CHAPTER 7.

Farming, pastoralism and forestry

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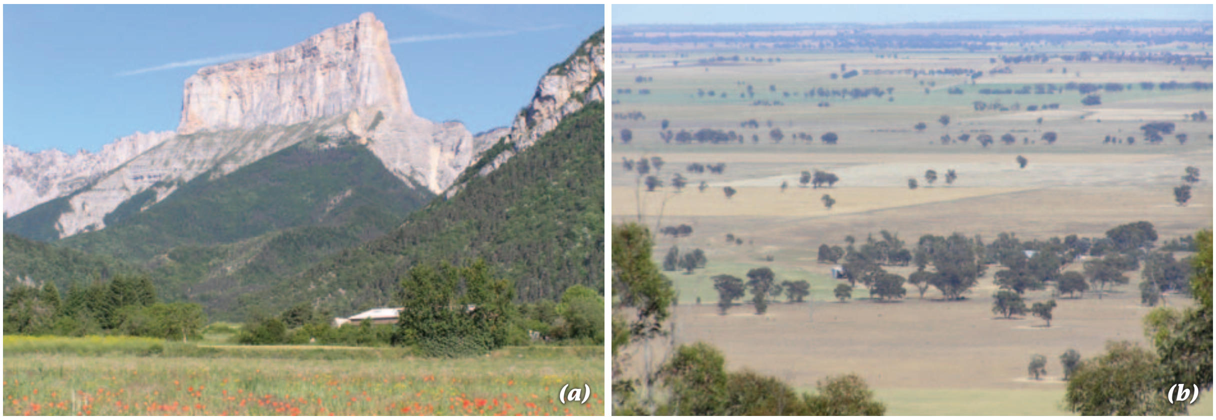
Key messages

- Australian agriculture provides food and fibre (e.g. cotton and wool) for millions of people in Australia and around the world, as well as economic benefits, but it also alters environmental conditions. This has led to changes in species' abundance according to their tolerance of the changed conditions.
- Having evolved under dry, infertile conditions, most Australian plants and animals cannot survive the more productive and disturbed conditions of intensive agriculture and plantation forestry.
- Less intensive methods of agricultural and forestry production provide opportunities for the coexistence of native species, while enhanced biodiversity can in turn provide agricultural benefits in such systems.
- To retain most native plants and animals where intensive farming and forestry occur, these landscapes need to be embedded in larger areas of less intensive production as well as among areas of native vegetation that are managed for conservation.
- Biodiversity conservation in agricultural landscapes has been strongly driven by the voluntary actions of landholders, and continuing progress will rely on technical support, policies, legislative arrangements and financial assistance.

INTRODUCTION – THE EVOLUTION OF AGRICULTURAL ECOSYSTEMS

The distinctive Australian native biota is the product of three strong influences: a stable geological history, soils of low fertility, and a variable climate (see Chapter 2). Fire is also a feature of the landscape, and has been used by Aboriginal Australians since their arrival 50 000 years ago.[1] In contrast, the glaciated landscapes of Europe have experienced the grinding of ice against rock, forming young, mineral-rich soils, with a natural fertility well suited for cultivation. Further, human disturbances in Europe – tree clearing, urbanisation and soil cultivation – have been more intense, long-standing and varied.



(a) *A glaciated landscape in the French Alps with farmland on the fertile valley floors.* ***(b)*** *In contrast, a typical farming landscape in south-eastern Australia with flat topography and old, weathered soils.*
Photos: Sue McIntyre, CSIRO.

Not surprisingly, from these two contrasting environments two broadly different floras have evolved: conservatively growing Australian natives adapted to eking out a living under limitations of water and nutrients, and the faster-growing European natives adapted to unpredictable destruction and rapid re-establishment.[2] While these two extremes typify the dominant environments of Australia and Europe, the spectrum of plant adaptations can be found in both continents.[3]

The development of European agriculture around 5000 years ago wrought large changes to local ecosystems, creating opportunity for species adapted to cleared and disturbed environments while causing the decline of others.[4] This history is now being repeated in Australia, but much faster and with a far greater environmental contrast and, therefore, more severe selection pressures. Modern agriculture and forestry have been introduced over a period of only a few hundred rather than thousands of years, so a phase of reassortment, retreat and extinction is taking place right now, and at a time when such changes are being documented by science.[5] Furthermore, the reassortment is occurring at the same time as the arrival of many non-native species already adapted to agricultural environments from Europe and increasingly elsewhere.

Additional pressure on local ecosystems stems from 20th century innovations in agriculture involving the intensive use of new kinds of inputs: fertilisers, non-native pasture species, pesticides and large machinery.[6] This 'intensive' agriculture has increased food and fibre production and with it prosperity, but our society is now realising that these benefits have produced a corresponding problem for biodiversity, raising the question: 'What are we going to do about minimising environmental harm?'

Not all agricultural and forestry systems are broad-scale, high-input and mechanised. This chapter examines different production intensities in Australia and their relationship to native biodiversity (Table 7.1). Circumstances are described in which the twin objectives of productivity for human uses and nature conservation might be met.

A HISTORY OF CHANGE, A SPECTRUM OF PRODUCTION STYLES

Aboriginal people practised a form of farming that manipulated the relative abundance of species, primarily through burning to modify or to protect vegetation in line with the values placed upon it.[7] But the technology imported along with European settlement was more varied than the firestick – domestic livestock, ploughs and, most of all, the many species that were brought to Australia.

