

# Trees and biodiversity

A guide for Australian farm forestry

David Salt, David Lindenmayer and Richard Hobbs





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David Salt, David Lindenmayer and Richard Hobbs

Production editor: Martin Field

Design and layout: Design One Solutions

Figures: Yvette Salt

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# Contents

|                                                                                                    |     |
|----------------------------------------------------------------------------------------------------|-----|
| Foreword                                                                                           | iv  |
| Preface                                                                                            | vi  |
| Acknowledgments                                                                                    | vii |
| 1 Setting the scene – The connection between farm forests and biodiversity                         | 1   |
| 1.1 Does farm forestry have a role in conserving nature?                                           | 2   |
| 1.2 Using this book                                                                                | 8   |
| 1.3 The business of farm forestry                                                                  | 9   |
| 1.4 The business of biodiversity                                                                   | 14  |
| 1.5 Farm forestry and biodiversity                                                                 | 34  |
| 2 Some biodiversity basics – A few principles to build on                                          | 37  |
| 2.1 Two underlying concepts                                                                        | 40  |
| 2.2 Five themes for enhancing biodiversity                                                         | 44  |
| 2.3 From principles to practice                                                                    | 95  |
| 3 What can be done – Putting principles into practice                                              | 101 |
| 3.1 Improving the biodiversity value of a tree planting                                            | 103 |
| 3.2 Options, strategies and trade-offs                                                             | 108 |
| 3.3 Weighing up the options and developing a plan of action                                        | 124 |
| 3.4 Specific situations                                                                            | 131 |
| 4 What if ... ? – Principles and guidelines for specific situations<br>(with some tips and tricks) | 133 |
| Appendix A Some biodiversity resources                                                             | 177 |
| Appendix B Species list                                                                            | 187 |
| Annotated bibliography                                                                             | 193 |

# Foreword

Australia's declining biodiversity is often cited as one of our greatest environmental threats. We have already lost 19 species of mammals, 23 species of birds and 68 species of plants. Thousands of animal and plant species are vulnerable or endangered, and an unknowable number of insects, fungi and microbes either have become extinct or are endangered. With the disappearance of these species, we also lose the many ecosystem services they provide — services that are intimately connected to the productivity of our agricultural landscapes.

One of the primary causes of this decline is the widespread clearing of native vegetation to make way for agriculture: nationwide, we have cleared 43 per cent of our forests, nearly 90 per cent of our temperate woodlands and mallee, and 75 per cent of our rainforests. Along with the decline in biodiversity, this has resulted in a loss of productive land to salinity and widespread declines in water quality.

Farm forestry — if carried out in an appropriate fashion — is widely promoted as a land use that has the potential to mitigate many of these environmental threats. But, although it is often claimed to be beneficial for our native animals and plants, there is little literature describing how tree plantings on farms might be managed to benefit native biota.

The Joint Venture Agroforestry Program supports and coordinates agroforestry and farm forestry research and development at the national level. It is managed by the Rural Industries Research and Development Corporation on behalf of its co-funding partners at Land and Water Australia, the Forest and Wood Products Research and Development Corporation, the Murray–Darling Basin Commission and the Natural Heritage Trust. The objective of the program is to promote the integration of sustainable, productive agroforestry systems and traditional farming practice, so as to alleviate environmental problems and increase farm productivity.

The Joint Venture Agroforestry Program has commissioned a number of projects to develop guidelines on different aspects of agroforestry design and practice for farm advisers, catchment managers and landholders. The guidelines published so far are *Design Principles for Farm Forestry*; *Trees, Water and Salt: an Australian guide to using trees for healthy catchments and productive farms*; and *Trees for Shelter: a guide to using windbreaks on Australian farms*.

This book, *Trees and Biodiversity: a guide for Australian farm forestry*, is an important and timely addition to the series. It provides the most up to date information on agroforestry and biodiversity, and we hope it will make a valuable contribution to the conservation of biodiversity right across Australia's agricultural landscape. It is complemented by the reports of a number of other biodiversity studies that have received support from the Joint Venture Agroforestry Program, together with the Natural Heritage Trust, among them *Quantifying Conservation and Environmental Service Benefits in Hardwood Plantations*, *Fauna Biodiversity Values in Queensland Agroforestry Systems* and *Plantation Design and Biodiversity Conservation*. These reports are all available from the Rural Industries Research and Development Corporation.

*Simon Hearn*  
*Managing Director*  
*January 2004*

# Preface

While we were preparing this book several things became apparent. First, wherever farm forestry is discussed, its value in terms of increasing biodiversity is promoted. But this claim is almost never substantiated. It is taken as a given: ‘more trees are good for native biota’.

Second, when you actually ask people working in the area of farm forestry (be they in research or on the land) what they think about the value of tree plantations for biodiversity, you hear the entire spectrum of opinions, from ‘they hold no value at all’ through to ‘they hold the answer to halting the loss of Australia’s biodiversity’.

Finally, although there have been many studies of biodiversity in large-scale commercial plantations, our knowledge of biodiversity in smaller scale farm forestry operations—and how to manage for it—is thin and patchy, to say the least. There are no definitive answers or guidelines out there. Just like farm forestry itself, the science of small and medium-sized tree plantations is still in its infancy. Our task, therefore, was to shed light on an area about which a lot is claimed but little is known.

To help us establish a framework for how this document might be developed, a wide range of scientists and extension officers with experience of farm forestry and revegetation came together for a workshop in Melbourne at the beginning of 2002. Their ideas and recommendations were discussed at length. David Lindenmayer then carried out an extensive review of the scientific literature on biodiversity in commercial plantations in Australia and summarised the main points and guidelines.

We then set about the writing task, aiming to synthesise what is known and to present it in a way that is relevant, informative and engaging for anyone who is interested in biodiversity and farm forestry in Australia. To fulfil this aim, we have broken a few of the conventions of the more traditional scientific literature. We have used common names of fauna and flora rather than scientific names—although there is a full species list in Appendix B—and we have included full reference citations in each of our case studies so that readers do not have to continually turn to the end of the book to find out where our information comes from. We have also described the research in a simple, jargon-free manner, although jargon inevitably creeps in from time to time.

The question is: Is farm forestry good for biodiversity? The answer is: It depends on how it is done. There are no precise formulas or prescriptions. It is our hope, however, that after reading this publication you will be convinced of the need to consider biodiversity in your planning and will be well equipped to judge what you might do to improve the biodiversity value of your tree planting. We also hope that, after learning about what other farmers are doing, you will be inspired by what they have achieved and will be keen to give it a go yourself.

*David Salt, David Lindenmayer and Richard Hobbs*

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An enormous number of people contributed suggestions, comments and supporting material. We thank everyone who participated in the two-day workshop held in Melbourne in February 2002 to discuss the scope of this document. Special thanks go to Rod Bird (Victorian Department of Sustainability and Environment), Saul Cunningham (CSIRO Entomology), David Freudenberger (CSIRO Sustainable Ecosystems), Phil Gibbons (New South Wales National Parks and Wildlife Service), John Ives (CSIRO Sustainable Ecosystems), Digby Race (Australian National University) and Paul Ryan (CSIRO Sustainable Ecosystems) for discussions and comments on the manner in which the various themes are presented.

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Steve Dahl (Norske-Skog), Craig Grabham (Charles Sturt University), Jacqui Stohl (CSIRO Sustainable Ecosystems) and Sue Streatfield and Susie Wilson (Greening Australia ACT & SE NSW) provided valued assistance with images, and Monica Ruibal kindly assisted with collection of the extensive (and rapidly growing) literature that now exists on biodiversity conservation in Australian plantations.



1

## Setting the scene

The connection between  
farm forests and biodiversity



Photo by D Salt

This introductory chapter defines a number of the concepts explored in this book—the connection between farm forestry and biodiversity, the potential role of farm forestry in nature conservation, and the value of biodiversity to both the farm and the wider community. It also briefly summarises what is known about the biodiversity of pine and native hardwood plantations.

## 1.1 Does farm forestry have a role in conserving nature?

Many people point to farm forestry as a way of generating a wide range of environmental and economic outcomes. One of those outcomes is improved nature conservation and protection of biodiversity. But what contribution can farm forestry actually make?

