T	----------	----------	----------	-+-------	----------	----------
CACTACEAE								
Opuntia stricta	E	Ph	----------	----------	----------	---------	----------	-----+++++
CAMPANULACEAE								
Wahlenbergia communis	N	H	----------	-++++++---	----------	--------+	-+-+-++--+	-++--+-+-+
CARYOPHYLLACEAE								
Arenaria leptoclados	E	T	--------+	----------	--------+	---------	----------	--------+
Cerastium glomeratum	E	T	----------	--------+	----------	---------	----------	----------
Paronychia brasiliana	E	H	--++++----	-+++-+++--	----------	---------	----------	----------
Petrorhagia nanteuilii	E	T	++++------	--+++-++--	--++-+----	---------	--++++----	----------
Polycarpon tetraphyllum	E	T	----------	-++-------	----------	---------	--+-------	--+--+---+
Silene gallica	E	T	--++------	----------	----------	--+------	----------	----------
CHENOPODIACEAE								
Atriplex spinibractea	N	Ph	----------	----------	----------	---+++---	----------	-------+--
Chenopodium melanocarpum	N	T	----------	----------	---+---+--	---------	----------	----------

Chenopodium pumilio	N	T	------++-+	+---------	----------	---------	----------	--+----+--
Einadia nutans	N	C	----------	++++++++++	-+----+---	+++++++++	+++++++--	++++++++++
Maireana microphylla	N	Ph	----------	----------	----------	+++++++++	----------	----------
Salsola kali	N	T	----------	----------	----------	+-+++----	----------	----------
CONVOLVULACEAE								
Convolvulus erubescens	N	H	----------	-++--++---	-++---+---	---------	-++----+-+	----------
Dichondra repens	N	H	+++++-+-++	++++++++++	++++++++++	+++++++++	+++--+----	++--+++-++
CRASSULACEAE								
Crassula sieberiana	N	T	----------	++-------+	-+------+-	+----+-++	++---+---+	++--++--++
CUCURBITACEAE								
Cucumis myriocarpus	E	T	----------	----------	----------	---------	+---------	----------
EUPHORBIACEAE								
Chamaesyce drummondii	N	H	----------	++++-+++--	++++++++--	---------	+++-------	----------
FABACEAE								
Glycine tabacina	N	H	-++---++--	++++-+++--	----------	---------	----------	-++-------
Medicago laciniata	E	T	----------	----------	----------	--------+	----------	----------
Medicago lupulina	E	H	----------	----------	----------	---------	-++--+---+	----------
Medicago minima	E	T	----------	----------	++--+++-+-	---------	--------+-	----------
Medicago polymorpha	E	T	----++--+-	++-+++-+++	++--+++-++	+++++++++	+++-++---+	+++-++--++
Medicago truncatula	E	T	----------	----------	----------	-++------	----------	----------
Trifolium angustifolium	E	T	----------	----------	----------	---------	---------+	----------
Trifolium arvense	E	T	----------	----------	--+-------	--+------	-++--+---+	-+---+----
Trifolium campestre	E	T	-+-------+	-++-------	--+--+-+--	---------	----------	----------
Trifolium glomeratum	E	T	--+-----+-	----+----+	----------	-++------	+++-++--++	----+++-+-
Trifolium repens	E	H	----------	----------	----------	--------+	----------	----------
Trifolium subterraneum	E	T	++-+++++-+	-+--------	-+--------	---------	----------	++-------+
Trifolium tomentosum	E	T	----------	----------	-+---+----	---------	----------	-+---+---+
Trifolium vesiculosum	E	T	----------	----------	--+-------	---------	----------	----------
GENTIANACEAE								
Centaurium erythraea	E	T	--+-------	--+-------	--+-++----	--+------	--++++----	----------
Erodium cicutarium	E	H	----------	+-------++	----------	---------	----------	----------
Erodium crinitum	E	H	----------	----------	----------	--------+	----------	+++-+++-++
Geranium solanderi	N	H	++-------+	++++++++++	-+--------	---------	---------+	+---------
GOODENIACEAE								
Goodenia pinnatifida	N	H	----------	-++--+----	----------	---------	----------	----------
Scaevola humilis	N	H	----------	--+---+---	----------	---------	----------	----------
LAMIACEAE								
Lamium amplexicaule	E	T	----------	----------	++---+--+-	+++-+++++	----------	---------+
Marrubium vulgare	E	Ph	----------	----------	--+-------	-+-+-----	----------	----------
Mentha satureioides	N	H	----------	+++---+---	++++++++++	---------	++--------	----------
Salvia reflexa	E	T	----------	----------	----------	---+-----	----------	----------
Salvia verbenaca	E	H	----------	---++---+-	----------	---------	----------	----------
MALVACEAE								
Malva parviflora	E	T	----------	----------	-+--------	-+-+--+-+	----+-----	+++-+-+-++
Modiola caroliniana	E	C	+++---++-+	------++--	----------	---------	----------	----------
Sida corrugata	N	H	----------	----------	----------	---------	----------	-----+++--
Sida spinosa	E	T	----------	----------	----------	---------	----------	-+++------
MYOPORACEAE								
Eremophila debilis	N	Ph	----------	---+------	----------	---------	----------	+---------
NYCTAGINACEAE								
Boerhavia dominii	N	H	----------	----------	--++-+++--	---+--+--	----------	--++-+++--
OXALIDACEAE								
Oxalis corniculata	N	C	+++----+-+	++++++++++	++++++++++	++-+--+-+	+++-+++-+-	+++---+--+
PLANTAGINACEAE								
Plantago debilis	N	H	----------	++++--+--+	++++++++++	--+-+---+	-+--------	-+++-++---
Plantago lanceolata	E	H	----------	----------	---+--+---	---------	----------	------+---
POLYGANACEAE								
Rumex brownii	N	H	++++-+++++	++++++++++	-----++--+	---------	+----+--+-	++++++++++
Polygonum aviculare	E	c	++--------	+++-+-+---	---+------	---+-----	----------	----------
PORTULACACEAE								
Portulaca oleracea	N	T	------+---	------+---	------+---	------+--	-------+--	--+---++--
PRIMULACEAE								
Anagallis arvensis	E	T	--+------+	+---------	++---+---+	---------	---------+	-+--------
RANUNCULACEAE								

