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Research Paper
No. 2 2001–02

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ISSN 1328-7478

Published by the Department of the Parliamentary Library, 2001

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Declining Biodiversity and Unsustainable Agricultural Production—Common Cause, Common Solution?

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21 August 2001

Acknowledgments

I am pleased to acknowledge the assistance of Parliamentary Library officers Bill McCormick, Brian Murray, June Verrier, Rod Panter, Angus Martyn, Greg Baker, Michael Emmery and Glenn Worthington at the seminar and in preparing the draft, and Brian Murray for preparing many of the maps. I also thank David Watson of Charles Sturt University for helpful comments on the draft report.

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Glossary

Biodiversity	The variety of living organisms—animals, plants and micro-organisms.
Endemism	Being confined to a given region, for instance, Australia.
Granivorous	Seed-eating.
Frugivorous	Fruit-eating.
Mammal	A member of the Class Mammalia, with three living sub-classes—monotremes, marsupials and placental mammals.
Monotreme	A sub-class of mammals consisting of the platypus and two species of echidna.
Passerine	Birds in the Order Passeriformes; often called perching birds or songbirds.
Savannah	Grassy plain with few or no trees in tropical and subtropical regions.
Taxon, pl. taxa	A category used in classifying and naming living organisms. The main taxa are kingdom, phylum, class, order, family, genus, species and subspecies.

Major Issues

A major wave of bird extinctions is now occurring in Australia's temperate agricultural zone. Equilibrium has not been reached, and there is no sign that it will unless land clearing is halted and massive revegetation is carried out. Declines are still occurring where clearing ceased decades ago, and the effects of current clearing activity, particularly in Queensland and NSW, have yet to be felt. The problems of the temperate agricultural zone are set to be repeated in tropical areas, where tropical woodlands are being cleared at unprecedented rates. We can expect to lose at least half the birds in both these areas if no action is taken, but there is no indication of the final extent of biodiversity losses, which could be overwhelming in the worst affected areas.

Land clearing has also had devastating effects on other vertebrates. Between 1983 and 1993, land clearing led to the deaths of at least a billion reptiles, or more than 100 million reptiles on average each year. Twenty species of mammals have been declared extinct, and almost half of our marsupials and monotremes are listed as extinct, endangered or vulnerable, with habitat loss and degradation as a major cause.

Living organisms provide a range of biological services that benefit people including pollination, recycling, nitrogen fixation, replenishment of atmospheric oxygen and removal of carbon dioxide. The value of these services is only starting to be properly recognised, and we are realising that in dollar terms alone, losses in biodiversity will have significant negative effects on the biological services that they provide.

Native vegetation provides a range of on-farm benefits such as the control of land degradation, salinity and soil erosion; shelter and shade for stock; and habitat for birds and other organisms that prey on pests. It protects livestock, particularly lambs and calves, from heat and cold stress. Windbreaks can have substantial benefits in protecting high value crops from wind damage. It also aids in the soil nutrient cycle, provides timber for on-farm use, and often enhances land values as well as providing biodiversity and aesthetic benefits.

The present paper focuses on over-clearing and subsequent degradation of land as the major threats to biodiversity and agricultural productivity. The degradation that results from over-clearing can be seen in the form of salination, waterlogging, overgrazing, erosion, feral and woody weed invasions, loss of soil fertility and structure, acidification, soil compaction and changed hydrological dynamics. The land loses its resilience, so that further disturbance has more drastic effects. The cost of degradation in rural landscapes has been estimated as at least $2 billion annually, and this figure is rising.

The present rate of land clearance in Australia is the sixth highest in the world, and the highest in the developed world. Three-quarters of current land clearing is occurring in Queensland. However, as a percentage of total area, Tasmania's clearing rate is the highest in Australia. In NSW, the *Native Vegetation Conservation Act 1997* contains loopholes and can be circumvented fairly easily as there is little political will to pursue prosecutions.

As the prime cause of unsustainability of agriculture and loss of biodiversity, land clearing should cease. Retention and replanting of native vegetation in agricultural areas are needed. In the short term, the economic advantages of native vegetation may not be apparent in all cases, and only by considering the long term sustainability of land use can they be justified. In one example, a sustained rehabilitation and revegetation program resulted in the return of over three-quarters of the bird species that inhabited the region's native woodlands and wetlands more than a century ago, as well as improving agricultural productivity.

The scale and extent of revegetation required to address biodiversity and agricultural decline are considerably greater than presently occur under existing government programs. Existing approaches such as Landcare have been voluntary, and can be argued to have delivered too little, too late. The main benefit of Landcare has been in raising community awareness rather than achieving the goal of Landcare, to achieve ecologically sustainable development within 10 years.

A new approach based on legislation is suggested, with the 'carrot' of grants, subsidies and tax incentives to complement the 'stick' of legislation. It is proposed that legislation be introduced to require landholders to produce a Farm Plan consistent with regional strategies and agreed in conjunction with officers of State and Territory Departments of Agriculture. A crucial element of the Farm Plan approach would be that native vegetation be retained and/or restored over at least 30 per cent of the farm area.

The proposed native vegetation retention/plantings for productivity and biodiversity do not take account of remedial works required to combat other aspects of land and water degradation such as salinity, erosion and acid sulphate soils. These appear to require expenditures far larger than present funding aimed at sustainability, such as the Natural Heritage Trust (Bushcare, Landcare) and even the recently announced National Salinity Action Plan, and are beyond the scope of this paper. Government agencies need to become more accountable for delivering environmental outcomes against money spent. For instance, tree plantings for salinity control should also bring biodiversity benefits, and the need to enhance biodiversity should be considered for any such plantings.

The solutions are not cheap or easy. They require political commitment in all jurisdictions plus significant public and private funds. However unless action is taken, increasing areas of degraded land will have to be retired from agriculture, and biodiversity will continue to decline.

Introduction

Birds are attractive and easily recognised, and people relate to them. In Britain, birds have recently been selected along with 11 other indicators (such as Gross Domestic Product, air quality and proportion of people in work) as Britain's official 'Headline Indicators' of sustainability.[1] A high bird diversity tends to be correlated with a high diversity of other vertebrates (mammals, reptiles, frogs), invertebrates and trees. Because birds can be found in nearly all habitats in Australia, they are a natural choice as indicators of the health of ecosystems. There are a number of historical records from early naturalists, giving a picture of bird numbers and diversity in earlier times.

This paper will examine the evidence for bird declines in Australia's woodlands and agricultural zones. The loss of bird species in the sheep-wheat belt and elsewhere points to a general loss of biodiversity and a broadscale dysfunction of ecosystems. Figure 1[2] shows the extent of the wheat/sheep zone in temperate Australia. Emphasis has been placed on declining species—those species currently undergoing significant contractions in range and/or abundance. The reasoning is that it is much easier to 'save' species before they are reduced to just a few hundred or a few thousand individuals when expensive recovery actions (which may or may not be effective) are brought into play. There is a chance that we can halt the declines in woodland birds by concerted action now. In so doing, we will contribute to the survival of many other, often unseen, species as well.