Two broad areas of benefit are often cited. Farm forestry has the potential to play a direct role in providing additional habitat for native animals and plants; it also has an indirect role in mitigating the broad-scale environmental problems of rising salinity and erosion that threaten landscapes and the fauna and flora they support. Using farm forestry to fight salinity and erosion is covered extensively in other publications: see, for example, *Trees, Water, and Salt* (Stirzaker et al. 2002). Here we focus more on farm forestry's direct impacts on biodiversity; we do, however, also discuss many factors relating to the indirect impacts.

Although the potential for planted trees to offer refuge and resources for native wildlife is often highlighted in promotional literature on farm forestry, the evidence to support this is actually quite thin—usually anecdotal observations of more birds found in and among planted trees. It is true that many landowners notice there are more birds when they add a tree plantation to land that was formerly pasture or crops. But does this mean we can meet the challenge of Australia's declining biodiversity by establishing trees on farms? And is it possible to modify plantation management so as to achieve commercial and nature conservation outcomes simultaneously?

No conclusive studies have identified precisely the biodiversity benefits that farm forestry can provide (see Box 1.2), but most of the evidence strongly suggests that plantations, even if they contains a mix of natives, are *not* a substitute for native forest or a patch of remnant native vegetation. They lack the structural complexity, the mix of ages, and the range of resources needed to support a diverse assemblage of native animals and plants.

(continued on page 6)

### Box 1.1 Is it a plantation or a farm forest?

‘Farm forestry’ means different things to different people but usually involves the planting and management of trees to generate positive outcomes—financial or environmental, or both—for the farm. This includes small woodlots, shelterbelts, alley systems and industrial-scale plantations. Because trees are sometimes planted with environmental outcomes in mind, it also includes biodiversity or habitat plantings with no direct commercial purpose; such plantings are also discussed in this book.

Plantations are simply planted stands of trees. Sometimes the word evokes an image of massive, industrial-scale operations, but small woodlots, shelterbelts and mixed-species habitat plantings are also plantations. The focus of this book is tree plantations of any scale on agricultural land.

It should be noted that most of the research into the biodiversity value of planted trees has been conducted in large-scale industrial plantations such as pictured in (c). The lessons from that research can often, however, be applied to planted trees at any scale (including woodlot (b), shelterbelts (a), and habitat plantings(d)).



This book focuses on tree plantations (of any scale) on land previously used for agriculture.  
(a) Photo by Greening Australia (b) Photo by R Bird (c) Photo by D Lindenmayer  
(d) Photo by Greening Australia)

## Box 1.2 The science on biodiversity, plantations and farm forests

It is commonly said that farm forestry benefits biodiversity in agricultural landscapes. But what does the scientific record say? Not much according to a review of the scientific literature conducted by CSIRO for a Dames and Moore report on the integration of farm forestry and biodiversity. (This finding is supported by our own comprehensive review of the scientific literature: see ‘Plantation biodiversity?’, in Section 1.4.) It is important to note that the little that is known is based on research done in and around commercial plantations, not smaller scale farm forests.

Among other things, the CSIRO review found the following:

- The evidence supporting the claim that farm forestry can improve biodiversity in agricultural landscapes is sparse and somewhat equivocal.
- Although landholders often plant trees for purposes other than timber—for example, for windbreaks or to fight salinity—they generally see wildlife conservation as a low priority.
- Evidence from bird studies in radiata pine plantations suggests that biodiversity is likely to be greatest on the edges adjoining eucalypt forests or woodlands.
- Insect species appear to be well represented in radiata pine plantations.
- Trees from large-scale radiata pine plantations can invade and establish themselves in adjoining native bushlands, becoming an environmental weed.
- Farm forest hardwood plantations have more insect species beneath them than do open pastures.
- The relative ease with which eucalypt species can hybridise may lead to genetic pollution; that is, genes from plantation species may escape into local species.
- Increased habitat for feral animals such as foxes, cats and wild dogs could lead to increased threats of predation on native fauna—although this may be balanced by the provision of new habitat for native animals.
- The use of herbicides, pesticides, fertilisers and baits as part of hardwood-plantation management can adversely affect biodiversity.

The report concluded that design and management practices for farm forestry plantings are likely to be important if a contribution to biodiversity is a goal of such plantings. In other words, of themselves and by themselves farm forests make little contribution to nature conservation. If nature conservation is your aim, you need to plan and manage for it.

It is worth noting, however, that farm forestry is still an emerging industry. Even though the CSIRO report is only a few years old, much research into biodiversity in plantations has been done since it was compiled. Some of these studies are discussed later. Many investigations are being initiated right now, and it is expected that our understanding of how to improve the biodiversity value of plantations will increase considerably in the coming decades.

Source: Dames & Moore 1999, *Integrating Farm Forestry and Biodiversity*, JVAP report no. 68/1999, Rural Industries Research and Development Corporation, Canberra, <<http://www.rirdc.gov.au/reports/AFT/99-166.pdf>>.

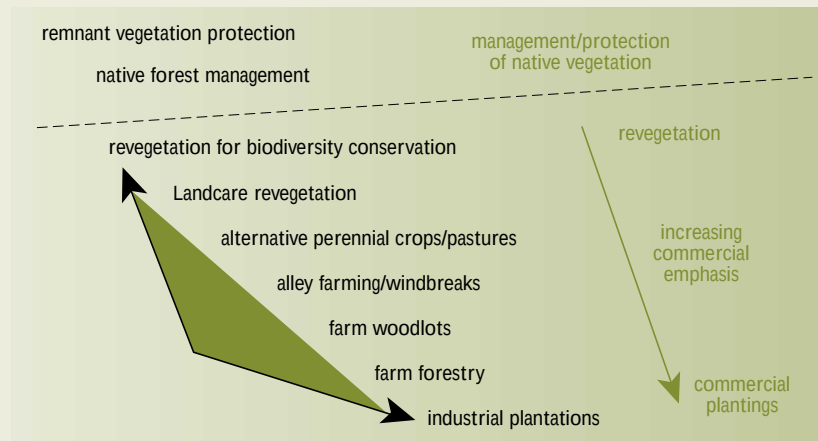


An assessment being made of a young blue gum woodlot in Victoria (Photo by D Salt)

### Box 1.3 The scope of this book

This book covers:

- commercial farm forestry—large and medium-sized plantations as well as small plantings
- hardwood plantations
- softwood plantations
- shelterbelts
- revegetation for biodiversity.



**Figure 1.1** The basic principles and guidelines outlined in this book are relevant to all forms of revegetation for biodiversity on farms. They are, however, most applicable to landowners and extension officers involved in farm forestry.

Nevertheless, a farm forest can provide some of the resources necessary for some of the wildlife and native plants present in your region. If planned sympathetically with the retention of existing native vegetation, farm forestry can produce significant conservation benefits. Further, you can modify your plantation and its management in many ways, so that it does not necessarily cost too much in terms of lost production or forgone opportunities. On the other hand, although a farm forest can serve as an asset to biodiversity if it is properly established and maintained, a poorly developed and maintained plantation can prove the opposite—a damaging environmental liability. Not only might it contain little of value for local species

of native wildlife and flora, it might also have serious negative effects on what is already present in the area.

Some people are openly sceptical about the value of broad-scale farm forests for biodiversity, suggesting that such talk is unfounded rhetoric put forward by the forestry lobby to promote a plantation agenda. Reports of commercial forestry operations clearing patches of remnant vegetation to make way for blue gum plantations serve only to fuel such cynicism. Scepticism is healthy, but there is little value in flatly dismissing farm forestry. The fact is that farm plantations are on the increase and will be a significant component of the agricultural landscape in the decades to come (see Box 1.4). To ignore their potential for nature conservation is to waste a precious opportunity.

Much of Australia's current problem of declining biodiversity has arisen from our inability to integrate biodiversity into agricultural practice as we cleared the Australian landscape of native vegetation. We should now know better. If farm forestry is to become a common agricultural activity, then surely the real challenge is to redress this earlier failing and develop a culture of tree-plantation management that acknowledges and incorporates biodiversity in its practice.

An important message is that not all farm forestry is good for biodiversity. What value it has to offer depends on how it is done. Each farm situation is unique; each action produces different results. However, knowing some of the basic principles and being able to identify the important needs of wildlife will allow farm foresters to more effectively consider their options.

This book aims to give farm foresters a greater understanding of how natural ecosystems function, how to build natural values into the management of a farm forest, and how to turn a plantation of trees into an asset for biodiversity.