This early depiction of Aboriginal hunting suggests the use of fire to create open areas and to flush game. Reproduction of Joseph Lycett, Aborigines using fire to hunt kangaroos*, circa 1820. PIC R5689, National Library of Australia.*

The continuum of production intensities established historically in Australia can still be found in different parts of Australia, and indeed some landscapes support more than one intensity (Table 7.1).

Table 7.1: The continuum of production styles found on Australian landscapes, from least to most intensive (left to right). Approximate differences in valued attributes are indicated by stars – the more stars, the greater the proportion of each attribute associated with that style

	Hunter–gatherer	**Firestick farming**	**Native pasture/ native forestry**	**Native–based pasture/native plantations**	**Intensive land use – cropping – non-native tree plantations**
Management aims	Harvest native species as encountered	Manipulate native species abundance	Manipulate native species abundance	Partially replace native species	Replace native species
Production	★	★	★★	★★★★	★★★★★★★★
Inputs		★	★	★★★	★★★★★★
Non-native species	★	★	★★	★★★★	★★★★★★
Native species	★★★★★★★	★★★★★★★★	★★★★★★	★★★	★
Ecological capital retained	★★★★★★★★	★★★★★★	★★★★★	★★★	★★

Production – *the amount of food, fibre and timber diverted for human use or completely removed from the system*

Inputs – *nutrients, energy and materials bought in from elsewhere for production purposes (e.g. fertiliser, lime, machinery, agrichemicals, crop seed)*

Non-native species – *the proportion of non-native species present in the system, deliberately or accidentally introduced*

Native species – *the proportion of native species persisting in the system*

Ecological capital retained – *the proportion of the sun's energy fixed by plants through photosynthesis (biomass) that is retained in the ecosystem, the rest being exported for human uses (via food, fibre and timber). This retained biomass can serve to maintain the ecosystem (e.g. through leaving enough vegetation to protect the soil from erosion or enough to burn to maintain desired species) and store carbon*

In Table 7.1 you can see that there are trade-offs among the different attributes. The more intensive styles have greater production, but require more inputs and tend to exclude native species and reduce the stability of the system, making it more vulnerable to extreme weather, erosion and invasion by foreign species. Less intensive land management requires fewer inputs and is lower in agricultural productivity, but supports more native species in greater diversity.

Within the broad production styles described in Table 7.1 are a range of land use types, which are described in the following section and summarised in Table 7.2.

Table 7.2: Productive land uses and management to improve habitat quality for native plants and animals	
Land use	**Examples of options for increasing habitat quality for native species**
Low-intensity land uses	
Hunting and gathering/ Firestick farming	▪ Avoid overharvesting of native plants and animals ▪ Apply appropriate fire regimes
Rangeland grazing	▪ Conservative grazing ▪ Control selected non-native plants and animals
Native timber harvesting	▪ Maximise harvesting rotations ▪ Retain mature trees and fallen timber ▪ Control selected non-native plants
Intensive land uses	
Crops	▪ Avoid excessive use of fertiliser and pesticides ▪ Avoid soil erosion ▪ Leave vegetated area between crops and watercourses ▪ Retain mature trees and avoid cropping close to them ▪ Establish native trees around crops
Fertilised pastures	▪ Avoid excess use of fertiliser and pesticides ▪ Retain mature trees ▪ Do not apply fertiliser close to trees or watercourses ▪ Establish native trees in and around pasture
Plantation forestry	▪ Maximise harvesting rotations ▪ Retain stands of regenerating native trees and shrubs ▪ Leave thinned trees and pruned material on the ground

OPTIONS FOR RETAINING BIODIVERSITY WITHIN DIFFERENT LAND USES

Low-intensity land uses

In remote areas of Australia, traditional hunting and bush food gathering take place where Indigenous people still have access to their Country. This land use favours the persistence of the remaining native plants and animals although, with the introduction of guns and vehicles, some species are vulnerable to overharvesting. Burning by Aboriginal people can maintain suitable habitat for many native species. However, frequent fire may reduce soil cover and soil carbon, making land more prone to erosion. Different species within the same ecosystem may have different burning requirements. All these issues need to be taken into account in planning burning strategies.

Commercial grazing of native vegetation occurs in many parts of Australia, but is most widespread on native grasslands, shrublands and woodlands in semi-arid regions, called rangelands. Moderate levels of livestock grazing allow all but the most grazing-sensitive plant species to persist (Figure 7.1)[8] and leave a sufficient proportion of plant growth to provide food for insects, reptiles, birds and mammals, and enough plant litter to protect the soil from erosion and recycle organic matter into the soil.