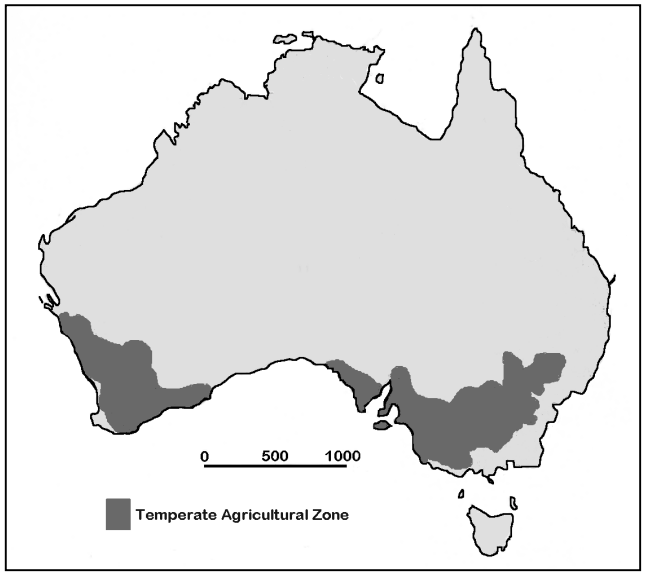

Figure 1: Australia's Temperate Agricultural Zone (TAZ)
Re-drawn from Williams, Hook & Gascoigne (1998)

The main threats to bird survival in agricultural areas is habitat loss caused by over-clearing of native vegetation, and subsequent degradation of the remnants of vegetation. The rate of clearance varies greatly between different parts of Australia. The States and Territories have responsibility for land clearance, and the success or otherwise of laws in regulating clearance is examined. SA, Victoria and the ACT have sound controls on clearing and WA has recently strengthened its controls.

Over-clearing causes severe delayed effects on the land itself and these are examined in the context of agricultural productivity. In contrast, where native vegetation has been retained, a range of agricultural benefits ensue; some of these benefits are detailed.

The common cause of biodiversity losses and land degradation in the agricultural zone, namely over-clearing of land, points to a common solution. Many government programs at Commonwealth and State level are aimed at halting land degradation. This paper will consider the success or otherwise of these programs, and what could be done to improve the outcomes, taking into account the need to conserve biodiversity. Further measures may be needed and a possible solution is put forward. It would be overly optimistic to think that the solution put forward in this paper, to retain/replant 30 per cent of agricultural land as native vegetation is either achievable or would completely restore the land and biodiversity to pre-European standards, but the consequences of inaction are further declines in biodiversity and increases in land degradation.

A Crisis in Biodiversity

Most people are aware that species of plants and animals have become extinct in historical times, but there has been little recognition of the extent and gravity of the world situation. The current rate of extinction for birds and mammals of around one per cent per century is 100–1000 times the natural rate. According to the latest World Conservation Union report, over 11 000 species of plants and animals are threatened, in almost all cases as a result of human activities.[3] This includes approximately 25 per cent of reptiles, 20 per cent of amphibians and 30 per cent of fish (mainly freshwater) so far assessed, as well as 24 per cent of mammal species and 12 per cent of bird species. A new phenomenon, the 'empty forest', is starting to appear. In Britain, where two national bird atlas projects have been carried out, 54 per cent of bird species had declined significantly in range nationally, and 81 per cent had declined in rural areas over a period of just 15 years (1968–72 to 1986–90).[4] According to an eminent biologist, '[the current destruction of the earth's biological diversity is humanity's most disastrous mistake … an era of loneliness is in store for us]'.[5] The loss of biodiversity is approaching what scientists are calling the sixth great extinction episode, but the difference with this one is that it is being brought about by one species—humanity.

In Australia, there still seems to be plenty of birds and other animals in many places—have we escaped the crisis here? Unfortunately the answer is no; of the world's mammals to become extinct in the last 100 years, half were Australian. Overall about 280 species, or

nearly 17 per cent of Australia's terrestrial vertebrates species, are listed by one organisation or another as endangered, rare or threatened. For instance, one in four mammal species is either extinct or threatened and nearly one in five bird species is listed as threatened or of 'special concern'.[6]

Biodiversity is directly important to people in a number of ways, many of which we take for granted. Living organisms provide a range of materials used by people for food, fuel, fibre and medicines. Living organisms provide a range of biological services that benefit people including pollination, recycling, nitrogen fixation, replenishment of atmospheric oxygen and removal of carbon dioxide. Our fresh water, clean air and fertile soil are the work of our natural environment and are integral to our well-being and economic prosperity. A recent report has valued global ecosystems at $33 trillion per annum—more than the global gross domestic product (GDP).[7]

Birds play a vital role in ecosystems by pollinating native plants, dispersing seeds and removing pests from crops and trees. By controlling insect populations, birds can keep alive the patches of trees on farms. A healthy bird community is able to remove 50–70 per cent of leaf-feeding insects and so help reduce eucalypt die-back associated with fertiliser use and over-clearing.

A further anthropocentric (people-centred) benefit of biodiversity is the aesthetic pleasure gained from nature, in the form of wildlife observation and ecotourism, and vicariously through films and videos. The rural community is particularly aware of nature as they tend to live outdoors. They perceive a gradual and insidious loss of biodiversity—particularly birds—in their surroundings and are often unaware of why this should be so.

Rare and Threatened Species

Where a species decreases in numbers and/or range dramatically, it is likely to fall into the red list categories of the International Union for the Conservation of Nature (IUCN). IUCN categories range from 'Critically endangered' in which a taxon is facing an extremely high risk of extinction in the wild in the immediate future, through Endangered and Vulnerable to Lower Risk. The last category, Lower Risk, includes Near Threatened taxa, those that are close to qualifying for Vulnerable. It is indeed a slippery slope for listed species. Box 1 indicates how many Australian birds fall into the various red list categories.

Box 1: Current IUCN red list status of Australian birds

The most recent Action Plan for Australian Birds[8] lists the current status of our birds that fall into IUCN's red list categories. The Plan lists 25 taxa (species and sub-species) as Extinct, 32 as Critically Endangered, 41 as Endangered, 82 as Vulnerable and 81 as Near Threatened as at 30 June 2000. Of the taxa known to have been present at the time of European settlement in Australia in 1788, 1.9 per cent are extinct, 11.5 per cent are Threatened and 6 per cent are Near Threatened. The Endangered Species Program of Environment Australia and similar programs in various State environment departments have the responsibility to devise and carry out threat abatement and recovery plans for these species, which are covered by threatened species legislation.

Land clearance, habitat fragmentation and degradation have had major impacts on a number of species and are implicated in the demise of 43 per cent of these species.[9] Perhaps it is not surprising that the same basic cause underlies the observed declines of those species discussed in the next section, which are not yet listed as Threatened or Near Threatened.

Threatening Processes

The *Action Plan for Australian Birds 2000* reaffirms that the principal threat to birds is loss of habitat due to land clearing. More than 82 per cent of bird taxa from mainland Australia and Tasmania have been affected by land clearance at some stage, and for half it is a continuing threat. Overgrazing by sheep and cattle, changed fire patterns and introduced predators are other important threats. Over 40 per cent of bird species affected by habitat loss occur in temperate or subtropical woodlands,[10] the main areas cleared for agriculture.

The Decline of Woodland Birds

Results from the First (1977–1981) and Second (1997–2001) Atlas of Australian Birds (see Appendix 1) provide an excellent comparison of the changes that have occurred over the intervening 20 years, and already some trends are emerging. Other projects have also compared present bird numbers with those previously present, and the results are often alarming.

A number of these studies show that woodland birds are decreasing in numbers and in range. Much of the data relates to Australia's temperate agricultural zone—the agricultural landscapes of southern Australia dedicated to cereal growing and sheep production. The open forest, woodland and mallee formations that once existed have now been extensively modified, with over 80 per cent of the original vegetation having been cleared in most regions. In some places, remnant vegetation is as low as five per cent of the original.

Many of the once-common birds in these areas are in decline. There is a trend towards local extinctions and reduced avian diversity, despite the fact that in many regions of the agricultural zone, especially the older settled areas, land clearance has effectively ceased. A further trend is the increased homogenisation of regional landscapes, with different areas losing their distinctiveness and becoming more similar to one another.