**This book is for people practising farm forestry or managing tree plantations.**  
(Photo by D Salt)



**Figure 1.2 Areas where farm forestry is being promoted**

## 1.2 Using this book

This book is for people practising farm forestry or managing tree plantations (and people thinking about becoming involved in such activities) who want to take into account the conservation of biodiversity. This includes farmers, foresters, farm forestry extension officers, investors and conservationists. The information is relevant to most forms of farm forestry, from the small to the large-scale plantation, although the emphasis is on operations with a commercial component in medium to high-rainfall (greater than 400 millimetres) regions of Australia.

The four chapters build on each other. People looking for specific information may want to skim some sections and concentrate on others: where possible, we have attempted to facilitate this with signposts and cross-references. Because we expect some readers will dip in and out of the book, some messages are repeated in several places, although usually in a different context.

Chapter 1—‘Setting the scene’—describes the context of farm forestry in Australia and explores some of the concepts that are developed throughout the book. It discusses the extent of tree plantations and farm forestry in Australia, what biodiversity is, and why it is in your best interests to protect it. It also summarises what is known about the biodiversity of pine and native hardwood plantations. This is a useful chapter for anyone wondering about the connection between plantations and biodiversity.

Chapter 2—‘Some biodiversity basics’—sets out five principles relevant to biodiversity and farm forestry: location, configuration, composition, complexity, and management. This is the framework on which the subsequent guidelines are based. Anyone wanting an understanding of the basic elements of biodiversity in relation to tree plantings will find this chapter useful. Each principle is presented with examples of research that supports it.

Chapter 3—‘What can be done’—takes the principles outlined in Chapter 2 and discusses them in terms of how they might be applied. It considers the issue of improving biodiversity on two scales: at the level of a stand of trees and at the broader level of the landscape. It also discusses the possible trade-offs involved. A pathway is then presented to show how these guidelines might be incorporated in a plan for the farm or tree plantation.

Chapter 4—‘What if ... ?’—examines a range of hypothetical farm forestry and plantation situations and asks what might be done to improve their value for biodiversity. It considers situations such as small tree plantings, woodlots, shelterbelts, special-purpose plantings, commercial-scale plantations and conservation-enrichment plantings and discusses the relevant principles and guidelines and their application.

Appendix A lists an array of information sources and expertise available in Australia to help you learn more about farm forestry, tree selection and biodiversity. Appendix B lists the plant and animal species mentioned in the text, along with their scientific names. Finally, the annotated bibliography will prove valuable for readers wanting to pursue the subject in greater depth.

## 1.3 The business of farm forestry

### Across the continuum

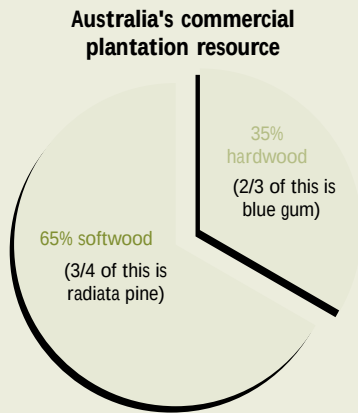
Many publications on farm forestry present a table or a graph that divides revegetation and tree planting into a number of separate categories depending on the degree of emphasis on timber production and the scale of the planting. This is often referred to as the ‘plantation continuum’. It seeks to separate different types of tree planting into the three broad categories of ‘land care’, ‘farm forestry’ and ‘industrial plantations’. Biodiversity plantings are classified as having a low emphasis on timber production and being conducted at a relatively small scale—sometimes under the ‘land care’ heading.

This categorisation of plantations is not particularly helpful in terms of improving the biodiversity value of plantations: it suggests that biodiversity is relevant to only a small section of the continuum and has nothing to do with small- or large-scale plantations. But biodiversity outcomes can be achieved to some degree at any point on the continuum. Indeed, the larger the scale of the planting the greater the importance of biodiversity as a factor in planning and management.

Declining biodiversity in agricultural landscapes has been consistently identified as a serious threat to the sustainability of these landscapes—see, for example, the Australian State of the Environment Reports of 1996 and 2001. Conserving biodiversity and valuing ecosystem services in all forms of land use are increasingly being assigned higher priority. Biodiversity is not merely an academic concern that is relevant only beyond the boundaries of the plantation. Furthermore, important biodiversity outcomes can be achieved without a major sacrifice of commercial outcomes.

### Box 1.4 Commercial plantations in Australia: a snapshot

How many commercial plantations are there in Australia? And what do they contain? The following snapshot is based on a report compiled in 2001 by the Bureau of Rural Sciences National Forest Inventory.



**Figure 1.4 Species composition of Australia's plantations**

- The combined standing plantation resource in Australia (planted to September 2000) is 1.5 million hectares. Of this area, 65 per cent is planted to softwood species and 34 per cent to hardwood species.
- The majority of the plantation estate is spread fairly evenly across New South Wales, Western Australia and Victoria. The most extensive hardwood plantation areas occur in Western Australia, Tasmania and Victoria.
- The area of hardwood plantations is increasing relative to that of softwood plantations. Between 1995 and 2000 the hardwood resource increased by 354 500 hectares (averaging 60 000 hectares annually); this compares with an increase of 156 000 hectares for the softwood resource.

- Australian hardwood plantations are dominated by eucalypt species. Of all hardwood species, blue gum accounts for 62 per cent of plantings and other eucalypts account for 19 per cent. Radiata pine accounts for 74 per cent of softwood plantations.
- Most of the pre-1970 plantation resource has been harvested. Only 8 per cent of the standing resource in 2000 was planted before 1970.
- Since 1994, 516 000 hectares of plantation have been established—an average annual expansion of 70 000 hectares in the last six years.
- Of the plantation estate in 2000, 46 per cent was on public land and 40 per cent was on private land. The remaining 14 per cent is thought to have belonged to private companies on private land.
- The majority of the current plantation estate is on what was previously agricultural land, while 21 per cent (of what is known) is on former native forest land and 20 per cent (of what is known) is second-rotation plantings on land previously under plantation. The great majority of plantations established on former native forest land were planted before 1990.

This very brief overview reveals several things about plantation forests in Australia: they contain only a few species; they are not very old; and a large proportion are exotic species (especially radiata pine). The existing plantation estate, therefore, has several major constraints limiting its value for biodiversity conservation. Chapter 2 discusses these limitations.

Source: Wood, M, Stephens, N, Allison, B & Howell, C 2001, *Plantations of Australia: a report for the National Plantation Inventory and the National Farm Forest Inventory*, Bureau of Rural Sciences, Canberra.

### Commercial plantations in Australia

No matter what you think about commercial tree plantations, one thing is certain: the plantation estate is expanding rapidly in Australia and farm forestry is set to become a major land use in much of southern Australia.

In 1996 Australian governments and industry agreed to develop a national strategy, called Plantations 2020, with the ambitious target of trebling the area of Australia’s timber plantations, to more than 3 million hectares by 2020. This target requires that an average of 80 000 hectares be planted each year, adding 2 million hectares to the plantation estate that existed in 1996. In 1996 the plantation estate, which was a little over 1 million hectares, comprised roughly 90 per cent softwood and 10 per cent hardwood. About 25 000 hectares of new plantations were established in 1996, but the rate has rapidly increased since then. Recent data put the average annual expansion from 1994 to 2000 at 70 000 hectares a year (see Box 1.4).

Plantations 2020 envisages that \$3 billion will be invested in establishing the extra plantations and that most of this will come from private investment. It further envisages that this investment will lead to a 20 per cent increase in farm incomes, the

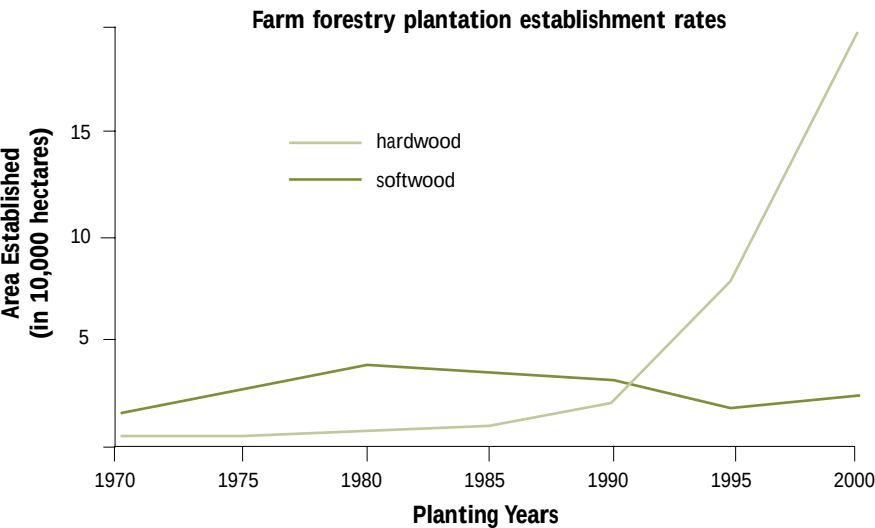


Figure 1.3 The area of plantations in Australia

Source: Wood, M, Stephens, N, Allison, B & Howell, C 2001, *Plantations of Australia: a report for the National Plantation Inventory and the National Farm Forest Inventory*, Bureau of Rural Sciences, Canberra.