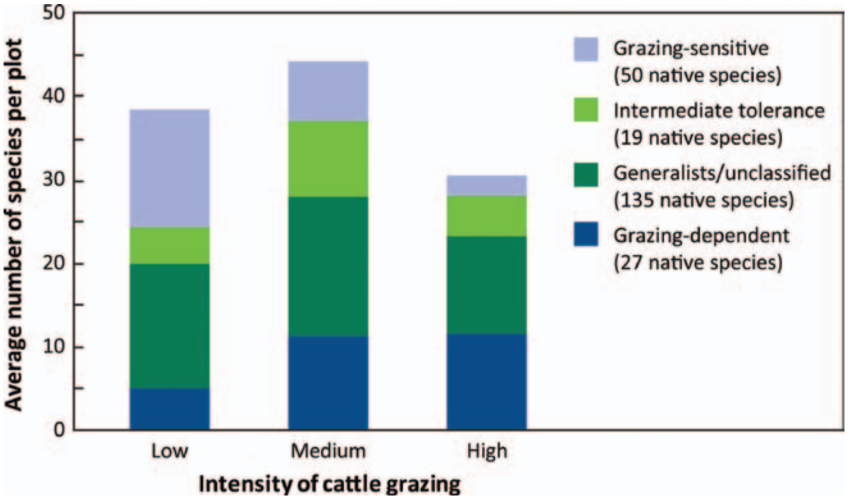


Figure 7.1: *Density of grassland plant species in three different grazing intensities. The species have been classified into four types based on their response to cattle grazing in subtropical native grassland. The histogram shows how cattle grazing causes shifts in the abundance of native species.*[8]

Overgrazing creates a downward spiral of pasture condition where trampling and reduced plant cover reduces soil condition and water infiltration, which further reduces plant cover.[9] As degraded soil is less productive, food supplies for both livestock and native animals are reduced. Overgrazing also alters the pasture, with most of the taller grazing-sensitive species being replaced by short-growing species, usually of lower productivity.[9] Large grass tussocks and shrubs can be lost, together with the insects, bird and reptiles that shelter and feed in them.[10] In many places in the rangelands, reduction in forage at the ground level can translate to lack of burning and thence to invasion of pastures by woody plants. With managed grazing, there is enough biomass remaining for fire to become a useful tool to reduce species that are unpalatable to livestock, so it can be useful for both biodiversity and pasture management.

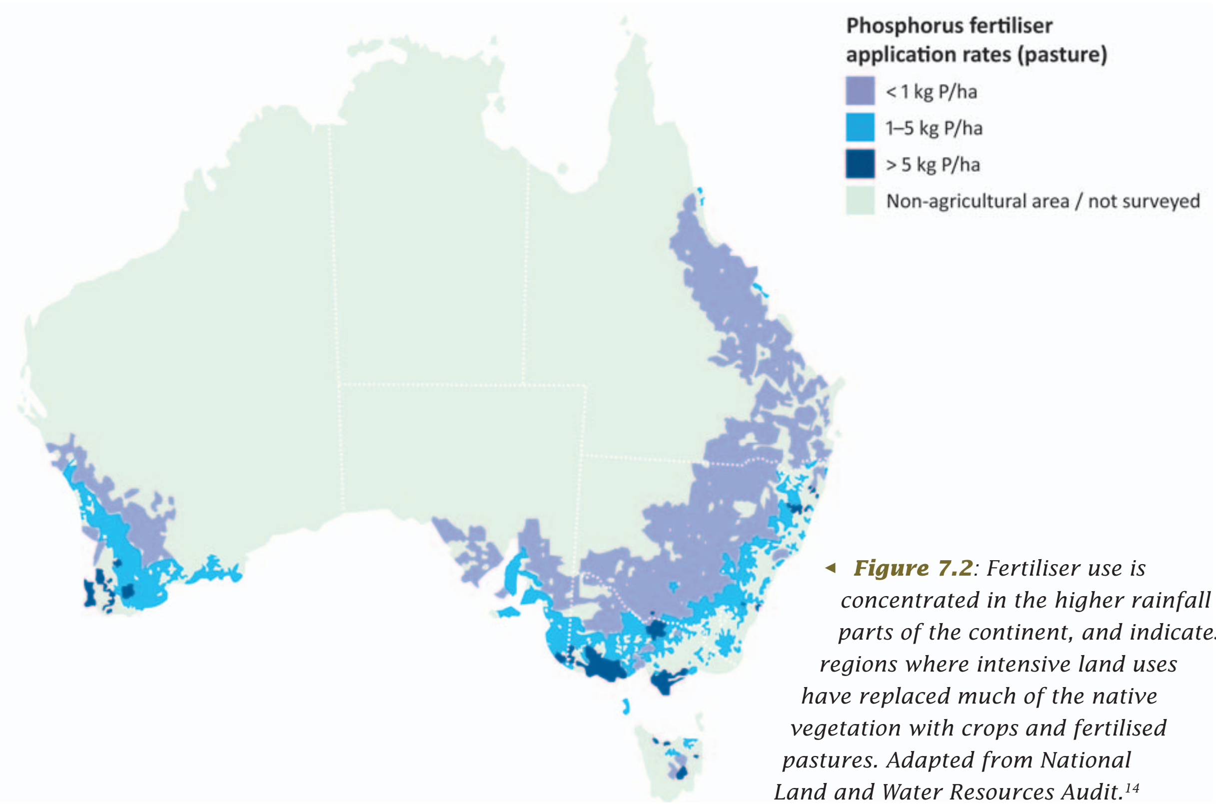
An additional task for the rangeland manager is the control of dingoes and wild dogs to protect sheep. However, the loss of these predators can allow kangaroo populations to flourish, which in turn can increase grazing pressure. It can also lead to higher cat density and negative effects on native mammals. Feral goats, camels, donkeys and horses also contribute to grazing pressure, so it is not simply a case of regulating livestock numbers to maintain an appropriate level of impact.