Ranunculus sessiliflorus	N	H	----------	----------	----------	--------+	----------	----------
ROSACEAE								
Acaena novae-zelandiae	N	C	----------	----------	----------	---------	----------	+----+----
RUBIACEAE								
Asperula conferta	N	C	----------	+++++++++-	++++-+++-+	---------	----------	----------
SCROPHULARIACEAE								
Kickxia spuria subsp. integrifolia	E	H	----------	----------	--+-------	---------	----------	----------
Linaria arvensis	E	T	----------	-+-------+	----------	---------	----------	----------
Verbascum thapsus	E	T	+++-------	----------	----------	---------	----------	----------
Veronica arvensis	E	T	----------	----------	----------	--------+	----------	----------
Veronica peregrina	E	T	----------	-+--------	----------	---------	----------	----------
URTICACEAE								
Urtica incisa	N	H	----------	----------	----------	-+-------	----------	----------
ZYGOPHYLLACEAE								
Tribulus terrestris	E	T	----------	----------	------+---	--++--+--	----------	--++--++--

APPENDIX 3

Species list for taxa represented in the farm case study (Chapter 4), Showing origin (O, N = native, E = exotic) and species occurrence frequency in each of six land uses (U = ungrazed woodland, G = grazed woodland, P = native pasture, R = roadside, C = crop, D = dry creek bed).

Species	O	U	G	P	R	C	D
Pteridophytes							
ADIANTACEAE							
Cheilanthes	N	1	1	1	-	-	-
Cheilanthes sieberi	N	1	4	1	1	-	1
Cycads							
ZAMIACEAE							
Macrozamia	N	-	1	-	-	-	-
Monocotyledons							
ANTHERICACEAE							
Arthropodium minus	N	2	1	-	-	-	-
Dichopogon	N	1	3	1	1	-	1
CYPERACEAE							
Carex breviculmis	N	1	2	-	-	-	-
Carex inversa	N	2	3	5	4	-	2
Cyperus gracilis	N	2	5	1	-	-	2
Scleria mackaviensis	N	-	1	-	-	-	-
IRIDACEAE							
Sisyrinchium sp. A	N	-	2	-	-	-	-
JUNCACEAE							
Juncus usitatus	N	-	-	2	-	1	-
ORCHIDACEAE							
Pterostylis sp.	N	1	-	-	-	-	-
PHORMIACEAE							
Dianella longifolia	N	3	-	-	1	-	-
POACEAE							
Aristida leptopoda	N	1	-	-	-	-	-
Aristida ramosa	N	3	5	5	5	3	2
Austrodanthonia	N	-	1	4	4	3	-
Austrodanthonia	N	3	5	2	2	-	2
Austrodanthonia	N	-	2	1	-	-	-
Austrostipa	N	-	-	-	3	-	-
Austrostipa scabra	N	3	5	5	4	1	2
Austrostipa setacea	N	-	-	-	2	-	-
Austrostipa	N	1	5	3	-	2	2
Avena barbata	E	-	-	1	5	3	-
Bothriochloa macra	N	3	5	5	4	1	2
Briza minor	E	-	-	1	-	-	-
Bromus catharticus	E	-	-	1	3	-	1
Bromus molliformis	E	-	1	4	5	3	1
Chloris truncata	N	-	-	4	2	3	1
Chloris ventricosa	N	3	2	2	-	1	2
Cymbopogon	N	3	2	-	-	-	-
Cynodon dactylon	N	-	1	2	2	2	-
Dichanthium	N	2	2	5	5	2	1
Dichelachne	N	-	2	1	1	-	1
Elymus scaber	N	1	2	3	4	-	2
Enneapogon	N	1	1	-	-	-	-
Enteropogon	N	1	1	-	-	-	-
Eragrostis	N	-	-	2	-	-	-
Eriochloa	N	-	-	-	1	-	-
Hordeum leporinum	E	-	-	3	2	7	-
Hyparrhenia hirta	E	-	-	-	3	-	-
Lolium perenne	E	1	2	5	5	7	-
Panicum effusum	N	1	1	-	1	-	2
Paspalidium gracile	N	3	4	-	-	-	1
Paspalum dilatatum	E	-	-	-	5	-	-
Poa sieberiana var. sieberiana	N	3	2	-	-	-	-
Rostraria cristata	E	-	-	4	2	3	-
Sarga leiocladum	E	2	-	-	1	-	-
Sorghum bicolor	E	1	-	-	-	1	-
Sporobolus creber	N	2	1	5	3	-	1
Themeda triandra	N	1	-	-	-	-	-
Triticum aestivum	E	-	-	-	-	2	-
Vulpia myuros	E	-	-	4	3	-	-
XANTHORRHOEACEA							
Lomandra filiformis	N	3	2	-	-	-	1
Lomandra longifolia	N	2	3	-	2	-	-
Lomandra multiflora	N	2	4	-	1	-	1
Dicotyledons							
ACANTHACEAE							
Brunoniella australis	N	3	3	-	-	-	2
Rostellularia	N	2	-	-	-	-	1
AMARANTHACEAE							
Alternanthera	E	-	-	1	-	-	-
APIACEAE							
Cyclospermum	E	-	-	4	3	5	-
Daucus glochidiatus	N	1	1	5	4	-	1
Foeniculum vulgare	E	-	-	-	1	-	-
Hydrocotyle laxiflora	N	1	3	1	-	-	1
ASCLEPIADACEAE							
Marsdenia viridiflora	N	-	-	-	-	-	1
ASTERACEAE							
Brachyscome	N	-	2	-	-	-	-
Calotis hispidula	N	-	-	3	-	-	-
Calotis lappulacea	N	2	2	4	1	3	-
Carthamus lanatus	E	-	-	5	2	2	1
Centaurea solstitialis	E	1	-	3	4	3	1
Chrysocephalum	N	2	-	-	3	-	1
Cirsium vulgare	E	1	1	-	-	-	-
Conyza bonariensis	E	-	-	2	-	1	-
Cotula australis	N	-	-	2	-	2	-
Cymbonotus	N	1	1	3	1	-	2
Euchiton	N	2	-	4	2	1	2
Hedypnois subsp. cretica	E	-	-	3	4	2	1
Hypochaeris	E	-	-	1	-	-	-
Hypochaeris radicata	E	-	-	5	1	-	-
Lactuca saligna	E	-	-	-	1	-	1
Microseris	N	1	-	-	-	-	-
Senecio	N	-	-	-	2	-	1
Silybum marianum	E	-	-	-	-	2	-
Solenogyne	N	1	2	-	-	-	2
Soliva sessilis	E	-	-	1	-	-	-
Sonchus oleraceus	E	-	-	2	2	3	-
Vittadinia muelleri	N	3	4	3	3	3	2
Xanthium spinosum	E	-	1	-	-	2	-
Cassinia laevis	N	1	1	-	-	-	-