**2020 vision: 3 million hectares of land under tree plantations (Photos by D Lindenmayer)**

conversion of Australia's \$2 billion trade deficit in wood and wood products into a trade surplus, and the creation of 40 000 jobs in rural areas. Additionally, it foresees the development of a thriving, sustainable plantation industry that will help reduce Australia's net greenhouse gas emissions and provide other environmental benefits without compromising the commercial attractiveness of the scheme. A grand plan.

As well as Plantations 2020, which focuses on the establishment of plantations in higher rainfall areas, there are under way many projects examining the feasibility of tree plantations such as oil mallee in low-rainfall areas. The aim is to create commercial tree crops that would result in a massive revegetation of the landscape and thus help to alleviate the increasing problem of rising salinity. The scale of the revegetation needed goes way beyond what is possible with land care and restoration plantings.

Regardless of their ability to meet multiple objectives, tree plantations are being encouraged by all levels of government. They are a major and expanding land use. The challenge for nature conservation is to raise the community's awareness of the limitations of tree plantations for the conservation of biodiversity, to set out practical guidelines on how plantations can be improved for wildlife, and to encourage the widespread uptake of these guidelines.

An important message that needs to be stressed is that traditional tree plantations are *not* a surrogate for native vegetation when it comes to biodiversity. The establishment of new tree plantations should *not* lead to the further clearing of native vegetation. Removing remnants of native vegetation to establish a farm forest would be a perverse outcome for a national program that claims environmental benefits as one of its objectives.

### Box 1.5 Plantation planet

In 1996 the combined area of plantations worldwide was estimated to exceed 130 million hectares. In 2001 the UN Food and Agriculture Organization estimated it to be 187 million hectares.

In almost all places where they have been established, the primary purpose of plantations is the production of large quantities of wood and fibre. Indeed, there is a global trend towards greater reliance on wood from plantations.

No matter what you think about tree plantations and their potential for nature conservation, it is undeniable that plantations are becoming an increasingly important category of land use around the world. Because they are taking up so much space, anything that can be done to improve their value for wildlife will make a contribution to protecting the planet's biodiversity.

This book explores approaches to promoting nature conservation in Australian plantations, although the information presented is relevant to plantations elsewhere. Much of the science reviewed here has focused on two broad types of Australian plantation forests—those dominated by exotic pines (mainly radiata pine) and those dominated by eucalypts such as blue gum and shining gum. This is because these are by far the most common types of plantings in Australia. They are also common elsewhere in the world: there are more than 20 million hectares of eucalypts in almost 100 countries (10 per cent of the world's plantations); and *Pinus* plantations account for 20 per cent of the world's plantations. Consequently, skills and knowledge generated in Australia might well be relevant to situations overseas.



**A eucalypt plantation in Portugal. Lessons and general principles learnt in Australian plantations may have important applications overseas, even though animal and plant species will differ elsewhere. (Photo by D Lindenmayer)**

## 1.4 The business of biodiversity

### What is biodiversity?

If you are wanting to improve a resource, the first step is to define that resource, so that you will be able to determine whether your plan of management is working. Unfortunately, biodiversity is not easy to pin down; it is a wide-ranging concept that is difficult to define in simple, practical terms. Despite this, many people are working to devise systems that will allow biodiversity to be assessed in a practical way at the farm level.

Most people know that biodiversity is about the variety of life. The most common measure of it is to count the number of different species of animals, plants, insects and microbes found in an area: the higher the number of species, the greater the biodiversity. But although the number of species in an area is an important measure it describes only one level of biodiversity. A full accounting requires consideration of two other levels: genetic diversity and ecosystem diversity.

‘Genetic diversity’ refers to the variety of genes available within a single species. The broad indicator of high biodiversity is a large number of different species living in the landscape (species diversity), but it is also important that there is a large amount of variation within each species (genetic diversity). It is the genetic information contained within a species of tree that foresters seek to exploit when trying to breed faster growing trees with superior timber properties. It is the genetic diversity in different strains of wheat that plant breeders exploit to develop disease-resistant varieties. Genetic diversity in wildlife is equally critical: it is the differences within a species that allow the species to adapt over time to changing conditions.

‘Ecosystem diversity’ refers to the variety of associations formed between groups of species. It relates to the range of animal, plant and microbial communities in the landscape and the ecological processes they drive.

Biodiversity is important at all three levels—species, within species, and between collections of species. The National Strategy for the Conservation of Australia’s Biological Diversity, released in 1996, defined biodiversity as ‘the variety of life forms: the different plants, animals and micro-organisms; the genes they contain; and the ecosystems they form’. This seems a straightforward statement, but it defies simple application. It might be relatively simple to count the number of species of large, charismatic vertebrates such as birds in a small area. It becomes much more difficult when looking at a large area—especially when all the different species of plants and microbial life are taken into account. Further, it is impossible to simultaneously determine the variation of genetic information contained within

each species or to specify the enormous variety of associations between species. Consequently, the term ‘biodiversity’ becomes a bit of a slippery concept that everyone applies with different emphasis depending on the specific situation.

An ornithologist (bird scientist) might concentrate on the genetic diversity found in a single species of bird and measure body size and colour variation occurring within different populations found across a landscape. A taxonomist (classification scientist) might be attempting to describe all the different species of bird found in a region. And an ecologist might be seeking to map the characteristics of different types of bush in order to determine the habitat requirements of birds. Each study is about biodiversity, each is important, and each is quite different.

Another important consideration is that, while declining biodiversity is often characterised by species disappearing, a greater number of species does not necessarily mean improved biodiversity. Biodiversity is not a contest in which the area with the most species wins. A site with the vegetation that originally covered it is more likely to contain a community of organisms similar to the original community that evolved to use that landscape. This might not necessarily result in the most species rich outcome. However, if the aims of your revegetation are to reinstate as much of the original vegetation as you can, and this approach is implemented across the landscape, it is more likely that you will be protecting diversity at the genetic, species and ecosystem levels.

What does this mean for the farmer or landowner interested in nature conservation?

First, *there is no definitive measure of biodiversity*. Unlike salinity (which can be quantified and measured) or carbon sequestration (which can be estimated to some degree), there is no widely accepted unit of biodiversity. It is difficult to give credits to someone for something that cannot be precisely quantified—which is not to say you should ignore it (see also ‘Banking on biodiversity’, towards the end of this chapter).

Second, *there are no absolute prescriptions for improving biodiversity on a farm*. Every situation is different: biodiversity is all about difference. You might know what species occur in an area but you will not know the genetic variability contained in each species or the nature of all the different interactions that occur between species. It is also impossible to predict precisely how the biodiversity in your area will change over time as conditions change. Of course, you may see general patterns emerging and be able to derive from them guiding principles for proceeding. There is a wealth of ecological research available to help you decide how to establish and manage a plantation that might improve biodiversity on your land. See Chapter 2 for examples of this research and the resource list in Appendix A.



Biodiversity is not just about the number of species, as reflected here by a variety of butterflies; it is also about the variety of genes found within a species, such as variations within the crimson rosella species. (Photos by D Salt)



Biodiversity is also about collections of species, the ecosystems they form, the structures they build, and the functions they perform. This native forest contains many species arranged in a variety of layers interacting in a variety of ways. (Photo by D Salt)

If all this sounds frustrating, it is not meant to be. It is important to understand what biodiversity encompasses but then to acknowledge that it is only feasible to concentrate on those elements of biodiversity that you can see and measure to some extent. As noted, biodiversity is much more than just how many animals and plants you can count, although this might be all you can monitor with limited resources.