In the forested regions of southern Australia, harvesting of native hardwoods, *Eucalyptus*, and softwoods, *Callitris*, is another activity where moderate levels of exploitation can be compatible with maintenance of a diversity of species.[11] Economic pressures can lead to shorter harvesting rotations, which lower the average age of trees in the forest. Keeping some of the largest, most mature trees is important for native mammal conservation because they are rich in hollows that are needed for breeding. As for rangelands, small shifts in forestry practice can make large differences to the quality of habitat for native species (Table 7.2).[12] Controlling non-native species, and limiting the disturbances that encourage their proliferation, is good conservation practice, though not all non-native species have negative impacts, and some can even provide useful resources for native species.[13]

This cypress pine forest has supplied firewood and timber since the 19th century but still supports significant woodland birds and native flora. Note the cut stumps, young regrowth trees and large specimens of cypress pine and eucalypt, creating a variety of structures for wildlife. Photo: Sue McIntyre, CSIRO.

Intensive land uses

Only in the 20th century did industrial-scale intensive production systems spread over large areas of Australia, following replacement of draught mules, horses and bullocks by engines. Subsequent leaps in technology have included the introduction of legumes (e.g. clovers) combined with fertilisers to improve soil quality, and the use of chemicals to control weeds, pests and diseases. Better quality soils in the higher rainfall areas have generally been the most economically suitable for intensive uses, indicated by the map of fertiliser application (Figure 7.2). Parallel technical advances in forestry have enabled the establishment of single-species plantations with close management of nutrition, pests and diseases.



◂ ***Figure 7.2***: *Fertiliser use is concentrated in the higher rainfall parts of the continent, and indicates regions where intensive land uses have replaced much of the native vegetation with crops and fertilised pastures. Adapted from National Land and Water Resources Audit.*[14]

The intent of intensive production is to divert all the available plant growth resources either towards the crop of interest, or towards growing forage for livestock consumption. A successful intensive system, therefore, is one where the unproductive pre-existing native species are completely absent, and all non-crop or non-forage plants are excluded. Intensive production systems can generally achieve exclusion because, as discussed earlier, native plants are poorly adapted to high levels of disturbance and fertility.

Plantations are managed with the aim of producing even-sized trees, spaced to optimise growth, and with few other plant competitors. Photo: Willem van Aken, CSIRO.

Cereal growers aim to create an area of land supporting only the crop, with no weeds to compete for water, nutrients or light. Photo: CSIRO.

A pronounced feature of intensive systems is that they tend to leak nutrients, agricultural chemicals and soil into the creeks and rivers, and into the groundwater.[15] This leakiness can have adverse effects on native species in adjoining habitats and downstream from the source of nutrients.

The blue-green algae in this irrigation drain are indicative of nutrients leaking out of cropped areas and flowing into creeks and wetlands. Photo: Willem van Aken, CSIRO.

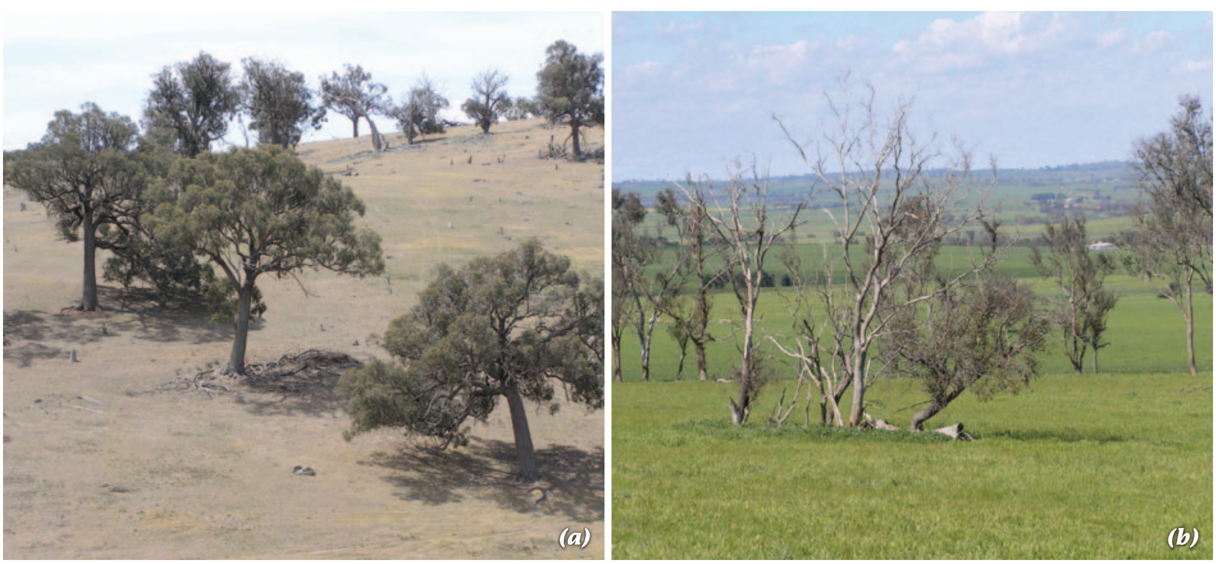
On the positive side, birds can benefit from an insect or grain bounty associated with intensive production areas, and kangaroos can benefit from nutritious food supply in, or near, fertilised crops and pastures.