ASTERACEAE							
Vittadinia sulcata	N	-	1	4	3	2	2
BIGNONIACEAE							
Pandorea pandorana	N	1	-	-	-	-	-
Pandorea pandorana pandorana	N	-	2	-	-	-	-
BORAGINACEAE							
Buglossoides	E	-	-	-	1	1	-
Echium	E	-	-	-	4	-	-
BRASSICACEAE							
Capsella bursa-	E	-	-	1	1	4	-
Lepidium africanum	E	1	1	2	-	4	-
Rapistrum rugosum	E	-	-	-	1	-	-
Sisymbrium	E	-	-	-	2	3	-
CACTACEAE							
Opuntia aurantiaca	E	-	1	-	-	-	1
Opuntia stricta	E	-	-	1	1	1	1
CAMPANULACEAE							
Wahlenbergia	N	2	3	5	2	-	2
Wahlenbergia	N	-	-	-	-	-	1
CARYOPHYLLACEAE							
Arenaria leptoclados	E	-	1	2	3	-	-
Paronychia	E	-	-	1	-	1	-
Petrorhagia	E	1	2	4	3	-	1
Polycarpon	E	-	-	2	-	3	-
CHENOPODIACEAE							
Atriplex suberecta	N	-	-	1	1	2	-
Einadia hastata	N	-	2	-	-	1	-
Einadia nutans	N	1	4	5	2	5	1
Maireana	N	1	-	-	1	-	-
Salsola kali	N	-	-	2	1	4	-
Maireana	N	-	2	3	3	4	-
CLUSIACEAE							
Hypericum	N	-	1	-	-	-	-
CONVOLVULACEAE							
Convolvulus	N	2	1	2	2	1	2
Dichondra repens	N	3	5	5	2	1	2
CRASSULACEAE							
Crassula sieberiana	N	-	1	5	-	5	1
EUPHORBIACEAE							
Chamaesyce	N	-	1	5	-	2	-
Phyllanthus virgatus	N	-	-	1	-	-	-
FABACEAE							
Glycine clandestina	N	1	3	-	-	-	-
Glycine tabacina	N	3	5	3	5	-	2
Hardenbergia	N	1	-	-	-	-	-
Cullen tenax	N	-	-	-	3	-	-
Desmodium	N	3	4	-	-	-	2
Desmodium varians	N	2	-	-	-	-	-
Lotus australis	N	-	-	-	1	-	-
Medicago lupulina	E	-	-	3	1	-	-
Medicago	E	3	3	5	5	3	2
Medicago sativa	E	-	-	-	1	5	-
Swainsona	N	-	1	1	1	-	-
Swainsona reticulata	N	-	-	-	1	-	-
Trifolium	E	-	-	-	3	-	-
Trifolium arvense	E	-	1	5	5	1	1
Trifolium	E	-	-	5	1	1	-
Senna occidentalis	E	-	-	-	2	-	1
GENTIANACEAE							
Geranium solanderi	N	-	1	3	5	-	-
GOODENIACEAE							
Goodenia pinnatifida	N	-	-	1	1	-	-
LAMIACEAE							
Ajuga australis	N	3	1	-	-	-	-
Marrubium vulgare	E	-	-	1	2	3	-
Mentha satureioides	N	1	-	1	3	-	1
LAMIACEAE							
Salvia reflexa	E	-	-	1	3	-	-
Teucrium sp. D	N	1	2	-	-	-	-
MALVACEAE							
Malva parviflora	E	-	-	1	-	5	-
Modiola caroliniana	E	-	-	1	1	-	-
Sida corrugata	N	1	4	4	1	-	1
Sida cunninghamii	N	1	-	-	-	-	-
MALVACEAE							
Sida trichopoda	N	1	-	-	-	-	1
Sida spinosa	E	2	1	2	1	1	-
MYOPORACEAE							
Eremophila debilis	N	1	-	-	-	-	-
NYCTAGINACEAE							
Boerhavia dominii	N	1	2	5	-	3	-
OLEACEAE							
Jasminum	N	1	1	-	1	-	-
Notelaea microcarpa microcarpa	N	2	2	-	-	-	-
OXALIDACEAE							
Oxalis corniculata	N	2	5	5	3	3	2
PITTOSPORACEAE							
Bursaria spinosa	N	-	3	-	1	-	2
PLANTAGINACEAE							
Plantago debilis	N	1	2	5	-	1	2
Plantago lanceolata	E	-	1	-	2	-	-
POLYGANACEAE							
Rumex brownii	N	-	2	5	3	-	2
Polygonum aviculare	E	-	-	-	-	3	-
PRIMULACEAE							
Anagallis arvensis	E	-	2	1	3	-	2
RUBIACEAE							
Asperula conferta	N	3	1	1	3	-	-
Galium aparine	E	1	1	-	2	1	-
Galium migrans	N	-	-	-	-	-	1
SAPINDACEAE							
Dodonaea sinuolata sinuolata	N	-	-	-	-	-	1
Dodonaea viscosa angustissima	N	1	3	-	-	-	1
SCROPHULARIACEAE							
Veronica arvensis	E	-	-	4	1	-	-
SOLANACEAE							
Solanum nigrum	E	-	-	1	-	-	-
THYMELAEACEAE							
Pimelea curviflora	N	-	-	-	-	-	1
Pimelea neo-anglica	N	2	-	-	-	-	-
URTICACEAE							
Urtica incisa	N	-	-	2	-	-	-
VERBENACEAE							
Verbena bonariensis	E	-	1	1	3	-	-
ZYGOPHYLLACEAE							
Tribulus terrestris	E	-	-	-	-	2	-

APPENDIX 4

Species list for taxa represented in regional survey dataset (Chapter 5), showing origin (O, N = native, E = exotic), life-form (LF, Pt = pteridophyte, Gl = grass like, G = Grass, F = forb, C = climber, LS = low shrub, G = geophytes), life cycle (LC, PE = perennial, PA = perennial with annual shoots, SP = short-lived perennial, A = annual), and land use (PC = pasture, previously cultivated, PU = pasture, never cultivated, G = woodland grazed by livestock, U = woodland not grazed by livestock)