Most landowners who become involved in native revegetation begin to observe a wider variety of birds on their land. When you do see new bird species appearing, it usually signifies that a lot more is happening on your land: there are probably new plants and insects around that are not so noticeable and that the birds are feeding on. The more sensitive you are to the changes that are occurring, the greater will be your appreciation of what biodiversity is. Understanding and appreciating it is an important step in the process of learning how to see, value, measure and protect it.

### Box 1.6 Boxing biodiversity

Biodiversity a lot more than just:

- endangered and threatened species
- animals and plants found in patches of remnant vegetation or in reserves.

Biodiversity includes:

- all forms of life on and around the farm
- the variety of genes the species contain
- the ecosystems they form.

Biodiversity is the source of:

- ecosystem products—the source of most of our food, clothing and shelter
- ecosystem services—the processes that sustain life, such as oxygen production, water purification, pollination of crops and pest control
- new products for the future—new medicines, chemicals, and so on.

Biodiversity holds the key to developing solutions to problems created by a changing world.

### Plantation biodiversity?

Are commercial plantations havens for wildlife or are they ‘biological deserts’, as they are sometimes described? They are neither, although the value they offer varies from situation to situation. Following is a review of some of what is known about biodiversity in pine plantations and hardwood plantations and a comparison with pasture, which is what many plantations are being established on.

#### Wildlife among the pines

There has been much controversy about the impact pine plantations have had on Australian wildlife. From the late 1960s on, considerable concern was expressed about the impact of clearing native forests to establish extensive stands of radiata pine. Early research showed that such practices led to the virtual elimination of resident adults of some species. For example, populations of tree-dwelling marsupials such as the greater glider, the mahogany glider and the mountain

brush-tail possum stayed in their home range during clearing for plantation establishment and most of them died rather than move out of that range. In the case of the greater glider and the mountain brushtail possum, the animals that survived were the ones with part of their home range intact.

There is also the concern that exotic pines do not provide the same range of resources as native eucalypts (see Box 2.13). Many studies have shown large differences in the range of animals found in radiata pine plantations as compared with stands of native forest. The majority of studies have found that animal assemblages in plantations are less diverse than those in native forests (for example, see Boxes 2.6, 2.9, 2.11 and 2.13).

Particular types of vertebrates such as hollow-using birds and tree-dwelling marsupials, as well as nectar-feeding, fruit-feeding, foliage-gleaning and canopy-feeding birds, were found to be absent or greatly reduced in abundance in radiata pine plantations. This is most probably because these exotic stands lack the basic resources needed by these animals—tree hollows, nectar, fruit, leaves, and so on.

There have been marked differences in the results of studies comparing small mammals in radiata pine stands and in eucalypt forests. Some found that the bush rat and other native species such as the agile antechinus may survive in radiata pine stands, whereas others found that, except where there were extensive areas of windrowed eucalypt logs, populations of small mammals were absent from radiata pine stands. Possibly the logs provided refuge (see Box 2.13).

Researchers have also detected significant differences in invertebrates in radiata pine plantations and in eucalypt forests. In one study, more species and more individuals were found in foliage, bark, soil and understorey habitats within eucalypt forests, although more mites occurred in litter habitats within stands of radiata pine.

Although pine plantations do not provide suitable habitat for many kinds of native animals, they are not biological deserts. Pictured is a white-fronted chat nesting in a plantation. (Photo by P Merritt)



Other studies have produced mixed results, depending on what invertebrate group was being surveyed. Overall, little is known about the use of pine plantations by most invertebrate groups.

In summary, research on wildlife in pine plantations in Australia suggests that some species—for example, the majority of species of tree-living marsupials—are uncommon or absent in these areas. But it cannot be said that pine plantations are biological deserts. They provide foraging habitat or nesting habitat, or both, for a range of birds, small mammals and invertebrates. It is notable that much of the focus on the species that do and do not occur in conifer plantations has been on birds and mammals, with some additional work done on invertebrates (partly because of potential pest problems). In contrast, there has been little research on groups such as reptiles and frogs.



Some species, such as the mahogany glider, were virtually eliminated from areas converted from native forest to pine plantation. (Photo by B Cowell, Queensland Museum)

### Box 1.7 Rare finds

It is not just the common species of native animals that can occur in plantations or farm forestry landscapes. Two classic examples from the extensive radiata pine landscapes at Tumut in New South Wales are the corroboree frog and the olive whistler. Careful plantation management can be extremely important for the conservation of these two species.

Source: Lindenmayer, D 2000, *Islands of Bush in a Sea of Pines*, Research report no. 6/00, Land and Water Resources Research and Development Corporation, Canberra.



Corroboree frogs are known to occur in pine plantations near Tumut, New South Wales. (Photo by G Schmida (NatureFocus))

Much of the biodiversity found in plantations is strongly related to the presence of nearby patches of native forest and the treatment history of planted areas—for example, thinning regimes and stand ages. These topics are explored in greater detail in subsequent chapters.

### A home among the gum trees

Compared with radiata pine plantations, much less is known about how wildlife use eucalypt plantations. This is because the eucalypt plantations have had a far shorter history than the radiata pine plantations. In addition, some of the studies that have been done were completed while the eucalypt plantations were still relatively young.



Compared with pine plantations, much less is known about the biodiversity value of hardwood plantations. The science, like farm forestry itself, is still developing. This koala was spotted in a young blue gum plantation in Victoria. (Photo by C Grabham)

For example, a recent set of studies has examined young blue gum plantations established on grazing properties in north-eastern Victoria (see Boxes 2.18 and 2.25). Studies of the biodiversity values of southern blue gum plantations in Western Australia have also been undertaken (see Boxes 2.3 and 2.4). All these studies have found trends similar to those discussed for pine plantations; that is, vertebrate and invertebrate assemblages are less diverse than those of native vegetation, largely because of the relative simplicity of the plantations' structure.

Nevertheless, like pine plantations, blue gum plantations are not biological deserts; instead, they provide habitat or resources for a range of species. In the Western Australian studies, the blue gum plantations were found to contain a selection of bird species considered to be at conservation risk. For this group of species, and for bats, species abundance was greater in plantations adjoining extensive areas of remnant vegetation compared with isolated plantations (see Box 2.3).

Work on eucalypt plantations to date has shown that, like conifer plantations, some groups of animals are largely missing from these areas. For example, hollow-using marsupials are virtually absent from all types of plantations. This is not surprising given that eucalypt hollows that are suitable for use by tree-dwelling marsupials can take several hundred years to develop—far longer than plantation rotation times. Birds that use tree hollows are sometimes found in eucalypt plantations, but they are not nesting there. It is noteworthy that when artificial hollows are added to plantations they are used by some cavity-dependent fauna, including tree-dwelling marsupials and bats.

### Plantation versus pasture

One of the important aspects of the recent national push for plantations is that in many areas the plantations are being established on land that was previously used for grazing. Where this has occurred, the question is: Is the local native wildlife better off? In many cases the answer is a qualified 'yes', but the benefits are variable. (An important exception is the case of native grasslands: these vegetation communities have experienced substantial reduction and degradation since white settlement, and plantations should not be established at their expense.)

Surveys in and around the blue gum plantations of Western Australia (see Box 2.4) have found that the insect fauna of pastures is quite different from that of plantations and remnant vegetation, probably because the habitat is so different. The greatest regional biodiversity therefore might be achieved by having some plantation and some pasture, rather than having a landscape devoted exclusively to one of these habitats.

Surveys in planted eucalypt forests in Victoria (see Box 2.18) have shown that bird diversity is higher in areas of exotic pastures where stands of plantation trees have been established, although it was significantly lower than for native woodlands. Studies in New South Wales and Queensland have also found that eucalypt plantations support more species of birds, mammals, amphibians and reptiles than pastures.

In some cases, in response to the establishment of plantations, new birds are appearing and replacing birds that were previously common. Large-scale experimental work in newly established radiata pine plantations on former grazing land in southern New South Wales suggests that open-country bird species have been replaced by species more typical of forest landscapes. In particular, two of the species that have colonised the plantations are the rufous whistler and the eastern yellow robin, which are thought to be declining in native eucalypt woodland environments. It is possible that the radiata pine stands act as structural mimics of native eucalypt habitats for these species, although this hypothesis requires further testing. Similarly, studies in blue gum plantations established on grazing land in southern Western Australia have found that bird species considered to be at risk, such as the western yellow robin, the inland thornbill and the western gerygone, are using the plantations (see Box 2.3).