Galahs, Eolophus roseicapillus, *benefit greatly from the food resources associated with crops and sown pastures, in this case the seed heads of non-native thistles, although they also need mature eucalypts with hollows to breed. Photo: Chris Tzaros.*

Where intensive production is economically profitable, it has led to dominance of the landscape by crops and fertilised pastures and, to a lesser extent, tree plantations.

Examples of intensive land uses dominating the landscape: ***(a)*** *cropping in the Riverina of New South Wales driven by the availability of irrigation water, and* ***(b)*** *radiata pine plantations near Queanbeyan, New South Wales. Photos (a) and (b): CSIRO.*

Such landscapes support relatively few native plants and animals, beyond those persisting in roadside vegetation and small nature reserves. Maintaining the health of mature scattered trees and managing for their eventual replacement is essential in intensive production landscapes, for both the survival and the movement of wildlife.[16] They also have aesthetic appeal, and provide shade for livestock. Without assistance they fail to recruit and eventually die out of the system.



(a) *Mature trees retained on land grazed for wool production provide critical habitat for birds and reptiles in a heavily grazed landscape. Note the lack of regenerating trees, and some tree death on the hill crest.* ***(b)*** *Trees remaining in fertilised crops and pastures are prone to die because of elevated nutrients and generally do not regenerate from seed. Photos (a) and (b): Sue McIntyre, CSIRO.*

Native plantings along the edges of paddocks allow some native birds to persist in cropped landscapes, but are not a complete substitute for the mature eucalypts.

Plantings in districts heavily cleared for cropping provide dense cover for birds but do not provide the hollows or quantity of food resources of mature trees. Photo: Wendy Henderson.

Tree plantations are monocultures managed to maximise growth through soil cultivation, added nutrients, and weed and pest control. Plantations support more native species than crops or sown pastures, but native plants do not thrive in any of these three habitats. There are ways of making plantations more biodiversity-friendly, however, including allowing stands of native shrubs and regenerating trees to remain, leaving thinned and pruned material on the floor of the plantation, and growing plantation trees to an older age.[17]

Mixed intensive production and rangeland-style grazing

In parts of Australia where a low proportion of land is suitable for cropping and fertilised pastures, we can see living evidence of the mixing of intensive and low-input land uses to achieve agriculturally productive landscapes that support a wide array of native fauna and flora. This biodiversity in return provides the ecosystem services of pollination and pest control. A common pattern is to locate fertilised pastures and crops on the creek flats and lower slopes of valleys, with grazing of native grassy vegetation on the sides of the valleys, and no livestock on the steepest, rockiest soils. This provides a fortunate mix of highly productive areas, bush for wildlife and native plants, and diverse, treed native pastures.

A common pattern of landscape use is to have intensive land use on the fertile valley floors (in this case, fertilised pastures seen on the foreground), grazed woodland on the slopes (mid-view) and forest on the highest parts of the landscape (the horizon). Photo: Sue McIntyre, CSIRO.

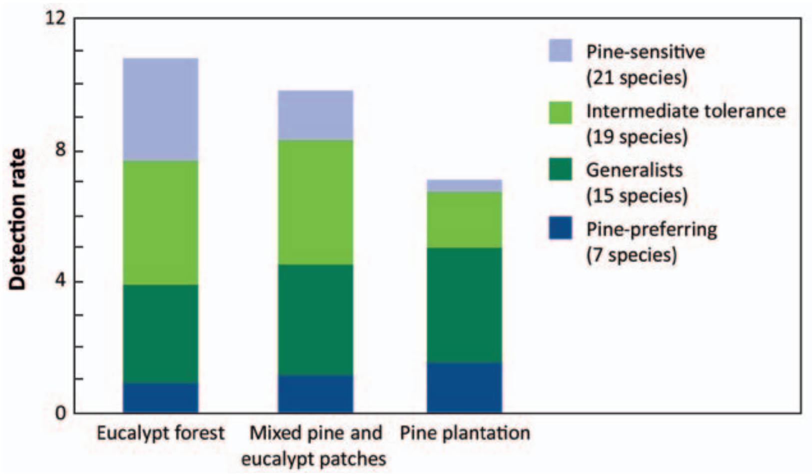
Many animals depend on treed watercourses and productive soils, so retaining or restoring native vegetation along creeks and rivers is needed to keep native fauna on the farm.[18] The way that native pastures are managed is also important. Retaining some trees is valuable for birds, and having a range of grazing intensities promotes native plant diversity.[19]

Riverside areas are important for wildlife, which benefits from the fertile soil and the presence of water, trees, shrubs and rocks. The diversity and numbers of birds are high when riversides are vegetated. Photo: CSIRO.