Reid[11] has identified 20 species of previously common woodland birds of the sheep-wheat belt of NSW that are in decline. According to later reports, a further four species must be added to the list.[12] The 24 species are:

Emu	Hooded robin
Whistling kite	Eastern yellow robin
Painted button-quail	Grey-crowned babbler
Spotted nightjar	White-browed babbler
White-browed treecreeper	Varied sitella
Brown treecreeper	Crested shrike-tit
Speckled warbler	Crested bellbird
Chestnut-rumped thornbill	Rufous whistler
Southern whiteface	Restless flycatcher
Black-chinned honeyeater	White-browed woodswallow
Jacky winter	Dusky woodswallow
Red-capped robin	Diamond firetail

The characteristics of declining woodland birds and regional variations in species declines are shown in Appendix 2. Appendix 3 explains why birds are lost from habitat fragments—even those fragments that contain apparently 'good' habitat.

Threatened Species

Australia has approached the conservation of threatened native animals and birds species by species. In reality, a broader approach is needed, with a shift from species preservation to the management of ecosystems. Also, conservation strategies must apply across all lands irrespective of tenure, requiring the cooperation of land managers, land owners and legislators.

Thirty seven species of land birds are listed as Threatened under NSW legislation[13]—see Appendix 4. Threatened species tend to be habitat specialists, and at least three (Superb parrot, Swift parrot and Regent honeyeater) live in the most fertile and productive types of woodland, those that were preferentially cleared for agriculture.

Apparently Unaffected Species and 'Increasers'

Not all bird species are declining as a result of land-clearing. Some have benefited by the open spaces and have healthy, increasing populations, even to the point of becoming pests in some areas. Many 'increasers' are birds of the arid and semi-arid regions which easily adapt to open grassy agricultural areas with an abundance of food and readily-available water. They include seed-eaters such as the galah, corellas, some other cockatoos, crested pigeon and some parrots, as well as other open country species such as the Australian magpie, ravens, willy wagtail, Australian magpie-lark, welcome swallow, skylark and common starling. The pied currawong, a fruit-eater outside the breeding season, is another increaser.

All of these 36 species are at least moderately common in the NSW sheep-wheat belt, and seven are introduced species—see Appendix 5. Some native species have benefited from the more open habitat and extensive grasslands that now exist but many need the remnants of natural vegetation at least for shelter and breeding.

Other Vertebrate Groups

In the world rank of endemism, Australia ranks first for both mammals and reptiles, second for birds, and fifth for both higher plants and amphibians.[14] For example, Australia has 850 species of reptiles, or about 12 per cent of the world's entire reptile fauna. Of these 850 species, over 89 per cent are endemic to Australia—a higher percentage of endemicity than for birds (43 per cent) or mammals (82 per cent).

Between 1983 and 1993, land clearing led to the deaths of at least a billion reptiles, or more than 100 million reptiles on average each year.[15] In 1993, the Action Plan for Australian Reptiles found that about 25 per cent of our reptiles were in significant decline. Land-clearing in Queensland alone over the past two years would have caused the deaths of nearly 170 million reptiles. As with birds, habitat loss is by far the greatest contributor to overall declines. Many reptile species cannot exist in cleared agricultural areas and isolated patches of native vegetation in a study area in central west NSW retained only 26–63 per cent of the original number of species.[16]

Mammals also fare badly under habitat loss, with predation another important factor. So far 21 species of mammals have been declared extinct, and almost half of our marsupials and monotremes are listed as extinct, endangered or vulnerable.[17] As with birds, even previously common species are being affected. An example is the loss of brushtail and ringtail possums from woodlands in WA, NSW, Queensland and Victoria. Possums are even disappearing from large tracts of woodland such as the Pilliga Forest of central west NSW. Here, the logging of mature narrow-leaf ironbarks down to two large trees per hectare compared with pre-European densities of 20–30 trees per hectare is a major factor, as the mature ironbarks provided hollows required by both species, especially ringtails.[18]

Land clearance and Land Degradation

Land 'clearance' by people began with Aboriginal use of fire. Perhaps unwittingly, this created a complex mosaic of burnt and unburnt patches which supported a rich variety of flora and fauna. The situation changed after European settlement over 200 years ago.

Three Stages of Agricultural Development in Southern Temperate Australia

In the initial pastoral phase of agricultural development in southern temperate Australia, squatters introduced large numbers of sheep and cattle (some 10 million sheep and 2 million cattle by 1860). In this period, with hunting, loss of Aboriginal burning regimes and limited clearing, some birds declined and disappeared from the region, most notably the paradise parrot (now extinct), bustards, brolgas and seed-eaters such as the star finch, squatter pigeon and black-throated finch. The decline of the paradise parrot was already far advanced by 1905, at which time there was little land clearing.

The second phase, extensive clearing for cropping and improved pastures, has affected the birds most severely. This main phase of agricultural development from the late 1800s to the mid–late 1900s (and still continuing in Queensland and parts of NSW) is now having a devastating effect on biodiversity as revealed in declines in woodland birds. Northern Australia (NT, Queensland, northern WA) is experiencing great increases in land clearing for agriculture and bird declines from this phase are likely to be detected in coming decades.

The third phase is intensification of agriculture, increased cropping and irrigation, and urbanisation in the form of rural residential subdivisions. In the northern and western parts of the eastern wheat belt of NSW, land use is intensifying accompanied by further clearing in previously marginal lands and great increases in water diverted for irrigation.[19] In general, the biodiversity effects of this third phase are still to be felt. In Britain and Europe, lapwings and small songbirds are disappearing from agricultural landscapes where they appeared to be able to survive. It looks as though Australia could lose many more species over the longer term, including some presently classed as having stable or even increasing populations. Figure 2 shows the percentage area of remaining native woody vegetation as at 1990–91.

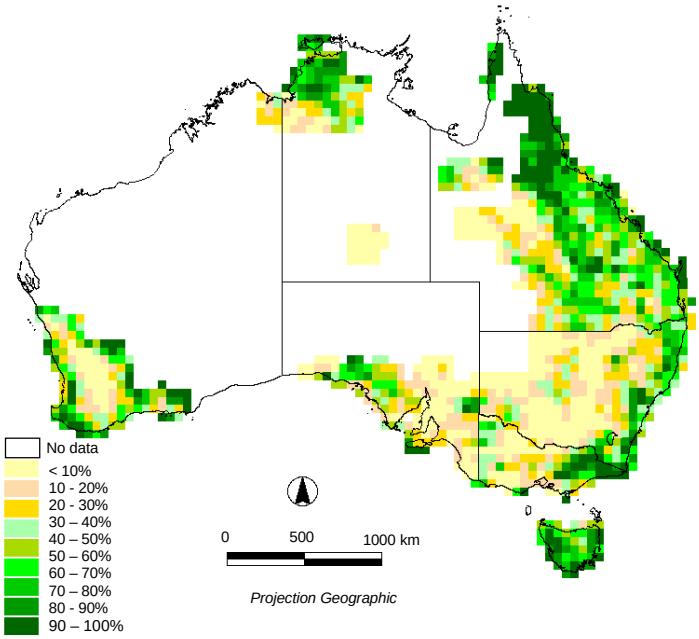

Figure 2: Percentage area of remaining native woody vegetation 1990–91
Source: Land cover change in Australia: results of the collaborative Bureau of Rural Sciences—state agencies' project on remote sensing of agricultural land cover change, Michele Barson, Lucy Randall and Vivien Bordas, 2000.