Plantations on land previously used for grazing change animals' patterns of movement: they provide connectivity and allow species to travel across the landscape more readily. This promotes the biodiversity of the region by allowing some mobile species or those with large home ranges to move through the landscape with greater ease.



**By their very presence, plantations add another element of structural complexity to a landscape dominated by pastures. (Photo by C Grabham)**

Finally, plantations established on cleared pasture (such as those in tropical areas) may be useful intermediary restoration vehicles, assisting in the regeneration of native plants that cannot become established in other ways—for example, because of competition with grasses that suppress the growth of young native trees.

### Why is biodiversity conservation important in farm forests?

What can farm forests offer over beyond what our conservation reserves offer? Although Australia has a world-class reserve system, some vegetation types and environments are not well represented in it. For example, almost all remaining areas of the now heavily cleared white box grassy woodland community—99 per cent of it has been cleared—occur on private land. Species such as the squirrel glider, which can be associated with white box, are also poorly represented in reserves. Conservation on private land, including areas where farm forestry is practised, can therefore be important.

Farm forestry could play a vital role in protecting poorly represented species such as the squirrel glider and endangered communities such as white box grassy woodlands. (Photo by P German (NatureFocus)).



### The value of biodiversity

Biodiversity influences the health, wealth and resilience of the land. It is not something that is found only in patches of native vegetation: it is all around us. Indeed, agriculture in all its forms is an ecological enterprise founded on biodiversity; it is dependent on ecosystem processes and functions such as soil formation, nutrient cycling, maintenance of hydrological cycles, and the pollination of crops, to name just a few.

Biodiversity is often described as the source of ‘ecosystem goods and services’. The goods are the products we harvest from ecosystems—for example, the grain from wheat crops, the meat from cattle, and the timber from forests. The services are the processes that maintain the integrity of the ecosystems as they produce these goods—for example, regulation of the hydrological cycle (including the production of water for human consumption), maintenance of nutrient cycling, removal of carbon dioxide, production of oxygen, and disposal of wastes.

Biodiversity is also the source of opportunities such as new foods, medicines and chemicals. ‘Bioprospecting’ is the term given to the search for new compounds and processes created by animals, microbes and plants. Penicillin, for example, is a compound manufactured by a fungal mould; as we know, its discovery some 60 years ago transformed modern medicine. Today the search is on for compounds to fight cancer, to produce superior sunscreens, and to find ways to break down toxic waste. In many cases, if there is an environmental problem to be solved, it is likely that somewhere there is an organism that has evolved a strategy for dealing with it. After all, there has been life on this planet for billions of years, and in that time various organisms have evolved ways of dealing with most of the conditions that are to be found.



**Biodiversity is the foundation of the many ecosystem services that sustain life. Recycling our air and water are two examples.**  
(Photo by D Salt)

## Losing it

Australia has a unique and diverse assemblage of animals, plants and microbes. Most of these life forms evolved here over long periods and are ideally suited to the challenging Australian environment, which in many areas is characterised by poor soils and a variable climate. We have a biodiversity treasure chest, and Australia is classified as one of only 17 ‘megadiverse’ countries in the world.

But our record of caring for this rich natural heritage is not a proud one. European settlement brought with it profound changes to the landscape as we cleared the native vegetation for agriculture, mining, forestry and human settlement. Nationwide, we have cleared 43 per cent of our forests, nearly 90 per cent of our temperate woodlands and mallee, and 75 per cent of our rainforests. In south-eastern Australia we have removed 99 per cent of our temperate lowland grasslands. We have replaced these complex, self-sustaining native ecosystems largely with simplified, exotic agricultural systems dominated by short-lived, shallow-rooted crops and pastures.

Such modification has produced a range of massive, albeit unintended, environmental problems. Looming large among them is the threat of rising salt (dryland salinity). This problem has arisen because we have cleared the native vegetation from most of our agricultural areas. The native vegetation, which is dominated



**Broad-scale clearing of the native vegetation has created enormous problems of rising salt, lost productivity and declining biodiversity. (Photo by D Salt)**



by woody, deep-rooted, evergreen perennials, makes use of almost all the rainfall—unlike the agricultural crops and pastures that have replaced it. In the absence of native vegetation, excess groundwater starts to accumulate in the landscape and in many areas rises to the surface. As it does so it brings with it salt that was previously locked up beneath the subsoil.

The redistribution of this natural stored salt from the depths to the surface and into streams is at the heart of the salinity problem. And it is a problem of massive proportions. In Victoria 100 000 hectares are affected by dryland salinity and a further 198 000 hectares are considered at risk; in Western Australia 900 000 hectares are affected and 2.4 million hectares are considered at risk. In 2001 the National Land and Water Resources Audit concluded that across Australia about 5.7 million hectares are at risk or affected by dryland salinity and that this could increase to 17 million hectares in 50 years' time.

Further, dryland salinity threatens 41 300 kilometres of rivers and 130 important wetlands. Land and water degradation alone are calculated to be costing Australia \$1.4 billion each year.

These are frighteningly large numbers. The future prosperity of our nation is at stake. Part of the solution to the problem has been identified as revegetation—putting back the deep-rooted cover. And part of the revegetation effort is focusing on the establishment of plantations of trees.

In addition to the impact land clearing has had on land and water quality, the widespread loss, fragmentation and disruption of habitat has had a devastating impact on biodiversity. Since European settlement, 19 species of mammals, 23 species of birds and 68 species of plants have become extinct, and over 1000 species of mammal, bird or plant are listed as either vulnerable or endangered. Little is known about what insect, fungal or microbe species may have been lost or are in the process of disappearing, but many thousands of species have probably been lost.

(Continued on page 29)

## Box 1.8 Fungal boost to trees

An important ecosystem service that often goes unacknowledged is the contribution many fungi make to the health and growth of trees. The fungi are overlooked because their activity occurs silently and out of sight, in the soil, but their contribution is enormous.

One important group are the mycorrhizal, or ‘fungus-root’, fungi, of which there are thousands of species in Australia. Many of them are associated with eucalypts. They grow on the surface of tree roots, between the root cells and among soil particles, and they increase the surface area of the root for the uptake of nutrients such as phosphorus, nitrogen, sulfur and potassium, which are often limited in Australian soils. The mycorrhiza pass the nutrients to the tree roots and in return receive carbon from the tree’s photosynthetic efforts.



Inoculation of blue gum plantation seedlings in Western Australia has led to increases in productivity. Compared with plantation sites where seedlings were not inoculated, the response to inoculation on ex-pasture sites was not as great because of fertiliser application over the years, which is believed to increase the availability of phosphorus. It is thought that inoculation might be vital to the productivity of plantations on ex-pasture sites in their second and third rotation, when the phosphorus may become limiting.

**Local trees and shrubs with local native fungi being planted in field trials in the Swan–Avon catchment of Western Australia. (Reproduced with permission of CSIRO Forestry and Forest Products)**

Specific mycorrhiza are also required for good performance of radiata pine and maritime pine.

In addition to production forestry, research is showing that an understanding of soil fungi may be critical to successful revegetation efforts. Researchers at CSIRO Forestry and Forest Products have shown that the soil under small patches of remnant woodland in Western Australia can contain more than 500 species of native fungi, all with a role in maintaining the healthy growth of the trees and shrubs. More than a 100 are mycorrhizal fungi; others play a vital role in recycling nutrients and in the decomposition of dead branches, twigs, leaves and roots.

At research sites on Wheat Belt farms in Western Australia and in New South Wales, researchers have found that fungal populations do not re-establish naturally when trees, shrubs and other vegetation found in nearby remnant woodland are planted. They suspect that the planted woodland may not survive ‘as a self-sustaining system’ in the long term unless fungi from the original woodland are also introduced. Research is proceeding on how this might best be achieved.

Source: CSIRO’s forestry newsletter: Onwood  
<<http://www.ffp.csiro.au/publicat/onwood/onwood37/story1.html>>.

### Box 1.9 Ecosystem services at Danengate

Danengate is a grazing property near Hamilton in Victoria. In 1947 it had over 600 remnant eucalypts; by 1987 only 37 remained. In most respects Danengate was just like any other grazing property in the area—lacking in native cover, heavily dependent on chemicals for pest control, with old trees in decline, and with stock that were vulnerable to cold weather events. In 1987 Danengate was bought by Don and Jann Jowett, whose vision for the property included a range of tree plantations integrated into the rest of their grazing activities.