Mixed plantation and native forestry

Topography and soil quality can also drive the choice of location of plantations, which can be within a mosaic of native forest, some of which may be logged and some managed for biodiversity conservation. Such mixed land uses can collectively support a range of bird life, with a few native species even preferring pine plantations (Figure 7.3).[20]

Native fauna will further benefit from the management actions that produce a range of ages of trees in both the plantations and natural forests. The retention of mature trees, understorey species and fallen timber, and other techniques for creating mixed habitats, such as dams and cleared areas, will also encourage a greater number of species.[17,19]



▲ ***Figure 7.3***: *Numbers of species of native birds in eucalypt forests, mixed habitats, and pine plantations. The effect of habitat disturbance in the form of pine plantations on birds echoes that of cattle grazing on native plants (Figure 7.1); there are more species that are sensitive to the most intense disturbance than prefer it. However, unlike native grasses and medium-intensity grazing, there is no overall positive response by birds to intermediate disturbance (the mixed pine and eucalypt patches).*[20]

SOIL LIFE – THE DIVERSITY UNDERPINNING EVERYTHING ELSE

Regardless of the production style, the soil beneath it supports invertebrates, fungi and microbes, which form a significant component of the total biodiversity within an ecosystem. Algae, bacteria and viruses in soil are critical to the working of natural ecosystems and production systems, due to the essential role many have in nutrient recycling through decomposition, and a myriad of physical and chemical activities that keep soil in a suitable condition for plant growth. Different land use intensities affect the types of larger invertebrates and micro-organisms that persist – not all species tolerate cultivation, fertilisation or dry or infertile soils. Fungi are thought to be more important recyclers of nutrients where fertility is low, and bacteria more important in fertilised soils.[21] Apart from recognising the importance of organic matter for the health of soil, there is little practical advice yet available on the management of soil biodiversity.[22]

LANDSCAPE PLANNING OPTIONS TO RETAIN NATIVE BIODIVERSITY

The importance of amount and arrangement of habitat

There are two ways of enabling farming and native biodiversity to coexist. First are refinements to the management of the land, as mentioned previously and summarised in Table 7.2, to influence the *quality of the habitat* for different organisms. This approach focuses on maximising usefulness of the land to native species within the constraints of the particular land use, and minimising its unwanted off-site effects, such as avoiding nutrient leakage from a crop into a creek or area of native vegetation. Sometimes these refinements can be made with only a minor loss of income from production, but at other times there may be a major trade-off.[23] At times, the productive land uses that dominate many landscapes simply do not provide suitable habitats for the most sensitive species, in which case parts of that landscape may need to be managed specifically for nature conservation, not only in public reserves but also on private land.

The second approach is landscape planning, which can help determine the *amount of habitat* and adjust amounts and location of land uses across farming and forestry landscapes. The aim is to provide sufficient habitat suitable for native plants and animals to feed, breed, shelter and move around.[24]

The *arrangement of the different land uses* is also important.[25] Two land uses side by side can detract from each other's purpose or, at the other extreme, be of mutual benefit. Crops and fertilised pastures can be poor neighbours to bushland or creeks if excess nutrients wash into these areas and encourage natives to be replaced by weeds. Conversely, planting trees adjacent to crops and sown pastures can encourage some native birds to forage on the fertile areas and native insects to assist pollination, while also providing a safe retreat and breeding sites. But if the feeding birds are damaging the crop, their presence might be viewed differently by producers.

The need for plants or animals to move across landscapes has preoccupied ecologists for years. The term 'connected landscapes' has been coined in recognition of the need for organisms to move between different areas to meet the essentials of survival (see Chapter 5). Many animals and many more plants are unable to move from small fragments of bush across extensive cleared areas (Figure 7.4).

Habitat connectivity is the product of the amount of habitat, whether it is arranged in isolated fragments or one continuous strip, and the extent to which adjoining land use interferes with the way in which species can use the habitat. Generally, if a habitat covers two-thirds or more of the landscape, the species using it will be able to move around freely, regardless of the arrangement.[26] If the same habitat covered only one-tenth of the landscape, the connectivity would depend very much on the way that it was arranged. If it was in a single strip across the entire landscape, it would give a species the opportunity to travel a long distance, but this connectivity may not be adequate for the wellbeing of the species. For example, a narrow roadside strip of reserve with a minimal shrub layer passing through cropland may provide poor protection to small birds travelling along it from predatory birds that thrive in open areas.

▲ ***Figure 7.4**: The range of a native bird in an agricultural landscape. **(a)** A female brown treecreeper,* Climacteris picumnus. ***(b)** Tracked movements shown in yellow of a female brown treecreeper attempting to disperse. The dense cluster of points indicates where she was born. The mapped path shows the use of roadside and streamside corridors and scattered trees. The treecreeper reached another patch of vegetation to the north, but there were no treecreepers there so she ultimately returned home, and dispersal failed. Credit: Erik Doerr, Veronica Doerr, and Micah Davies.*

How much native habitat is enough?

The question for farm and landscape planning is: 'How much intensive production can take place without excluding most native species from the landscape?' Roughly speaking, if any land use that largely excludes native biodiversity (crops, plantations, fertilised pastures) covers less than one-third of the landscape, it is unlikely to lead to the disappearance of native plants and animals (Table 7.3).[19,27] Obviously the activities in the other two-thirds of the landscape are important in determining exactly which species thrive and which do not. Based on a review of the evidence, scientists have developed suggestions for the relative balance of different land uses across a landscape, known as the 10:20:40:30 guidelines.[17] They are summarised in Table 7.3 and Figure 7.5, and are based on the principle that a balanced range of land use intensities can provide a variety of landscape elements able to support the majority of local native species together with a range of human activities. The important underlying principle is that, regardless of how it is arranged, habitat covering two-thirds of the landscape is fully connected for all the species dependent on it, including those that are totally restricted to the habitat.