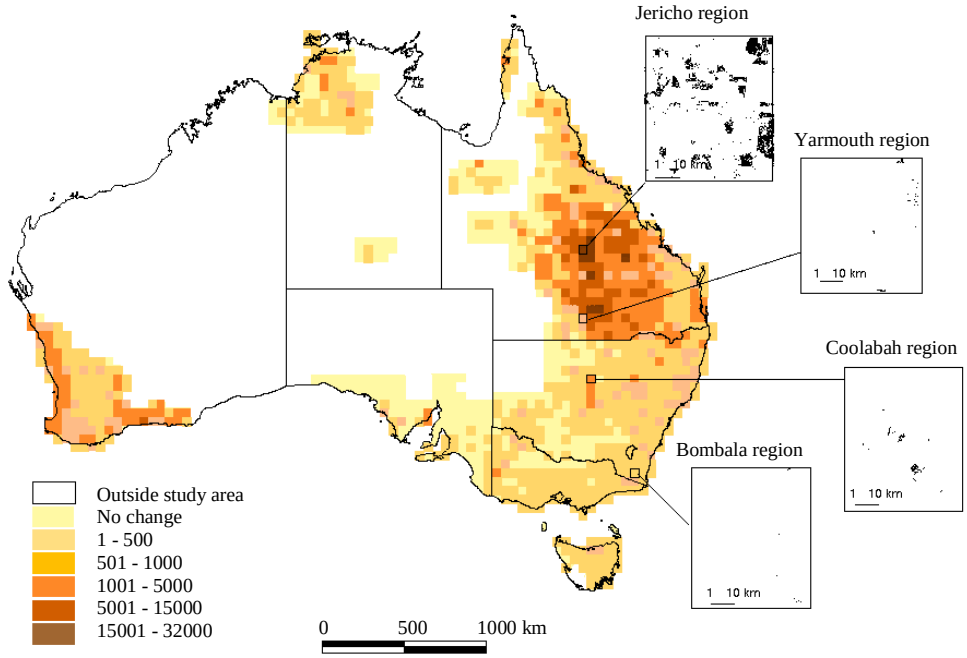

Figure 3: Distribution of clearing (ha) of woody vegetation 1990–91 to 1995 for agriculture, grazing and development.
Source: Land cover change in Australia: results of the collaborative Bureau of Rural Sciences—state agencies' project on remote sensing of agricultural land cover change, Michele Barson, Lucy Randall and Vivien Bordas, 2000.

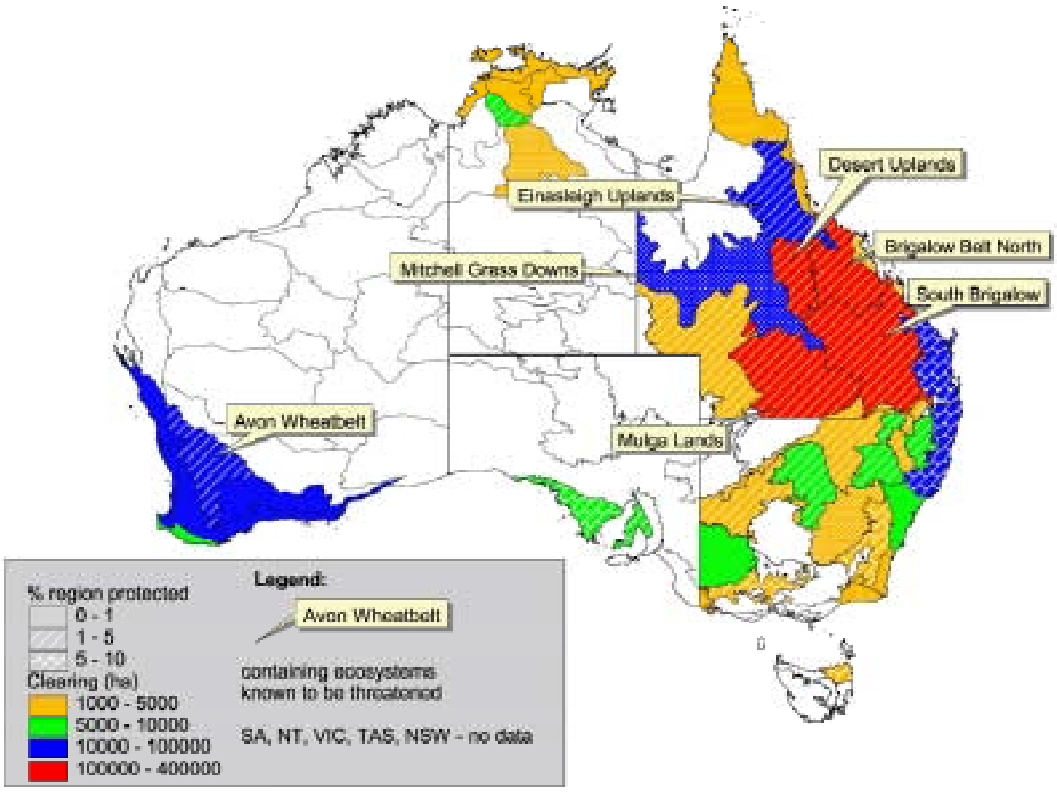

Figure 4: Extent of clearing over the study period by Interim Biogeographic Region.
Source: Land cover change in Australia: results of the collaborative Bureau of Rural Sciences—state agencies' project on remote sensing of agricultural land cover change, Michele Barson, Lucy Randall and Vivien Bordas, 2000.

Present Status of Land Clearance

Australia's rate of land clearing is amongst the highest in the world. Latest figures for the year 2000 show it has the sixth highest clearing rate on earth (behind Brazil, Indonesia, Sudan, Zambia and Mexico), at approximately 565 000 ha per annum, a rise of seven per cent over the previous year.[20]

Some States and Territories have sound native vegetation planning systems in place, particularly SA, Victoria and the ACT. WA has recently strengthened its land clearing controls. The success of these planning systems in controlling land clearing can be seen in the clearing rates for the various States and Territories—see Table 1. Figure 3 shows the distribution of clearing of wood vegetation for the years 1990–91 to 1995. Figure 4 shows the extent of clearing in hectares for this period.

Table 1: Land clearing in the States and Territories for the year 2000[21]

State/Territory	Area cleared (ha)	Clearing as % of State's area	Clearing as % of Australian total
Queensland	425 000	0.246	75.2
NSW	100 000	0.125	17.7
Tasmania	17 000	0.251	3.0
Northern Territory	12 700	0.009	2.2
WA	6 000	0.002	1.1
Victoria	2 500	0.011	0.4
SA	1 600	0.002	0.3
ACT	Minimal	-	-
Total	*564 800*	*0.074*	*100.0*

Queensland

In Queensland, the rate of land clearing was 290 000 ha per annum during 1991–95, 340 000 ha per annum in the period 1995–97 and 425 000 ha per annum in the period 1997–99. This last figure, amounting to 0.246 per cent of the State's area, is 25 per cent higher than the 1995–97 figure and 47 per cent higher than for the 1991–95 period. Massive panic clearing prior to passage of the *Vegetation Management Act 1999* caused an escalation possibly to more than 500 000 ha in 1999.[22]

The Act was proclaimed on 7 September 2000. This legislation protects woodlands and forests that are endangered (less than 10 per cent remaining) but the section protecting woodlands and forests 'of concern' (10–30 per cent remaining) was removed from the legislation after successful lobbying by farmers, and failure to secure federal compensation for preserving these communities.

Most land clearing is carried out in the semi-arid and arid rangelands to create pasture. Nearly 60 per cent of the clearing is in the Brigalow Belt and another 30 per cent in the Mulga Lands and Desert Uplands. Coastal areas of SE Queensland are being cleared for urban expansion and coastal areas in North Queensland for sugar cane.