Species	O	LF	LC	PC	PU	G	U
PTERIDOPHYTES							
ADIANTACEAE							
Cheilanthes distans	N	Pt	PE	0	0	0	5
Cheilanthes lasiophylla	N	Pt	PE	0	0	1	1
Cheilanthes sieberi	N	Pt	PE	6	13	14	23
MONOCOTYLEDON							
ANTHERICACEAE							
Arthropodium fimbriatum	N	Gl	PA	6	11	15	9
Arthropodium minus	N	Gl	PA	2	3	8	4
Arthropodium sp. B	N	Gl	PA	0	0	1	0
Dichopogon fimbriatus	N	Gl	PA	0	1	1	5
Tricoryne elatior	N	GL	PA	0	1	3	0
ASPHODELACEAE							
Asphodelus fistulosis	E	Gl	AN	0	0	0	1
Bulbine bulbosa	N	Gl	PE	0	2	3	5
COLCHICACEAE							
Wurmbea biglandulosa	N	GL	PA	1	3	5	2
COMMELINACEAE							
Commelina cyanea	N	Gl	PE	0	0	2	1
CYPERACEAE							
Carex breviculmis	N	GL	PE	0	0	0	1
Carex incomitata	N	GL	PE	0	0	0	1
Carex inversa	N	GL	PE	26	23	26	15
Cyperus fulvus	N	GL	PE	0	0	1	1
Cyperus gracilis	N	GL	PE	2	4	18	16
Fimbristylis dichotoma	N	GL	PE	0	0	0	1
Lepidosperma laterale	N	GL	PE	0	0	0	5
Schoenus apogon	N	GL	PE	0	0	0	1
Schoenus subaphyllus	N	GL	PE	0	1	0	0
Scleria mackaviensis	N	GL	PE	0	1	2	6
HYPOXIDACEAE							
Hypoxis hygrometrica	N	F	PE	0	1	1	0
IRIDACEAE							
Romulea minutiflora	E	F	PA	0	0	0	0
Romulea rosea	E	F	PA	1	0	0	0
Sisyrinchium sp. A	E	Gl	AN	0	0	1	0
JUNCACEAE							
Juncus bufonius	E	GL	AN	1	0	1	0
Juncus capitatus	E	GL	AN	0	1	0	0
Juncus continuus	N	GL	PE	1	0	0	0
Juncus filicaulis	N	GL	PE	0	0	1	0
Juncus firmus	N	GL	PE	0	0	1	0
Juncus homalocaulis	N	GL	PE	0	0	2	0
Juncus pauciflorus	N	GL	PE	1	0	1	0
Juncus subglaucus	N	GL	PE	1	0	1	0
Juncus subsecundus	N	GL	PE	1	0	0	0
Juncus usitatus	N	GL	PE	7	6	6	1
Luzula densiflora	N	GL	PE	0	0	1	1
Luzula flaccida	N	GL	PE	0	1	0	1
LUZURIAGACEAE							
Eustrephus latifolius	N	C	PE	0	0	0	3
ORCHIDACEAE							
Microtis unifolia	N	GL	PA	1	2	2	0
Pterostylis curta	N	GL	PA	0	0	0	1
PHORMIACEAE							
Dianella caerulea var. cinerascens	N	GL	PE	0	0	0	3
Dianella longifolia var. longifolia	N	GL	PE	0	0	1	8
Dianella revoluta var. revoluta	N	GL	PE	1	1	1	8
Dianella revoluta var. vinosa	N	GL	PE	0	0	0	1
POACEAE							
Aira cupaniana	E	G	AN	0	3	4	3
Anthoxanthum odoratum	E	G	PE	1	0	0	0
Aristida acuta	N	G	PE	0	0	0	1
Aristida caput-medusa	N	G	PE	0	0	1	0
Aristida jerichoensis	N	G	PE	0	0	1	0
Aristida leptopoda	N	G	PE	0	0	1	0
Aristida ramosa	N	G	PE	30	23	18	26
Aristida vagans	N	G	PE	0	0	0	1
Austrodanthonia bipartita	N	G	PE	23	10	8	9
Austrodanthonia caespitosa	N	G	PE	9	4	7	1
Austrodanthonia racemosa var. obtusata	N	G	PE	1	1	0	3
Austrodanthonia racemosa var. racemosa	N	G	PE	4	5	8	15
Austrostipa scabra	N	G	PE	24	17	22	21
Austrostipa setacea	N	G	PE	1	1	1	1
Austrostipa verticillata	N	G	PE	9	8	17	8
Avena barbata	E	G	AN	10	2	1	1
Avena sativa	E	G	AN	1	0	0	0
Bothriochloa macra	N	G	PE	35	20	17	17
Briza minor	E	G	AN	7	6	4	0

Bromus brevis	E	G	AN	0	1	0	0
Bromus catharticus	E	G	SP	7	1	7	1
Bromus hordeaceus	E	G	AN	34	20	11	3
Chloris truncata	N	G	PE	34	16	7	4
Chloris ventricosa	N	G	PE	2	9	13	13
Cymbopogon refractus	N	G	PE	0	1	4	24
Cynodon dactylon	N	G	PE	10	4	2	0
Dichanthium sericeum	N	G	PE	20	14	5	15
Dichelachne crinita	N	G	PE	1	4	0	0
Dichelachne micrantha	N	G	PE	12	7	16	8
Digitaria brownii	N	G	PE	1	1	6	8
Digitaria coenicola	N	G	PE	1	0	0	0
Digitaria divaricatissima	N	G	PE	0	0	1	2
Echinopogon intermedius	N	G	PE	2	0	1	1
Echinopogon ovatus	N	G	PE	0	0	2	1
Eleusine tristachya	E	G	SP	11	1	1	0
Elymus scaber	N	G	PE	12	11	20	16
Enneapogon gracilis	N	G	PE	1	4	1	10
Enneapogon nigricans	N	G	PE	1	2	2	0
Enteropogon acicularis	N	G	PE	2	1	1	1
Eragrostis cilianensis	E	G	AN	2	1	0	0
Eragrostis leptostachya	N	G	PE	12	10	6	2
Eragrostis parviflora	N	G	AN	0	0	0	1
Eriochloa pseudoacrotricha	N	G	SP	1	0	0	1
Eulalia aurea	N	G	PE	1	0	0	0
Hordeum leporinum	E	G	AN	26	11	9	0
Hyparrhenia hirta	E	G	PE	0	2	0	7
Lachnagrostis filiformis	N	G	AN	1	1	0	0
Lamarckia aurea	E	G	AN	2	1	0	0
Lolium perenne	E	G	SP	35	18	19	6
Lolium rigidum	E	G	AN	0	0	0	1
Microlaena stipoides	N	G	PE	5	1	9	2
Notodanthonia longifolia	N	G	PE	0	0	0	1
Panicum effusum	N	G	PE	12	6	5	13
Paspalidium gracile	N	G	PE	2	0	5	14
Paspalum dilatatum	E	G	PE	4	1	0	0
Pennisetum alopecuroides	N	G	PE	1	0	0	0
Phalaris aquatica	E	G	PE	1	0	0	1
Phalaris paradoxa	E	G	AN	8	2	0	0
Poa annua	E	G	AN	3	0	1	1
Poa labillardierei	N	G	PE	7	3	2	3
Poa sieberiana var. hirtella	N	G	PE	0	0	2	1
Poa sieberiana var. sieberiana	N	G	PE	7	6	16	23
Psilurus incurvus	E	G	AN	0	1	1	0
Rostraria cristata	E	G	AN	20	15	5	2
Sorghum leiocladum	N	G	PE	1	2	2	11
Sporobolus africanus	E	G	PE	2	0	0	0
Sporobolus caroli	N	G	SP	0	0	1	0
Sporobolus creber	N	G	PE	23	11	8	4
Themeda triandra	N	G	PE	1	1	1	6
Tragopogon porrifolius	E	G	SP	1	0	0	1
Tragus australianus	N	G	AN	0	1	0	0
Urochloa panicoides	E	G	AN	2	0	0	0
Vulpia bromoides	E	G	AN	2	1	1	0
Vulpia muralis	E	G	AN	0	2	0	0
Vulpia myuros	E	G	AN	21	9	5	2
XANTHORRHOEACEAE							
Lomandra filiformis	N	GL	PE	2	2	8	17
Lomandra longifolia	N	GL	PE	0	2	2	3
Lomandra multiflora	N	GL	PE	0	3	10	15