They surrounded the paddocks with fenced shelterbelt plantings (two to three rows wide) and planted some small circular woodlots (0.4 to 1.0 hectare) within the paddocks. The shelterbelts and woodlots provide timber, shelter and biodiversity, while the pastures and stock provide annual cash flow. The paddocks are small, so shelter is always close by, and birds appear to exploit insects and seeds in the nearby pasture from the safety of the perimeter shelterbelts and the woodlots. (On the basis of what he has observed, Don now makes his shelterbelts four rows wide to improve their biodiversity value.)

On average, 1–2 hectares of timber trees have been planted each year since 1989. Among them are blackwood, black wattle, drooping she-oak, river she-oak, swamp she-oak, Monterey cypress, Mexican cypress, manna gum, mountain grey gum, Sydney blue gum, river red gum, spotted gum and radiata pine. The aim has been to plant 30 per cent of the property to trees, with 5–10 per cent permanently fenced off.

To some, the Jowetts are pioneers who have introduced a valuable new approach to grazing systems; to others with more traditional views about agriculture, they are mavericks. But what they are doing is paying dividends.

Between 1987 and 1992 the pastures required regular spraying for cockchafer and red-legged earthmite. Since 1992 no pasture has been sprayed or has needed spraying. In 1989–90 all plantations had to be sprayed for spitfires, leaf blister and looper caterpillars. Since then, the trees have not needed to be sprayed for insects. Don and Jann's conclusion is that their revegetation activities have improved the biological control of pest insects on pastures and trees.

On 1 December 1987 unseasonal snow, rain and wind killed 50 000 sheep in the area surrounding the property. Today, sheep off-shears can be placed onto any paddock on Don and Jann's property with safety. In the early 1990s, lamb losses were significant in the exposed western areas of the farm, which precluded the use of these paddocks for lambing. Today, lambing occurs in all paddocks and there are few, if any, losses from the cold.

After winter rainstorms, run-off leaving the property is clear and clean, whereas the run-off leaving the neighbours' property is cloudy with high silt loads. Protection of degraded watercourses has been achieved by installing troughs in all paddocks. Earthworm numbers are consistently over 400 per square metre—an indication of healthy soil.

Overall, Don has no doubt that Danengate's productivity is now greater than it was before areas of the farm were retired from grazing to grow trees. His figures show a 320 per cent increase in sheep numbers, despite 33 per cent of the original area of pasture being devoted to trees. Ecosystem services are an important and nurtured source of farm income.

And what of the 37 remnant eucalypts Don and Jann inherited in 1987? Well, by 1993 just 24 were left and their health was very poor as a result of overgrazing by insects, termites, possums, and possibly stock. With the farm ecosystem now more balanced, however, those 24 gums are still around in 2002 and are quite healthy.

Source: Race, D & Freudenberger, D 2003, *Farm Forestry for Green and Gold: Australian experiences of linking biodiversity to business solutions*, Environment Australia, Canberra.



Well-fed, well-sheltered sheep feed under spotted gum. In the distance is a shelterbelt of mixed natives. The trees are providing shelter, pest control and habitat and will one day provide timber and another source of income. (Photo by R Bird)

### Box 1.10 Lanark and the wealth of the land

Following a disastrous drought in 1967, John and Cicely Fenton, the owners of a grazing property named Lanark in Victoria's Western District, set about rebuilding the natural ecosystems that had once been a feature of the local area. They established wetlands, fenced off remnant native vegetation and planted trees. By creating an environment in which wildlife could co-exist with livestock, they hoped to buffer Lanark's production systems and its profitability against climatic variability and so secure their family's future.



**Lanark from the air.** For the Fentons, who own the property, the wealth of their land is not merely measured in dollars. (Photo by R Bird)

Today, the Fentons still produce wool, raise fat lambs, and occasionally grow cereal crops. But their farmscape is totally transformed. Through an intensive program of farm forestry and revegetation, the family has planted over 80 000 trees and shrubs in shelterbelts, plantations and native woodlands, featuring native species from the area.

Through their kitchen window they can now watch ducks, dusky moorhens and black swans on the large lake that forms part of the wetland surrounding the homestead site. Swamp rats delving for roots and invertebrates in the

moist ground between the house and the lake's edge have brought the soil to a fine tilth—even if they have made a vegetable garden impossible.

At dusk, eastern barred bandicoots forage quietly in the grassland and understorey of the native woodland around the homestead. At night, frogs in the wetlands keep up a nocturnal racket. And by day, in the skies around the farm and from every tree across the property, birdsong is testimony to the miraculous transformation that has occurred on Lanark.

We all need money, but for the Fentons, as for many farmers, wealth is not merely measured in dollars. Life on the land is also about family, continuity, order and aesthetics—values that emerge from a simple love of the land. How do you quantify the pleasure given by the call of a bird as you walk from the house to the woolshed?

For further accounts of what has been achieved at Lanark, see Boxes 2.27 and 2.28.

Source: O'Neill, G 1999, 'Renaissance on Lanark', *Wingspan*, vol. 9, no. 1 (suppl.), Birds Australia, Hawthorn, Victoria.

Declining biodiversity has often been cited as one of Australia's most serious environmental threats. The 1996 State of the Environment Report said:

*The loss of biological diversity is perhaps our most serious environmental problem. Whether we look at wetlands or saltmarshes, mangroves or bushland, inland creeks or estuaries, the same story emerges. In many cases, the destruction of habitat, the major cause of biodiversity loss, is continuing at an alarming rate.*

The 2001 State of the Environment Report gave us no reason to think things were improving. In relation to ecosystem diversity it said there had been little change in conditions since the 1996 report, and it added that genetic diversity was declining and species diversity was generally deteriorating.

As with salinity, the hope is that intelligent establishment of farm forests might contribute to protecting and improving biodiversity.

### Why bother integrating biodiversity into farm forestry?

It is easy to see how biodiversity is important in a 'global' sense: it feeds, clothes and shelters us; it recycles our air, soil, water and waste; it is the source of new products; and it buffers us against change. But where is the pay-off on the farm? Managing a plantation of trees so that it provides habitat for native animals or increased protection for the native birds, bugs and bush in the corner of the back paddock might sound like a nice idea but it comes at a cost. Why bother? Three main reasons should appeal to the farmer and landowner:

- Native animals and plants contribute important *ecosystem services* on and around your property that affect farm productivity.
- Native animals and plants contribute to *quality of life*.
- Biodiversity is a *valuable asset* that is increasingly being acknowledged by the community, government and business and is likely to prove a valuable asset to you and your family in the future.

### Ecosystem services

Native animals play important roles in regulating the numbers of invertebrate pest species (see, for example, Box 1.9). Australian magpies are known to eat large numbers of scarab larvae from pastures. Ibis eat large quantities of crickets, grasshoppers and beetle larvae from pastures; it is estimated that a flock of 2000 can remove half a million pasture grubs each day. Pied currawongs have been known to control local outbreaks of stick insects, and forest birds have been observed to control heavy infestations of psyllids.



Some bat species consume half their body weight in insects every night. (Photo by E Beaton)

Some native wasp species parasitise scarab larvae (including pest Christmas beetles, which can defoliate eucalypts), and a small native wasp parasitises plague locust eggs (above 90 per cent in some egg-bed sites).

Insectivorous bats are active in many rural areas. These small creatures have huge appetites and can consume up to half their own body weight in insects each night. Their diet incorporates a wide range of insects, including pests such as moths, beetles, bugs, mosquitoes, grasshoppers and crickets.

Sugar gliders inhabiting remnant forest vegetation in south Gippsland, Victoria, are estimated to consume 3.24 kilograms of insects per glider per year: a colony of gliders might consume over 200 kilograms of insects each year. Many of the insects consumed—for example, Christmas beetles—are associated with pasture damage and eucalypt dieback.

Dieback of trees is a big problem in many rural areas. Although it is the result of a complex process, it is evident that native wildlife play an important role in maintaining healthy woodland ecosystems. In a healthy eucalypt woodland, birds can take about half of the insects produced (some 30 kilograms per hectare per year) and small mammals (bats, sugar gliders, and so on), predatory insects and spiders take a substantial proportion of the rest. Woodland in the New England tablelands suffering severe defoliation and dieback from insect attack was found to have only 10 per cent of the bird population of a healthy woodland. The decline of insectivorous wildlife—in particular, birds—in rural Australia has been suggested

as one important factor that may be placing trees on farms under considerable stress because of higher levels of defoliation by insects.