New South Wales

The NSW *Native Vegetation Conservation Act* has been in operation for three years. However, over 300 000 ha have been cleared since the Act was introduced, and of that nearly 78 000 ha was approved for clearing in 2000.[23] The latest State of the Environment Report suggests that clearing in NSW may be as much as 150 000 ha per annum.[24] Recent clearing has been most extensive in a belt of land, 150 kilometres wide, along the eastern and southern boundaries of the Western Division, and in the northern wheat belt of the Central Division. In other places, clearing is targeted at remnant vegetation.[25]

There have been no successful prosecutions under the Act, although at least 614 breaches[26] involving some 29 000 ha have been reported, including the destruction of 8 000 ha of bush near Mungindi in July 2000 by accidental spraying of herbicide. As only about 30 per cent of breaches are reported, the extent of illegal clearing may be much higher.[27]

The Act contains loopholes and can be circumvented fairly easily as there appears little political will to pursue prosecutions. The Act allows clearing of two ha per annum and seven trees per hectare per annum for on-farm use without development consent. The New South Wales Department of Land and Water Conservation, through the development consent process, frequently imposes conditions requiring offsetting the clearing of isolated patches by creating on-farm reserves free from grazing pressure by fencing and/or replanting elsewhere. Such a system may work in the mallee areas of southwestern NSW, accompanied by removal of watering points, but generally plantings are expensive to establish and less effective as habitat compared with conserving native vegetation. The creation of on-farm reserves would essentially be paid for by the gain to the individual from additional clearing.[28]

The estimated ratio of clearing to revegetation is at least 30:1, showing that NSW will have difficulty in abiding by its commitment under the Natural Heritage Trust for no net loss of native vegetation by 2001.[29]

Tasmania

As a percentage of total area, Tasmania's clearing rate is the highest in Australia. Tasmania has controls on native forest for logging purposes but has no legislation to control broad acre agricultural clearing on private land. Land clearing rates in Tasmania have been fairly consistent over the last 25 years at about 10 000 ha per annum. The present rate of clearance is about 17 000 ha per annum. This figure includes losses from inundation, establishment of tree plantations and clearance for agriculture. The 1999–2000 Annual Report of the Tasmanian Forest Practices Board indicates a permanent removal of native forests of some 17 000 ha per annum over a three year period.

Almost all clearance now is to convert native forests to plantations of exotic species (principally *Eucalyptus nitens* and *Pinus radiata*). These plantations are being established as part of the Regional Forest Agreement. The Australian taxpayer is in effect subsidising the conversion of native forest to plantation.[30]

Northern Territory

The estimated clearing rate for the NT is 12 700 ha in 2000, comprising 'routine' annual clearing estimated at 5000 ha, plus 2,700 ha cleared in the Tiwi Islands and 5000 in the Katherine basin in 2000.[31] In the past 5–7 years, there has been a significant increase in

clearing in the NT, and it is set to rise even more drastically in coming years due to planned huge expansions in agriculture and horticulture.[32] The intention is to clear over one million hectares of native vegetation from the Katherine and Daly River area, the Ord River, the semi-arid Sturt Plateau and the Point Stuart – Wildman River area, among others. These schemes show an intent to clear native vegetation on a scale and intensity not experienced previously in the region.

With the north under pressure from development, it appears that the NT is not benefiting from knowledge of the problems of over-clearing in southern States.

Western Australia

The present estimate for land clearing in WA is 6000 ha per annum (Table 1). The Perth region had a clearing rate of some 3000 ha per annum several years ago, and the urban area has continued to expand. Rural clearing in the south-west of the State is 3700 ha per annum.[33] The Ord Scheme in the north of the State is set to expand by some 17 000 ha, which was approved in September 2000 for clearing. Apparently the serious salinity problems of the southern wheat belt are constraining further clearing there, but expansion is set to occur in the north.

Victoria

Victoria is the most heavily cleared State, with approximately 70 per cent cleared. It continues to lose native vegetation at about 2500 ha per annum or 0.011 per cent of the State, a figure that does not take into account clearing under legislative exemptions, clearing of scattered trees, and degradation of habitat in remnants.

South Australia

SA has the tightest controls on land clearing of any State or Territory. In 1999–2000, permission was given to clear 1564 ha of land and nearly 6000 individual trees.[34] These figures obviously exclude any illegal clearing. Although the areas of clearing are small, they involve some significant vegetation communities and habitats.

Australian Capital Territory

Land clearing is little documented in the ACT but appears to be less than in other areas of Australia. Figures for 1991–95 show that 1100 ha were cleared annually, as revealed by satellite sensing.[35] Clearing for urban expansion and rural residential development in the northern third of the ACT is still occurring, with endangered ecological communities at risk.

Problems with Over-clearing

Despite evidence of land degradation, agricultural productivity has been increasing at the rate of 2.5 per cent a year, due to extra inputs of fertilisers, water, and genetic improvements. However, there is evidence that these increases are unsustainable, and that they have occurred despite increasing land degradation. A recent Rural Industries Research and Development Corporation publication states:

> In fact, productivity has grown at an average of 2.5 per cent a year in the agricultural sector. Other imports—fertiliser and water management requires, genetic improvements and so on—have maintained and increased yields despite increasing degradation.[36]

There is also the move to clear and crop marginal areas such as the edges of the Western Division in NSW, mentioned earlier. Sophisticated analysis in NSW has shown that soil structure decline and increase in soil acidity both led to reduced profits, but increases in dryland and irrigation salinity did not—farmers moved to increase crop and animal production by shifting to more intensive production on the better land.[37] Thus, in the short term, it is possible for agricultural productivity to remain stable or even to rise despite land degradation.

If farms are overcleared, the basic resource, the land, becomes degraded. The results can be seen in the form of salination, waterlogging, overgrazing, erosion, feral and woody weed invasions, loss of soil fertility and structure, acidification, soil compaction and changed hydrological dynamics. The land loses its resilience, so that further disturbance has more drastic effects.

Land degradation is now recognised as a mainstream issue, with about 70 per cent of agricultural land now suffering from some form of degradation.[38] Many processes such as salination are slow to start, but once begun, they proceed rapidly. These processes have been called 'desertification'.

Clearing of land can result in invasion of woody weeds. When an open woodland system is cleared, it often grows back as thick woody regrowth, as can be seen in many places in Queensland, NSW and elsewhere. This is a land degradation problem for the future. The growth of native grasses is suppressed by the woody weeds and the soil is exposed leaving it vulnerable to soil erosion.

The failure of the market to allocate scarce resources, such as land with native vegetation, in a manner that maximises net benefits to the community is one argument for government intervention in the market system.[39]

Salinity

Australian soils are prone to salinity because much of the country (for instance, the Murray Darling Basin) is underlain by ancient marine sediments and there is also more salt coming in from the sea with rainfall. Two types of salinity caused by human activity can be recognised in Australia: dryland and irrigation salinity.

Dryland salinity occurs in places where salt is stored in the soil or groundwater and there is an increase in the amount of surface water seeping down to the water table, effectively filling up the water table and bringing salty groundwater close to the surface. Shallow-rooted annual crops and pastures that replace deep-rooted perennial vegetation have a much lower capacity to capture and transpire water, thus allowing significantly more water to pass through the soil to the water table. There the excess water mobilises salt from groundwater and brings it to the soil surface, from where it can also enter streams and rivers. Irrigation salinity is due to more surface water being added to the land, thus raising groundwater levels. Figure 5 forecasts areas of high risk of dry land salinity in the year 2050.

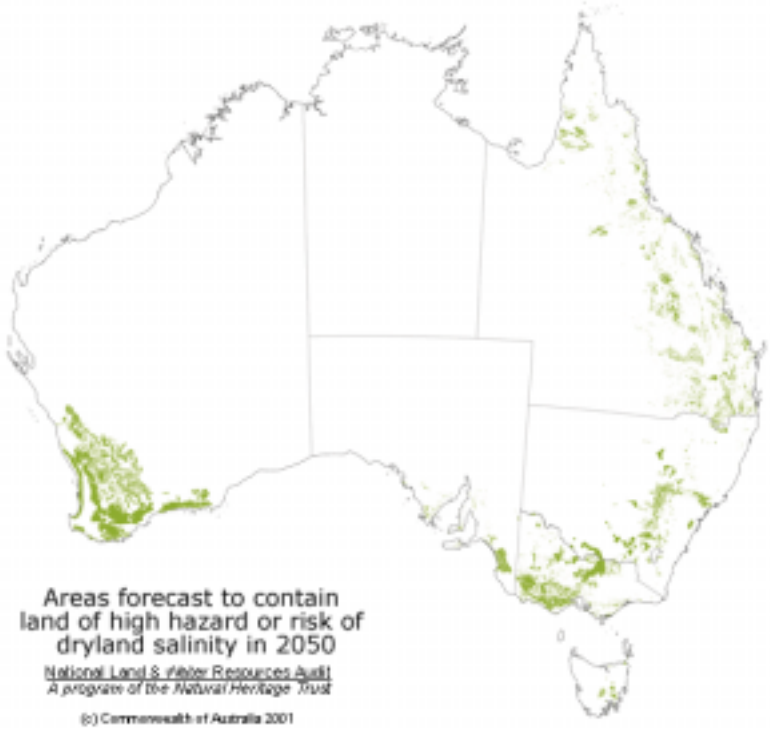

Figure 5: Areas forecast to contain land of high hazard or risk of dryland salinity in 2050.