DICOTYLEDON							
ACANTHACEAE							
Brunoniella australis	N	F	PE	2	4	6	17
Rostellularia adscendens	N	F	PE	3	1	13	20
AMARANTHACEAE							
Alternanthera denticulata	N	F	AN	0	1	0	0
Alternanthera nana	N	F	AN	2	1	1	2
Alternanthera pungens	E	F	SP	3	0	0	0
Amaranthus retroflexus	E	F	AN	1	1	2	0
APIACEAE							
Ammi majus	E	F	SP	1	0	0	0
Cyclospermum leptophyllum	E	F	AN	28	16	15	5
Daucus glochidiatus	N	F	AN	22	19	20	15
Hydrocotyle laxiflora	N	F	PE	6	10	19	11
Torilis nodosa	E	F	AN	2	1	3	1
APOCYNACEAE							
Marsdenia viridiflora	N	C	PE	0	0	0	1
Parsonsia eucalyptophylla	N	C	PE	0	0	0	1
ASCLEPIADACEAE							
Gomphocarpus fruticosus	E	F	PE	2	0	1	0
Tweedia coerulea	E	F	PE	0	0	0	1
ASTERACEAE							
Ammobium alatum	N	F	PE	0	0	2	0
Bidens pilosa	E	F	AN	0	1	7	1
Bidens subalternans	E	F	AN	3	1	0	3
Brachyscome ciliaris var. lanuginosa	N	F	PE	4	2	1	2
Brachyscome ciliaris var. subintegrifolia	N	F	PE	0	0	1	2
Brachyscome dissectifolia	N	F	PE	0	0	1	0
Brachyscome melanocarpa	N	F	PE	0	0	0	1
Brachyscome microcarpa	N	F	PE	0	0	0	1
Brachyscome multifida var. multifida	N	F	AN	0	1	2	2
Calotis cuneifolia	N	F	PE	0	1	0	0
Calotis hispidula	N	F	AN	1	0	0	0
Calotis lappulacea	N	F	PE	22	14	20	16
Carthamus lanatus	E	F	AN	38	20	13	2
Cassinia laevis	N	LS	PE	0	1	3	8
Cassinia quinquefaria	N	LS	PE	0	0	0	2
Centaurea melitensis	E	F	AN	0	1	1	0
Centaurea solstitialis	E	F	SP	8	10	8	1
Chondrilla juncea	E	F	PE	1	1	1	0
Chrysocephalum apiculatum	N	F	PE	6	1	11	11
Cichorium intybus	E	F	PE	1	0	0	0
Cirsium vulgare	E	F	SP	19	11	16	4
Conyza bonariensis	E	F	AN	29	16	17	9
Conyza sumatrensis	E	F	AN	0	1	0	0
Cotula australis	N	F	AN	7	4	7	2
Craspedia variabilis	N	F	SP	0	0	0	1
Cymbonotus lawsonianus	N	F	PE	22	11	16	7
Euchiton involucratus	N	F	PE	34	11	17	11
Euchiton sphaericus	N	F	SP	2	4	3	0
Gamochaeta calviceps	E	F	AN	3	2	3	0
Glossocardia bidens	N	F	PE	2	2	7	13
Hedypnois rhagadioloides subsp. cretica	E	F	AN	8	7	2	1
Hypochaeris glabra	E	F	AN	1	0	0	0
Hypochaeris microcephela	E	F	PE	3	2	3	0
Hypochaeris radicata	E	F	PE	24	20	20	7