In addition to pest control, native animals and plants contribute a range of other ecosystem services that are often taken for granted. Among these are the dispersal of seeds and fruits, nutrient cycling, water purification and the pollination of plants.



Many possums, such as this sugar glider, provide valuable ecosystem services by preying on pest insects. (Photo by M Greer)

### Quality of life

Imagine a farm landscape without wildlife—no laughing kookaburras, no chorus of magpies, no croaking frogs at night. And what about the sight of a basking blue-tongue lizard, a yellow explosion of flowering wattle, or the dappled shade under

the gnarled old gum tree in the top paddock? We take these things for granted. The sights and sounds of native animals and plants on the farm are part of the tapestry of rural Australia, and they make an important contribution to our wellbeing and sense of place. They have been part of the land for generations, and most of us hope they will continue to be around for our children and their children (see Box 1.10). It is difficult to put a dollar value on them, but surely that makes them priceless rather than valueless?

### A valuable asset

Declining biodiversity has been identified as a serious threat to Australia's future sustainability. This message is being consistently and repeatedly broadcast by ecologists and natural resource managers from all over the country. Increasingly, it is also being acknowledged at all levels of government. The response to the message has, however, been varied; the rhetoric has been strong, but the follow-up action has been quite mixed in its effectiveness. There are several reasons for this: biodiversity is a difficult resource to define; we are still ignorant about the functioning of many of Australia's ecosystems; and some Australians retain something of a frontier mentality, in which progress is all about clearing the bush and establishing traditional farming enterprises. (Keep in mind that it was only a few decades ago that farmers were expected, and legally obligated, to clear bush as a condition of owning land.)

Although it is impossible to predict what economic value the community and the market will attach to remnant vegetation and wildlife in the future, these natural assets will probably acquire increasing value with time. Furthermore, landowners who are lucky enough—or smart enough—to have significant reserves of biodiversity on their property may well be able to use this to obtain funds from government, capital from lending agencies, or investment from developers seeking to obtain biodiversity credits to offset their activities.

### Banking on biodiversity

Take the case of salinity. Salinity problems have been increasing for many years in the Murray–Darling Basin and are widely recognised as posing a growing threat to the economic prosperity of the region. The Murray–Darling Basin Commission has come up with a workable system of salinity credits whereby new developments in one part of the Murray River (for example, a new irrigation scheme that would add to the salt load of the River) are allowed to go ahead only if other works (such

Land clearing is a serious threat to biodiversity in Australia. (Photo by D Lindenmayer)



as salt-interception schemes) are undertaken in other parts of the River to offset the increase in salinity. Development is allowed provided it does not exacerbate the overall problem, and developers may proceed only if they can obtain salinity credits elsewhere.

Given the increasing pressure on governments and industry to protect our declining biodiversity, it is only a matter of time before some form of biodiversity credit or accreditation system is established whereby developers are allowed to use a particular area of native bush only if they can offset their activity by improving biodiversity elsewhere. The problem with such a scheme is that we lack an objective, practical and repeatable way of scoring the biodiversity value of land, be it a paddock with scattered trees, a patch of virgin bush or a plantation.

It also needs to be emphasised that tree plantations—even plantations established with nature conservation in mind—are not true replacements for a patch of quality bush. This fundamental concept should never be overlooked, and it makes the concept of offsetting the clearing of native bush by establishing tree plantations theoretically impossible. Nevertheless, appropriate establishment and management of tree plantations can protect and enhance existing patches of native vegetation, thus improving their biodiversity value.

How this might work is difficult to say, but the growing awareness and concern about our declining biodiversity make it reasonable to expect that some kind of mechanism will be developed for ascribing to the biodiversity value of a piece of land a notional score that will carry with it a market value (for example, see Box 1.11). That value can be traded with developers who are looking to offset their activities in other areas.

This ‘biodiversity value’ can also add value to the products yielded by a plantation. In years to come, certified environmentally friendly timber may well attract a significant premium and be in high demand. There is already market demand for environmentally friendly wood products. The coveted Forest Stewardship Council certification is the key to opening up lucrative European markets. It requires that plantation management be sustainable and sympathetic to an area’s biodiversity.

Thus far, no Australian plantation company has obtained FSC certification, although several companies (for example, Integrated Tree Cropping—see Box 3.5) are in the process of applying for it.

Quality bush high in ‘biodiversity value’ is also beginning to attract greater land value through a number of schemes that are attempting to preserve biodiversity by purchasing land. For example, the Bush Heritage organisation is a national independent

**A property with a healthy cover of native vegetation that is high in biodiversity value will usually attract a much higher market value than a property with little cover and growing degradation. (Photo by Greening Australia ACT & SE NSW)**



### Box 1.11 Scoring biodiversity

There have been many attempts to come up with a system for assessing the quality and condition of a piece of native vegetation. The problem with most methods developed so far is that they are highly subjective and usually involve value judgments. The Victorian Department of Sustainability and Environment has recently developed a system called ‘habitat hectares’ in an effort to overcome this problem.

Habitat hectares is based on explicit comparisons between existing vegetation features in a patch of bush with ‘benchmarks’ representing the average characteristics of mature stands of native vegetation of the same community type in a ‘natural’, or ‘undisturbed’, condition. In other words, a patch of native vegetation is assessed by comparing it with a similar patch of native vegetation that is acknowledged to be in excellent condition.

The comparison is made in terms of criteria such as: How many large trees are present? What is the canopy cover? What condition is the understorey in? Are weeds a threat? Is there much organic litter? Are logs present? How connected is the patch to other patches? How big is the patch?

A habitat score of between 0 and 100 per cent is created by adding together the scores for each of the criteria. Multiplying the ‘habitat score’ by the area of the patch offers a quality–quantity measure that is termed a ‘habitat hectare’. For example, 10 hectares of mature, fully natural grassy woodland could be counted as 10 habitat hectares whereas a similar-sized patch of grassy woodland with a habitat score of only 50 per cent (because, say, it lacked mature trees and a natural understorey and was weed infested) would be scored as 5 ‘habitat hectares’.

The system is still being refined, and there are some important questions about how the component scores should be combined—for example, because you multiply the habitat score by the area, you are multiplying any inaccuracy in the original score. The hope is that, with further development, the system will be useful for planning and management. Although it has been developed for assessing native vegetation, researchers are also investigating whether it could be used to assess revegetation (see, for example, Box 4.12).

Source: Parkes, D, Newell, G & Cheal, D 2003, ‘Assessing the quality of native vegetation: the “habitat hectares” approach’, *Ecological Management and Restoration*, vol. 4, pp. 29–38.



The biodiversity score a patch of native vegetation will receive is based on a range of factors, including its size, condition and connectedness. (Photo by CSIRO Sustainable Ecosystems)

non-profit group created to preserve Australia's biodiversity by protecting the bush through the creation of reserves on private land. There is also the Bush Brokers scheme in Western Australia, which is a collaboration between the Western Australian Soil and Water Conservation Council, the World Wildlife Fund and the Real Estate Institute of Western Australia. It aims to market and sell bush at premium rates based on the conservation value of that bush. The Victorian Trust for Nature is another scheme whereby land with significant biodiversity value is purchased. Birds Australia has also begun acquiring properties of national significance in terms of bird habitat in order to protect biodiversity. (Contact details for these organisations are in Appendix A.) These are just a few examples illustrating the point that land containing high biodiversity value is beginning to attract increasing real estate value.

Although the future economic value of high-quality remnant vegetation and wildlife-friendly plantation timber is currently unknown, if you hope to capitalise on these assets, it is important to act now rather than wait until the value has been determined. Building biodiversity values into your farm forest cannot happen overnight: it involves planning and management over years, sometimes even generations.

## 1.5 Farm forestry and biodiversity

Anyone who has considered farm forestry or is practising it should be able to relate to the value of biodiversity because there are several linking themes. As discussed, biodiversity represents the wealth, health and resilience of the land. In a sense, this is what farm forestry is about too: successful farm forestry aims to produce income (wealth), remediate and improve the land (health), and diversify the farm enterprise to hedge against changing market conditions in the future (resilience).

This chapter describes some general concepts relating to what biodiversity is and why it is important, the nature and extent of tree plantations in Australia, and the limitations of these plantings in terms of improving biodiversity. Chapter 2 explores the basic elements that need to be present in and around a tree planting if it is to have value for wildlife.