The solution to dryland salinity is to replant perennial vegetation, which may involve revegetation of over 50 per cent of the landscape. However, the effects of clearing of the upper catchment are felt in other areas, namely downstream, with a certain lag time. Conversely, revegetation may need to be carried out in different areas from the sites of greatest impact.[40]

The Value of Native Vegetation: Sustainable Agriculture and Biodiversity

Numerous studies have shown that native fauna require native vegetation for their survival. For instance, the Birds on Farms survey carried out by *Birds Australia* showed that native vegetation provides the best habitat for wildlife,[41] while clearing of native vegetation results in a dramatic decrease in the richness of reptile species in an area.[42]

Native vegetation provides a range of on-farm benefits such as the control of land degradation, salinity and soil erosion; shelter and shade for stock; and habitat for birds and other organisms that prey on pests. It protects livestock, particularly lambs and calves, from heat and cold stress. Windbreaks can have substantial benefits in protecting high value crops from wind damage. It also aids in the soil nutrient cycle, provides timber for on-farm use, and often enhances land values. However, in the short-term, the economic advantages of native vegetation may not be apparent in all cases, and only by considering the long term sustainability of land use can the benefits be realised.

A number of studies are showing the value of native vegetation in enhancing agricultural productivity. There is an increase in wheat and crop yields in sheltered zones of between 22–47 per cent (Rutherglen, Victoria); an increase in lupin yields of 27 per cent in the area between windbreaks (Gibson, south-west WA); increased yields of 25–45 per cent in sheltered crops of wheat, oats and lupins, and yield increases of 20–100 per cent in horticultural crops (area not specified). There is also increased net cereal yield of 15 per cent due to the sheltering effect of windbreaks in a USA cereal-growing area.[43]

Trees can also benefit pasture growth. A 20–30 per cent higher yield was obtained in protected farm areas, compared with unprotected areas, with annual benefits of $38–66 per ha (mainland Australia) and a 20 per cent increase in average annual pasture growth in protected areas of a farm (Australia and overseas).[44]

A study near Gunnedah in northern NSW found that gross value of pasture output was highest where the proportion of tree cover across the farm was at 34 per cent, with no further increases in output being achieved beyond this point.[45] While presence of canopy cover can result in apparently lower levels of pasture biomass in parts of Queensland, the species of grasses may be more productive with higher levels of digestibility and protein, and so may not result in lower animal production. Canopy cover can reduce soil temperature, moderate the extremes of temperature, and reduce evapo-transpiration leading to shifts in species composition in the herbaceous layer towards more productive pasture grasses.[46]

Livestock production is enhanced in areas with native vegetation. Over a five year trial, a 31 per cent increase in wool production and 21 per cent increase in liveweight was found in sheltered areas, along with 18 per cent more pasture in sheltered zones (Armidale, NSW). In North Queensland, shelter belts resulted in 10–16 per cent more lambs present at marking due to reduction in the heat load on ewes, as well as faster growth rates and more wool from lambs in the first 16 months of life. Availability of shelter resulted in a 50

per cent reduction in lambing losses (Eastern Highlands of SW Victoria) and greatly reduced lamb mortality (western Victoria, SA). Dairy production is improved where shelter is present—up to 17 per cent increase in dairy milk production for sheltered areas, and conversely, unsheltered cows have 26 per cent less dairy milk production than unshaded stock.[47]

The immediate, direct economic benefits of remnant vegetation have been studied in NE Victoria and for the NSW Murray Catchment area. Under current management, 52 per cent of Victorian participants in the study and about 82 per cent of NSW participants were gaining a net economic benefit from their remnant native vegetation in the form of stock and crop shelter, firewood production and prevention of land degradation. However, under a more conservation-oriented management regime, the vast majority of landholders would experience a net financial loss.[48] The economic costs associated with conservation management are such that they require significant financial incentives for landholders to undertake activities that benefit biodiversity and long-term agricultural sustainability.

The Solution?

The unsustainability of agriculture and the loss of biodiversity have a common cause, which for much of southern temperate Australia stems from over-clearing and subsequent land and water degradation. The common cause points to a common solution. It is not only possible but highly desirable to attain the twin goals of sustainable agriculture and conservation of biodiversity by concerted action to retain and replant native vegetation. As shown above, clearing rates are at record levels through large parts of Australia, despite the clear links between over-clearing and land and water degradation and loss of productivity. In this view. it can be argued that the clearing of further native vegetation should effectively cease.

With agricultural areas in every State and Territory still subject to very substantial clearing, most remaining large tracts of native vegetation occur in national parks and State forests. Ecologists warn that these are not sufficient to conserve biodiversity and that conservation on private land is vital.[49] A number of State programs such as Land for Wildlife in Victoria and Land for Nature in Queensland seek to retain and/or plant native vegetation on private land. Victoria's Land for Wildlife program was established in 1981 and has operated in its current form since 1990. As it does not offer financial incentives, it only attracts landholders convinced of the value of conservation and those who seek advice on how to manage to maintain this value. It is not legally binding on participants. Similar schemes are now operating in Tasmania, WA and parts of Queensland. Queensland's Voluntary Conservation Agreement project has protected 1315 ha of private land by means of rate discounts to landholders.[50]

National programs such as Save the Bush and One Billion Trees have had a similar aim. The two largest national programs, Bushcare and Landcare, are discussed briefly below, as well as a non-government program, Greening Australia.

A national approach to increasing the skills of farmers is the expanded FarmBis[51] program, with funding of $167.5 million over four years. Property management planning is part of this voluntary program.

Landcare

The Decade of Landcare began in l989 with $340 million in funding over a 10 year period. This funding was greatly increased with an expenditure of $450 million over the past five years to the National Landcare Program.

About one-third of farmers are members of the 4500 Landcare groups. Group members decide on priorities and carry out the works. A real benefit from Landcare has been the heightening of community awareness about sustainability and environmental matters.

However, an unintended effect of Landcare funding is that it has made it easier for State Governments, with responsibility for land management, to 'cost shift' and substitute federal money and positions for what was previously supplied from State funds. Federal funds pay for positions such as Landcare Coordinators, allowing the State-funded agricultural extension officers to be withdrawn.

The recent Olympic Landcare initiative resulted in the planting of over 2 million trees around Australia since 1998. Despite impressive figures like this, Australia's poor record on land clearing means that for every tree planted under the Federal Government's Natural Heritage Trust program, 100 000 were cleared by landholders.[52]

Landcare funding in the latest Budget (May 2001) has been cut dramatically over the next four years, from $101 million this financial year, to $70 million, $53 million, $40 million and $41 million in subsequent years. However, from 2002–03, it is expected that additional funds would be available for Landcare from the extension of the Natural Heritage Trust.[53]

A recent evaluation of the Decade of Landcare has been carried out by its architects, Phillip Toyne and Rick Farley.[54] This evaluation has found that, despite the massive increases in funding and resources to overcome the chronic decline of our lands and waterways, most of the problems that the Decade of Landcare addressed are still increasing in severity and scale. Landcare can be judged a success only by its achieving a change in community attitudes. Its main benefit has been in raising community awareness rather than achieving the goal of Landcare, to achieve ecologically sustainable development within 10 years. This goal proved to be too optimistic; land degradation has not been fixed in that time frame and is in fact worsening. Nor have there been substantial improvements in clearly defined priority issues such as land clearing, salinity or water quality.