Table 7.3: Balancing production, habitat for native species and ecosystem function in different land use intensities.[27] Mobile species (e.g. most birds) cross unfavourable habitat; non-mobile species (e.g. many plants) require continuous habitat.

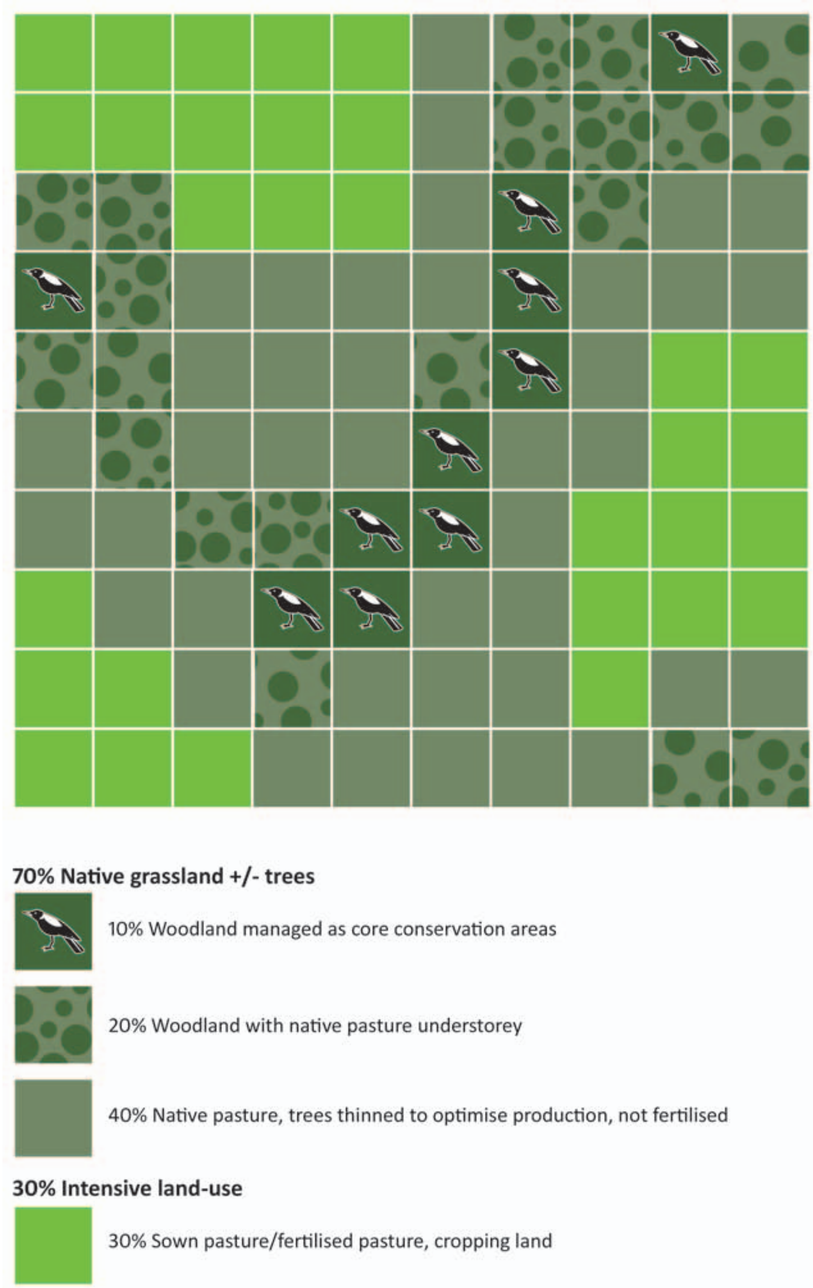
<table>
<tr><th></th><th>Native vegetation – managed for conservation</th><th>Native vegetation – production uses</th><th>Moderate-intensity production</th><th>High-intensity production</th></tr>
<tr><td>Suggested proportion of landscape</td><td>≥ 10%</td><td>≥ 20%</td><td>0–70%</td><td>≤ 30%</td></tr>
<tr><td>Examples of land use</td><td>Conservation reserve, recreation area</td><td>Livestock grazing, native forestry</td><td>Native tree or shrub plantation, tree clearing to increase grazing production</td><td>Annual crops (cereals, vegetables), sown, fertilised pastures</td></tr>
<tr><td>Functions provided</td><td colspan="3">≥ 70% of landscape covered with perennial vegetation</td><td>≤ 30% annual vegetation</td></tr>
<tr><td>Habitat provided for native species</td><td>Nearly all species, including those sensitive to human activities</td><td>Most species</td><td>Moderate number of species</td><td>Very few species highly tolerant of disturbance</td></tr>
<tr><td>Connectivity for non-mobile species</td><td colspan="3">≥ 70% if ground layer is intact under moderate production; provides connectivity for most plants and invertebrates</td><td rowspan="2">≤ 30% not suitable for most plants and many animals to move through</td></tr>
<tr><td>Connectivity for mobile species</td><td colspan="2">≥ 30% of landscape with trees and/or shrubs, providing connectivity for mobile species that require these elements for movement</td><td>Suitability will depend on species and land use</td></tr>
</table>

Not all landholders are inclined or able to implement these guidelines. In recognition of this, several strategies have been developed by governments to encourage voluntary biodiversity conservation on private land (see Chapters 4 and 5).