Isoetopsis graminifolia	N	F	AN	1	0	0	1
Lactuca saligna	E	F	SP	15	9	6	2
Lactuca serriola	E	F	SP	11	6	14	3
Leiocarpa panaetioides	N	F	PE	1	0	0	1
Leptorhynchos squamatus	N	F	PE	0	0	1	1
Microseris lanceolata	N	F	PA	1	0	0	2
Olearia elliptica subsp. elliptica	N	LS	PE	0	2	2	12
Olearia viscidula	N	LS	PE	1	1	3	3
Onopordum acanthium	E	F	AN	5	1	2	0
Pseudognaphalium luteoalbum	N	F	AN	2	1	0	1
Rhodanthe anthemoides	N	F	PE	0	0	1	0
Schkuhria pinnata var. abrotanoides	E	F	AN	2	1	1	0
Senecio diaschides	N	F	PE	1	0	0	0
Senecio madagascariensis	E	F	SP	1	1	1	3
Senecio quadridentatus	N	F	PE	5	4	7	3
Sigesbeckia australiensis	N	F	AN	1	1	8	8
Silybum marianum	E	F	SP	12	6	5	2
Solenogyne bellioides	N	F	PE	0	4	12	6
Soliva sessilis	E	F	AN	6	6	5	1
Sonchus asper	E	F	AN	0	1	1	0
Sonchus oleraceus	E	F	AN	22	19	22	9
Stuartina hamata	N	F	AN	1	5	2	3
Taraxacum officinale	E	F	PE	6	1	3	1
Triptilodiscus pygmaeus	N	F	AN	5	6	1	1
Vittadinia cervicularis	N	F	PE	0	0	0	3
Vittadinia cuneata var. hirsuta	N	F	PE	0	0	2	4
Vittadinia muelleri	N	F	PE	19	12	10	13
Vittadinia sulcata	N	F	AN	5	5	5	7
Xanthium spinosum	E	F	AN	2	0	0	0
Xerochrysum bracteatum	N	F	PE	0	2	2	0
Zinnia peruviana	E	F	AN	1	0	0	0
BIGNONIACEAE							
Pandorea pandorana	N	C	PE	0	0	1	3
Amsinckia intermedia	E	F	AN	0	1	0	0
Anchusa arvensis	E	F	AN	0	1	0	0
Buglossoides arvensis	E	F	AN	5	2	6	3
Cynoglossum australe	N	F	PE	0	0	0	1
Cynoglossum suaveolens	N	F	PE	0	1	0	2
Echium plantagineum	E	F	AN	1	1	2	1
Echium vulgare	E	F	AN	1	0	0	0
Heliotropium amplexicaule	E	F	PE	1	0	0	0
BRASSICACEAE							
Capsella bursa-pastoris	E	F	AN	24	11	9	1
Coronopus didymus	E	F	SP	1	0	1	0
Lepidium africanum	E	F	AN	21	9	9	3
Lepidium bonariense	E	F	SP	4	1	4	1
Rapistrum rugosum	E	F	SP	1	0	0	0
Sisymbrium erysimoides	E	F	SP	2	0	0	0
Sisymbrium irio	E	F	SP	2	6	3	0
Sisymbrium officinale	E	F	SP	6	1	12	0
Sisymbrium orientale	E	F	SP	0	0	2	0
CACTACEAE							
Opuntia aurantiaca	E	F	PE	0	1	0	10
Opuntia stricta	E	F	PE	4	4	3	8
CAMPANULACEAE							
Wahlenbergia communis	N	F	PE	26	24	26	24
Wahlenbergia gracilenta	N	F	PE	1	1	0	3
CARYOPHYLLACEAE							
Arenaria leptoclados	E	F	AN	19	14	11	6
Cerastium glomeratum	E	F	AN	11	6	6	0
Gypsophila tubulosa	E	F	AN	1	0	0	0
Paronychia brasiliana	E	F	PE	14	3	8	0
Petrorhagia nanteuilii	E	F	AN	22	24	20	12
Polycarpon tetraphyllum	E	F	AN	13	10	7	0
Sagina apetala	E	F	AN	0	6	2	2
Silene gallica	E	F	AN	1	1	1	0
Spergularia rubra	E	F	SP	2	0	1	0
Stellaria media	E	F	SP	1	0	3	1
CHENOPODIACEAE							
Atriplex spinibractea	N	F	PE	1	2	1	0
Chenopodium album	E	F	AN	0	1	0	0
Chenopodium pumilio	N	F	AN	2	3	5	3
Einadia hastata	N	F	PE	4	1	9	4
Einadia nutans	N	F	PE	20	11	12	11
Einadia trigonos	N	F	PE	1	0	3	1
Maireana enchylaenoides	N	F	PE	0	0	0	1
Maireana microphylla	N	LS	PE	7	3	5	4
Salsola kali	N	F	AN	3	3	0	1
Sclerolaena birchii	N	F	PE	3	0	0	0
CLUSIACEAE							
Hypericum gramineum	N	F	PE	3	4	12	10
Hypericum perforatum	E	F	PE	0	1	0	0
CONVOLVULACEAE							
Convolvulus erubescens	N	F	PE	8	8	1	2
Dichondra repens	N	F	PE	19	21	26	20
Dichondra sp. A	N	F	PE	0	0	0	9
Evolvulus alsinoides var. decumbens	N	F	PE	0	0	0	3
CRASSULACEAE							
Crassula sieberiana	N	F	AN	21	13	13	8
CUCURBITACEAE							
Cucumis myriocarpus	E	F	AN	0	0	1	0
DILLENIACEAE							
Hibbertia obtusifolia	N	LS	PE	0	3	3	4
Hibbertia riparia	N	LS	PE	0	0	0	1
EPACRIDACEAE							
Lissanthe strigosa	N	LS	PE	0	1	0	2
Melichrus urceolatus	N	LS	PE	0	1	1	8
EUPHORBIACEAE							
Chamaesyce drummondii	N	F	PE	6	5	10	6
Phyllanthus gunnii	N	LS	PE	1	4	3	0
Phyllanthus virgatus	N	F	SP	0	1	0	3
Poranthera microphylla	N	F	AN	0	1	0	3
FABACEAE							
Acacia decora	N	LS	PE	0	0	0	2
Acacia juvenille	N	LS	PE	0	0	0	1
Cullen tenax	N	F	PE	0	1	0	3
Desmodium brachypodum	N	F	PE	0	2	7	24
Desmodium gunnii	N	F	PE	0	0	0	4
Desmodium varians	N	F	PE	5	10	13	17
Glycine clandestina	N	C	PE	0	2	6	13
Glycine tabacina	N	C	PE	13	18	24	28
Glycine tomentella	N	C	PE	0	0	0	1
Hardenbergia violacea	N	C	PE	0	0	0	1
Lespedeza juncea subsp. sericea	N	LS	PE	0	1	0	0
Lotus australis	N	F	PE	0	0	1	0
Lupinus angustifolius	E	F	AN	0	0	0	1
Medicago arabica	E	F	AN	0	0	0	0