The analysis has shown deficiencies in Landcare policy. These relate to the failure of Landcare to position its actions in the bigger picture, for instance in relation to structural adjustment, market systems, macroeconomic policy and economic incentives, and even as regards State Government responsibilities, regional structures, service provision and incentives.[55]

Bushcare

Australia's largest revegetation program, Bushcare, is a $350 million, four year program funded through the Natural Heritage Trust. Bushcare works with community groups, land managers, industries and government agencies to manage remnant native vegetation sustainably and revegetate for a range of purposes including conserving biodiversity, rehabilitating degraded areas, improving agricultural production and conserving wildlife habitat. Bushcare provides information on revegetation, assists with planning projects under the National Heritage Trust (and so links with Landcare), helps people gain access to funding to protect remnant vegetation, and organises information days and workshops on topics such as seed collection and native plant propagation. The program's national goal is to reverse the long-term decline in the quality and extent of Australia's native vegetation cover.

Under this program, just over 10 000 ha were planted to 31 January 1999,[56] and it is expected that at the end of the program there will be 150 000 ha of revegetation. However, some projects were not able to achieve their revegetation aims due to budgetary limitations. The mid-term review of the program showed that it will have very limited impacts on addressing loss of biodiversity because of the generally small scale and scattered distribution of the projects in relation to the scale of the problem. It is also not effectively addressing sustainable production issues or other important environmental problems such as dryland salinity.[57]

Farm Forestry

Another Natural Heritage Trust program deals with farm forestry. The original program was allocated $17 million under the 1995 Wood and Paper Industry Strategy, to support the establishment of regional plantation committees, regional projects and complementary national initiatives. The program was aimed at commercial wood production on cleared agricultural land and integration of this wood production into farming systems.

The Farm Forestry Program was expanded to the extent of $36.5 million under the National Heritage Trust, with the aim of encouraging the incorporation of commercial tree growing and management into farming systems for the purposes of wood and non-wood production, increasing agricultural productivity and sustainable natural resources management.

The mid-term review found that the short horizon of funding for the program was at odds with the long term investments required for farm forestry. Although farm forestry has the potential to make positive contributions to land, water and biodiversity conservation, it is often perceived to be in tension with biodiversity objectives. A longer time frame is needed for proper assessment of the outcomes of the program against its objectives.[58]

Greening Australia

Greening Australia is a non-government, not-for-profit national organisation which has been working with rural and city groups, farmers, schools and business in every State and Territory since 1982. It aims to protect remnant vegetation and biodiversity, repair and prevent land degradation, improve water quality and provide habitat for native fauna, by helping the community to conserve and plant native trees, shrubs and grasses. It supports Bushcare and the Farm Forestry program, and manages planting programs for local and State governments. Greening Australia operates independent seedbanks, seed orchards and nurseries.

The Commonwealth Government's Farm Forestry program, run by Agriculture, Fisheries and Forestry Australia, works at the interface between agriculture, forestry and the environment. Greening Australia assists this program by helping and advising farmers and landholders to manage trees on farms for profit. Trees can provide timber and non-timber products such as oils, seeds and nuts, and shelter for stock, as well as conserving biodiversity and lowering water tables, thus reducing soil salinity.

Their revegetation project in the ACT and southeastern NSW has resulted in the establishment of 3400 km of treeline using direct seeding techniques on 400 properties, the planting of 40 000 trees and shrubs each year, and the establishment of 50 ha of vegetation corridors.[59]

Proposal for a National Action Plan

The Prime Minister's Media Release of 10 October 2000 outlined a National Action Plan for Salinity and Water Quality. The Commonwealth has committed $700 million over seven years to address salinity and water quality problems, and is requiring a dollar for dollar matching commitment from the States. However, to date only three States—SA, Queensland and NT—had committed to the plan, with NSW and Victoria likely to agree. The SA Government has committed $100 million towards controlling salinity. WA has not committed to the plan, despite having significant salinity and water quality problems.

The Action Plan will be directed towards 20 or so highly affected catchments and regions in all States and NT. Part of the Plan involves a ban on further land clearing if this would lead to unacceptable land or water degradation. Queensland, NSW and Tasmania are mentioned as possibly needing to tighten clearing regulations in order to combat salinity.

The work required under the Action Plan will take at least 6–8 years, possibly longer. Therefore it requires a sustained commitment from all parties to succeed.

The Action Plan is more focussed in its approach than any previous attempts to attack salinity. For the first time ever, national salinity targets are being developed. Cumbersome grants processes are being replaced with direct funding to accredited regional strategies, with more emphasis on monitoring and reporting, and national oversight by a Natural Resources Ministerial Council.

However, there is a need to incorporate biodiversity benefits into regional strategies. For instance, tree plantings to control salinity and other land degradation problems such as soil erosion, acidification, nutrient runoff, and decline in soil structure, should be carried out with the specific aim of enhancing biodiversity as well. Principles have been developed that enhance regeneration activities to increase their value for conserving wildlife.

'Good News' Stories

Individual farmers, families and groups have been restoring degraded rural landscapes often independently of organised activities such as Landcare. In each case, the biodiversity benefits are apparent, but not all have realised economic benefits from their efforts.

Lanark

Thirty five years ago, this 800 hectare property in the Western District of Victoria produced nearly 200 bales of wool in good years, as well as raising fat lambs for the domestic market on its improved pastures. Then the 1967 drought brought physical, emotional and financial hardship to the district and caused a re-evaluation for the owners of this typical grazing property, John and Cicely Fenton. The Fentons decided that production levels of the occasional 'boom' years were unsustainable, and set about re-creating a balance between the farming enterprise and the natural environment, to the overall benefit of both. This exercise was intended to go beyond just drought-proofing the property.

At a time when other Western District farmers were still clearing native vegetation and draining wetlands on their properties, the Fentons started to do the opposite, reinstating the wetlands that had once existed, fencing off large parts of existing paddocks, and planting trees in the fenced-off areas. They hoped to create an environment where wildlife could coexist with livestock, and buffer Lanark's production systems against the vagaries of the climate, thus ensuring the future viability of their family and the land itself.

Since 1967, the Fentons have planted over 80 000 trees and shrubs in shelter belts, plantations and native woodlands featuring locally endemic species. They still produce wool, raise fat lambs and grow some cereal crops. Fifty per cent of the property is sown to

improved pasture, and 30 per cent is native pasture, the latter acting as a buffer zone between improved pastures and sensitive wildlife habitat that is vulnerable to nutrient runoff.

The Fentons have spent 40 years planting trees at an estimated cost of $320 000, of which little will be returned in their lifetime. Farm forestry now covers six per cent of Lanark, and could generate up to 70 per cent of the net farm income from 2009, by harvesting approximately two ha annually from a total of 52 ha. The work done on Lanark is not reflected in the farm's immediate profitability, but the Fentons have shown that with long-term vision and commitment, trees can provide a reliable income. Their farm is now well-insulated against drought, salinity, water contamination, algal blooms, insect pests and disease.