ADOPTING NEW LAND USE PATTERNS AND MANAGEMENT

Societal change and voluntary actions

Awareness of biodiversity conservation among land managers has increased dramatically since the 1970s. The establishment of Landcare in the 1980s, and many other programs initiated by regional, state and federal governments, have continued to raise awareness. Increased two-way communication between researchers and land managers has helped more rapid dissemination of new technical knowledge, as well as providing realistic perspectives of the constraints and practicalities of biodiversity in production landscapes. We now see mainstream acceptance of biodiversity conservation in principle, although voluntary adoption of changed practices is not universal among landholders.



▸ ***Figure 7.5****: An idealised map of a grassy woodland property developed for maximum intensive land use and grazing but within the developmental limits for biodiversity conservation and provision of ecosystem services as described in Table 7.3. Land uses have been located so as to maximise connectivity for native plants and animals.*[8]

Legislative protection

Protection of individual threatened native species was the intent of earliest legislation, introduced progressively from the mid 20th century. As ecological understanding has evolved, the need to protect not only a range of species but also their habitats has become increasingly apparent. The financial rewards of agricultural development continued to drive the clearing of native bush, but at the same time the awareness of the environmental issues was gathering pace. In response, state and federal governments implemented vegetation and biodiversity protection

Programs such as Landcare have helped raise awareness of biodiversity conservation among landholders. Photo: Landcare Australia Limited.

legislation (see Chapter 3). Although necessary, regulations cannot solve everything.[28] For example, landholders may be reticent about revealing the presence of endangered species, or even eliminate them on their properties, fearing unwanted legal interventions. Other approaches are needed, as described next.

Regional land management initiatives

We are all responsible for determining the state of natural resources to be left for future generations and in many areas governments act on our behalf. Landscape planning to manage natural resources involves state and Commonwealth agencies, with responsibilities more recently being devolved to regional community groups. Planning and management may be organised around particular river catchments or threatened ecosystems. More recently, though, the scale has broadened to improving habitat connectivity between regions, where the long-distance movement of wildlife has been considered important (see Chapter 5).

Financial incentives

Implementation of landscape-scale guidelines presents significant and sometimes insurmountable financial challenges for primary producers, particularly in the most developed landscapes where reduction in the area of cropping land is rarely contemplated and where restoration has an uncertain outcome.[29] Financial subsidies to offset the cost of protecting particular habitats are applied directly or through tax relief. More recently markets have been used to change behaviour. One example is environmental auctions, contracts with government to protect vegetation at a particular site. Landholders bid for grants to improve conservation value, based on site condition, the proposed actions and the resources needed by the landholder.[30]

It comes down to us

Native species will survive best in farming and forestry landscapes when activities that continue to create positive long-term attitudes to biodiversity conservation are designed and implemented. Success depends upon continuing to find a balance between community values and involvement and individual decision-making, and appropriate levels of government intervention without leading to a reliance on it.[30] Many serious decisions affecting native plants and animals are everyday actions which superficially appear to have little consequence for conservation: the location of a shed, the decision to fertilise a lawn or paddock, the choice of plants selected from the nursery, or where heavy machinery is parked by the road. As personal awareness grows, it will influence the multitude of these small decisions, and may motivate us to tread more lightly on the landscape.

FURTHER READING

Dorrough J, Stol J, McIntyre S (2008) *Biodiversity in the Paddock: A Land Managers' Guide*. Future Farm Industries Cooperative Research Centre. <http://www.futurefarmonline.com.au/publications/other-publications.htm>.

Fisher A, Hunt L, James C, Landsberg J, Phelps D, Smyth A, Watson I (2005) *Management of Total Grazing Pressure: Managing for Biodiversity in the Rangelands*. Australian Government Department of Environment and Heritage, Canberra. <http://www.environment.gov.au/land/publications/rangelands-grazing.html>.

Gibbons P, Lindenmayer DB (2002) *Tree Hollows and Wildlife Conservation in Australia*. CSIRO Publishing, Melbourne.

Lindenmayer DB (1998) *The Design of Wildlife Corridors in Wood Production Forests*. Office of Environment and Heritage, Sydney.

McIntyre S, McIvor JG, Heard KM (Eds) (2002) *Managing and Conserving Grassy Woodlands*. CSIRO Publishing, Melbourne.

Pyne SJ (1991) *Burning Bush: A Fire History of Australia*. University of Washington Press, Seattle.

Rawlings K, Freudenberger D, Carr D (2010) *A Guide to Managing Box Gum Grassy Woodlands*. Australian Government Department of Environment, Heritage, Water and the Arts, Canberra. <http://www.nrm.gov.au/resources/publications/stewardship/bggw-handbook.html>.

Salt, D, Lindenmayer DB, Hobbs RJ (2004) *Trees and Biodiversity: A Guide for Australian Farm Forestry*. Publication 03/047. Rural Industries Research and Development Corporation, Canberra.