Medicago laciniata	E	F	AN	1	0	0	0
Medicago lupulina	E	F	SP	17	7	2	1
Medicago minima	E	F	AN	0	0	2	1
Medicago orbicularis	E	F	AN	0	1	2	0
Medicago polymorpha	E	F	AN	27	16	19	6
Medicago sativa	E	F	PE	3	0	1	0
Medicago trunculata	E	F	AN	0	0	1	0
Pultenaea foliolosa	N	LS	PE	0	0	0	1
Pultenaea sp. G	N	LS	PE	0	1	0	3
Rhynchosia minima	N	C	PE	0	0	0	2
Swainsona galegifolia	N	F	PE	4	3	18	14
Swainsona monticola	N	F	PE	0	2	1	0
Swainsona reticulata	N	F	PE	2	0	2	1
Templetonia stenophylla	N	LS	PE	0	0	0	1
Trifolium angustifolium	E	F	AN	10	7	8	2
Trifolium arvense	E	F	AN	26	20	20	8
Trifolium campestre	E	F	AN	15	18	20	6
Trifolium cernuum	E	F	AN	9	3	0	0
Trifolium glomeratum	E	F	AN	32	16	24	5
Trifolium hirtum	E	F	AN	0	3	1	0
Trifolium repens	E	F	PE	17	10	6	1
Trifolium striatum	E	F	AN	5	2	3	0
Trifolium subterraneum	E	F	AN	3	7	0	0
Trifolium tomentosum	E	F	AN	5	5	4	1
Trifolium vesiculosum	E	F	AN	4	4	5	0
Vicia sativa	E	C	AN	1	1	1	0
Zornia dyctiocarpa var. dyctiocarpa	N	F	PE	0	0	5	0
GENTIANACEAE							
Centaurium erythraea	E	F	AN	6	5	4	1
Sebaea ovata	N	F	AN	0	0	1	0
GERANIACEAE							
Erodium cicutarium	E	F	AN	3	3	0	1
Erodium crinitum	E	F	AN	2	6	3	1
Geranium retrosum	N	F	PE	2	1	0	1
Geranium solanderi	N	F	PE	23	16	24	10
GOODENIACEAE							
Goodenia bellidifolia subsp. argentea	N	F	PE	0	0	0	0
Goodenia glabra	N	F	PE	0	1	1	0
Goodenia hederacea var. hederacea	N	F	PE	1	0	2	3
Goodenia pinnatifida	N	F	AN	3	2	9	7
Scaevola humilis	N	F	PE	0	1	1	0
LAMIACEAE							
Ajuga australis	N	F	PE	0	2	6	15
Lamium amplexicaule	E	F	AN	9	7	5	1
Marrubium vulgare	E	F	PE	3	2	9	3
Mentha diemenica	N	F	PE	0	0	0	2
Mentha satureioides	N	F	PE	5	7	9	2
Salvia reflexa	E	F	AN	5	1	4	0
Salvia verbenaca	E	F	PE	1	0	0	0
Teucrium sp. D	N	F	PE	1	1	2	3
MALVACEAE							
Abutilon tubulosum	N	LS	PE	5	0	0	1
Malva parviflora	E	F	AN	10	5	6	0
Malvastrum americanum	E	F	SP	0	0	0	5
Modiola caroliniana	E	F	SP	11	3	5	0
Sida corrugata	N	F	PE	11	10	10	10
Sida cunninghamii	N	F	PE	0	3	1	6
Sida spinosa	E	LS	PE	3	4	3	2
Sida trichopoda	N	F	PE	0	0	2	0
MYOPORACEAE							
Eremophila debilis	N	LS	PE	1	0	1	13
NYCTAGINACEAE							
Boerhavia dominii	N	F	PE	11	9	10	8
OLEACEAE							
Jasminum lineare	N	LS	PE	0	0	0	4
Jasminum suavissimum	N	LS	PE	0	0	5	6
OXALIDACEAE							
Oxalis corniculata	N	F	PE	15	14	22	19
Oxalis perennans	N	F	PE	21	8	2	2
PAPAVERACAE							
Agremone ochroleuca	N	F	AN	0	3	0	0
Papaver hybridum	E	F	AN	3	1	1	0
Papaver somniferum	E	F	AN	6	1	1	1
PLANTAGINACEAE							
Plantago cunninghamii	N	F	PE	0	0	0	1
Plantago debilis	N	F	SP	17	13	21	11
Plantago lanceolata	E	F	SP	4	0	1	2
POLYGANACEAE							
Acetosella vulgaris	E	F	PE	1	1	1	0
Fallopia convolvulus	E	F	AN	0	1	0	0
Rumex brownii	N	F	PE	35	27	26	10
Rumex crispus	E	F	PE	1	0	0	0
Polygonum aviculare	E	F	SP	15	2	4	0
Portulaca oleracea	N	F	AN	2	0	2	2
PRIMULACEAE							
Anagallis arvensis	E	F	SP	18	15	17	9
RANUNCULACEAE							
Clematis glycinoides var. glycinoides	N	C	PE	0	0	0	6
Clematis microphylla	N	C	PE	0	0	0	3
Ranunculus lappaceus	N	F	PE	0	1	1	1
Ranunculus sessiliflorus var. sessiliflorus	N	F	AN	5	7	16	6
ROSACEAE							
Acaena agnipila	N	F	PE	0	0	1	0
Acaena novae-zelandiae	N	F	PE	0	0	1	2
Acaena ovina	N	F	PE	5	4	6	3
Rosa rubiginosa	E	LS	PE	0	1	1	2
Rubus anglocandicans	E	LS	PE	0	0	2	0
Rubus parvifolius	N	LS	PE	0	1	0	1
RUBIACEAE							
Asperula conferta	N	F	PE	14	6	13	11
Galium aparine	E	F	AN	0	3	5	8
Galium gaudichaudii	N	F	PE	0	0	0	2
Galium migrans	N	F	PE	0	1	0	1
Opercularia hispida	N	F	PE	0	0	0	1
Sherardia arvensis	E	F	AN	0	0	1	0
RUTACEAE							
Correa reflexa	N	LS	PE	0	0	0	1
SCROPHULARIACEAE							
Kickxia spuria subsp. Integrifolia	E	F	PE	0	0	0	0
Linaria arvensis	E	F	AN	9	11	7	3
Linaria pelisseriana	E	F	AN	3	1	0	0
Misopates orontium	E	F	AN	0	0	1	0
Verbascum thapsus	E	F	SP	5	5	0	1
Verbascum virgatum	E	F	SP	1	0	0	1
Veronica arvensis	E	F	AN	19	10	3	1

Veronica calycina	E	F	AN	0	0	1	0
Veronica plebeia	N	F	PE	0	1	0	3
SOLANACEAE							
Solanum esuriale	N	F	PE	0	0	1	1
Solanum nigrum	E	LS	SP	0	1	4	0
Solanum parviflorum	N	LS	PE	0	0	0	1
Solanum prinophyllum	N	F	SP	0	1	0	1
STACKHOUSIACEAE							
Stackhousia monogyna	N	F	PE	0	0	0	8
Stackhousia viminea	N	F	PE	1	0	3	3
THYMELAEACEAE							
Pimelea curviflora	N	LS	PE	5	5	13	3
Pimelea linifolia subsp. linifolia	N	LS	PE	0	0	0	1
Pimelea micrantha	N	LS	PE	1	2	0	0
Pimelea neo-anglica	N	LS	PE	3	3	13	11
URTICACEAE							
Parietaria australis	N	F	AN	0	0	0	1
Urtica incisa	N	F	PE	10	6	17	1
VERBENACEAE							
Glandularia aristigera	E	F	PE	0	0	2	0
Oncinocalyx betchei	N	F	PE	0	0	1	4
Verbena bonariensis	E	F	PE	2	1	1	1
Verbena brasiliensis	E	F	PE	0	0	0	1
Verbena gaudichaudii	E	F	PE	0	1	1	2
Verbena incompta	E	F	PE	2	1	2	2
Verbena officinalis	E	F	PE	2	0	2	0
Verbena quadrangularis	E	F	PE	4	0	0	0
VIOLACEAE							
Viola betonicifolia	N	F	PE	1	1	2	2
ZYGOPHYLLACEAE							
Tribulus terrestris	E	F	AN	1	2	2	2

APPENDIX 5

Thirty five climatic variables derived from ANUCLIM (Hutchinson et al. 2000)

1	Annual mean temperature
2	Mean diurnal range
3	Isothermality
4	Temperature seasonality
5	Max temperature of warmest period
6	Min temperature of coldest period
7	Temperature annual range
8	Mean temperature of wettest quarter
9	Mean temperature of driest quarter
10	Mean temperature of warmest quarter
11	Mean temperature of coldest quarter
12	Annual precipitation
13	Precipitation of wettest period
14	Precipitation of driest period
15	Precipitation seasonality
16	Precipitation of wettest quarter
17	Precipitation of driest quarter
18	Precipitation of warmest quarter
19	Precipitation of coldest quarter
20	Annual mean radiation
21	Highest period radiation
22	Lowest period radiation
23	Radiation seasonality
24	Radiation of wettest quarter
25	Radiation of driest quarter
26	Radiation of warmest quarter
27	Radiation of coldest quarter
28	Annual mean moisture index
29	Highest period moisture index
30	Lowest period moisture index
31	Moisture index seasonality
32	Mean moisture index of highest quarter
33	Mean moisture index of lowest quarter
34	Mean moisture index of warmest quarter
35	Mean moisture index of coldest quarter

APPENDIX 6

Gross margin – Merino ewes (19.5 micron) x terminal rams

Flock size	1,300		
Flock mortality	2%	Ram	2%
Productive life	5 years	Marking	90%
Ewe body weight	50 kg	Weaning	85%
DSE rating /ewe	2.1	Weaning	3 months

INCOME					
Wool	**number**	**class**	**kg hd^{-1}**	**$ kg^{-1}**	**Budget**
Shear	1,274	ewes	4.8	6.50	39,759.68
	26	rams	3.5	6.50	591.66
	1,105	lambs	1.5	5.18	8,585.85
Crutch	2,407	mixed ages	0.4	3.45	3,318.01
Sheep Sales	**number**	**class**	**$ hd^{-1}**	**cwt**	
	245	CFA ewes	60.00	22.60	14,700.00
	5	CFA rams	61.00		305.00
	1,094	mixed sex store	101.20	20.24	110,712.80
A. Total Income:					**177,973.01**
VARIABLE COSTS					
Replacements	**number**	**class**	**cost ($)**	**reps**	
	5	rams	800.00		4,000.00
	271	ewes	90.00		24,390.00
Cartage	271	ewes	2.00		542.00
Wool Harvesting & Selling Costs					
Shearing	1,274	ewes	5.98	1	7,618.52
	26	rams	8.43	1	219.18
Crutching	1,287	ewes	0.85	1	1,098.20
	26	rams	1.71	1	44.37
	1,094	weaners	0.85	1	933.51
Wool tax			0.02		1,045.10
Commission, warehouse, testing charges	49	bales	42.99		2,106.51
Wool cartage and packs	49	bales	38.19		1,362.39
Sheep Health	**number**	**class**			
Drenching following DrenchPlan					
Broadspectrum	1,300	adults	0.42	2	1,092.00
	1,170	lambs	0.21	3	737.10
Dipping	1,300	adults	1.07	1	1,391.00
Jetting	1,300	adults	0.58	1	754.00
Vaccination- 6 in 1	1,300	adults	0.24	1	312.00
	1,170	lambs	0.24	1	280.80
Mark	1,170	lambs	1.35	1	1,579.50
Scanning	1,274	ewes	0.90	1	1,146.60
Livestock Selling Costs					
Livestock cartage	1,344	sale sheep	2.00		2,688.00
Commission on sheep sales			0.05		6,285.89
Yard dues	245	CFA ewes	0.50	per	122.50
	5	CFA rams	0.50	per	2.50
	547	mixed 20kg	0.50	per	273.50
	547	mixed 22kg	0.50	per	273.50
Transaction levy	245	CFA ewes	0.20	per	49.00
	5	CFA rams	0.20	per	1.00
	547	mixed 20kg	0.20	per	109.40
	547	mixed 22kg	0.20	per	109.40
Rural Lands Protection Board rates			0.24	per	666.94
Grain/Fodder/Forage Crop/Pasture inputs					
Grain	1,274	ewes	0.63	8	6,420.96
Grazing oats	70	@	210		14,700.00
Pasture maintenance	110	@	76.75		8,442.50
Note: Pasture cost calculated at 125kg of single super applied every 4th year - $550/ton and $8/ha application cost.					
B. Total Variable Costs:					**90,798.17**
		GROSS MARGIN (A-B)			87,174.84
		GROSS MARGIN /EWE			67.06
		GROSS MARGIN /DSE			**31.93**
		GROSS MARGIN /HA			127.73

APPENDIX 7

Gross margin – trade cattle

Herd size	100	trade cattle
Stocking rate	4.4	DSE ha^{-1}
Mortality	2	%
Target body weight:	500	kg
DSE rating	11.3	DSE hd^{-1}

INCOME					
Stock sales - number	**class**	**kg hd^{-1}**	**c kg^{-1} LWT**	**\$ hd^{-1}**	**Budget (A$)**
98	steers	500	1.95	975	95,550.00
A. Total Income:					95,550.00
VARIABLE COSTS					
Replacements	**class**	**kg hd^{-1}**	**c kg^{-1} LWT**	**\$ hd^{-1}**	
100	steers	400	1.75	700	70,000.00
Purchasing Commission	100	head	5		500.00
Health					
Broadspectrum	100	head	1.5	1	150.00
Vaccination- 5 in 1	100	head	0.25	1	25.00
Bloat capsules	100	head	18.25	1	1,825.00
Livestock Selling Costs					
Livestock cartage	98	head	10		980.00
Levies	98	head	5		490.00
Yard dues	98	head	4		
Commission on sales	0.05	on	1	of sales	4,777.50
Fodder					
Supplementary fodder	0	@	190		0.00
Lucerne	71	@	145		10,295.00
Improved pasture	34		76.75		2,609.50
Native pasture	150				0.00
B. Total Variable Costs:					91,652.00
		GROSS MARGIN (A-B)			3,898.00
		GROSS MARGIN /HEAD			38.98
		GROSS MARGIN /DSE			**3.46**
		GROSS MARGIN /HA			15.25