The birds on Lanark reveal some of the biodiversity benefits of the Fentons' actions. A local naturalist has kept meticulous records of the birds over 45 years, revealing that 155 bird species are now to be found there. This is despite considerable losses to the avifauna with surveys revealing only 40 species present in 1956. It is thought that the pre-European species list would have been close to 200 species; thus over three-quarters of the bird species that inhabited the region's native woodlands and wetlands more than a century ago have returned.[60]

Genaren Hill Landcare Group

'Genaren' is a conservatively-managed property in the Central West of NSW, within the sheep-wheat belt. It includes well-managed native grasslands and tree cover, with over 400 native plant species. It has never been overstocked and some land has never been ploughed. As a result of this sympathetic management, it contains a diverse set of flora and fauna, and is the focus of many of the Genaren Hill Landcare Group's activities. A recent activity is fencing off a six square kilometres patch of bushland with cat- and fox-proof fencing, and reintroduction of the brush-tailed bettong (*Bettongia pencillata*) to the enclosure. The underlying philosophy of the group includes a desire for economic benefits to flow from encouraging biodiversity. However, the group is unusual in that their restoration activities have gone beyond the usual tree planting to consider the health of organisms that live in the soil and its dependence on animals such as the brush-tailed bettong.[61]

Dairy Farm at Jeetho, Victoria—Landcare Success

In Victoria, the owners of a 110 ha dairy farm at Jeetho, Tom and Sue Loughridge, started to integrate landcare practices with traditional farming techniques. They began an extensive tree planting program in the early 1980s, planting some 20 000 trees over 16 years. Their efforts have been rewarded as they have stopped soil losses from landslips, and tunnel and streambank erosion, in this landslip area. Most importantly, they have also

been able to profit economically from their efforts, with the dairy herd increasing from 160 in 1982 to 230 at present. Fifteen per cent of the farm has been retired from grazing to stabilise the soil, which also benefits biodiversity.[62]

Murray and Murrumbidgee Catchment, NSW

The economic benefits of sustainable farm management, including retention of native vegetation (trees, shrubs and native perennial grasses) have been demonstrated in a practical fashion by farmers of the NSW Murray Catchment. For instance, the Strong family at 'Arcadia' near Narrandera, NSW, have used holistic grazing management principles combined with other sustainable practices, such as retention of native vegetation and revegetation with native grasses, to save up to $40 000 a year on chemical bills for pesticides. The Taylor family at 'Pooginook' near Jerilderie in the NSW Riverina district have also adopted holistic farm management, with increases in native perennial grasses, shrubs and trees, and improvements in animal health and ground cover, even in dry years. A further example is the Sloane family of 'Kilnyana', who have retained significant areas of native vegetation on their property, providing important shelter for animal health and production, and also for crop and soil protection. Their bush remnants are significant in terms of wildlife habitat and also provide a basis for a sustainable approach to land management. The family derives a great deal of pleasure from their remnants, over and above monetary values.[63]

What Else is Needed?

The lack of strong land clearing controls in some States and Territories, notably Queensland, Tasmania and the NT, and the failure to fully implement the provisions of the clearing laws in NSW, has been mentioned earlier as grave concerns. The SA experience has been that voluntary approaches to limiting vegetation clearance do not work.[64] It is also apparent that revegetation programs relying largely on voluntary commitment, some of which are outlined above, are inadequate to address revegetation on the scale required. Present schemes are revegetating only a small fraction of the land now being cleared. Therefore it is apparent that some other mechanisms must be brought into play to cap or halt land clearing.

Federal Powers and Legislation

The federal *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) replaces much previous federal environmental legislation.[65] Previously, the Commonwealth used various powers under the *Commonwealth Constitution Act 1900* to intervene in some famous environmental disputes, besides having its own more recent legislation. Under the new EPBC Act, the Commonwealth is empowered to intervene in six areas of national environmental significance, namely:

- the Commonwealth marine environment
- nuclear actions
- World Heritage properties
- Ramsar wetlands of international importance
- migratory species protected under international agreements, and
- nationally threatened species and communities.

The legislation does not have explicit powers to deal with the nationally significant issue of salinity, as two of the fundamental causes of salinity, land clearing and water allocation, are excluded as issues of national environmental significance. Other issues excluded from the 1999 legislation are greenhouse and climate change, native forests and sustainability.

Land clearance and climate change were listed as Key Threatening Processes (KTPs) under the EPBC Act. There is no automatic requirement for a Threat Abatement Plan under the EPBC Act, as existed under the old *Endangered Species Protection Act 1992*. Nevertheless, the way is now open for a Threat Abatement Plan for land clearing, which could involve (federal) legislation. Many consider that land clearing needs a suite of strict legislation similar to that being implemented for long-line fishing. The federal government would have had automatic power to intervene if land clearance had been added to the list of six matters of national environmental significance.

Four ecological communities occurring in Queensland and northern NSW were recently gazetted as endangered ecological communities under the EPBC Act. These are Brigalow; semi-evergreen vine thickets of the Brigalow belt (north and south) and Nandewar regions; bluegrass dominated grasslands of the Brigalow belt; and the community of native species dependant on natural discharge of groundwater from the Great Artesian Basin. These gazettals will mean that recovery plans will have to be developed for these four communities. It is ironic that much of the land clearing that caused the endangerment of at least three of these communities occurred in just the past few years.

Thus the framework exists for broader Commonwealth involvement in land clearing issues. Any Threat Abatement Plan would require State and Territory cooperation, particularly from Queensland and NSW, but there is provision for the Minister to prepare and implement plans nationally for KTPs if this cannot be done in cooperation with the States and Territories.

A New Approach to Property Management

Land and water degradation problems—dryland salinity, increased soil erosion, degraded river systems, poor water quality and loss of biodiversity—can be caused by over-clearing. Private lands hold the key to conserving biodiversity, as national parks and State forests alone are not sufficient. Thus farmers have a vital role to play in restoring degraded agricultural systems and in conserving biodiversity.

In a new approach, landholders could be required to develop Farm Plans under my proposed Sustainable Agriculture legislation in the States and Territories, to ensure cost-effective measures to rehabilitate the land. Legislation controls virtually every other facet of activity, and there are sound reasons to include farming enterprise under legislative control—a principal one being 'mutual obligation'—when public money is involved, there should be a parallel commitment to agreed outcomes by the recipients.

Under legislation proposed here, landholders would have to develop an integrated Farm Plan. The purpose of the Farm Plan is to maintain or restore the viability of the farm by taking a variety of measures to conserve and enhance native bushland, protect waterways, maintain or improve soil fertility and structure, and prevent erosion, salination and waterlogging. The Farm Plan would be submitted to a local Extension Officer employed by a Sustainable Agriculture Branch within the State/Territory Departments of Agriculture for discussion and approval. Extension Officers would have responsibility to ensure that individual plans were coordinated under Regional Plans. After approval, the landholder would take actions identified under the Farm Plan.

Financial assistance for works carried out under the Farm Plan could be provided in the form of tax deductions, tax concessions and direct grants. The type and extent of financial assistance to landholders is not discussed in detail here but indicative cost-sharing arrangements between landholders, private investors and governments for important elements of reparative activities is given in the Australian Conservation Foundation/National Farmers Federation sponsored report 'Repairing the Country'.[66] An Environmental Levy may be needed to fund the proposed changes. Such a levy could also be used to fund the program suggested in this paper, to repair the country environment.

Rick Farley and Philip Toyne have proposed that a one per cent National Landcare tax be imposed for the next 10 years to raise funds in the order of $30 billion. The idea of a 'Green Tax' is being supported increasingly. The bipartisan House of Representatives Standing Committee on Environment and Heritage, chaired by National Party MP the Hon Ian Causley, recently released a report 'Co-ordinating Catchment Management'. One of the recommendations was that the Government consider a National Environmental Levy to be put in place for 25 years. Subsequently, NSW Premier Bob Carr called for a referendum on a national green levy.

On 15 June 2001 the Treasurer, the Hon Peter Costello MP, announced that he will introduce amendments to taxation laws to ensure that private landholders who enter in

covenants to set aside part or all of their land for conservation in perpetuity will have their capital gains tax liability on that land reduced or eliminated.[67] He said that only those covenants entered into for consideration, which will enhance environmental values and which are approved by the Federal Environment minister will be eligible for the new tax treatment.

Revegetation to Benefit Farm Productivity and Biodiversity

The focus of the Farm Plan is farm productivity in perpetuity. The intention is that farm land be restored and rehabilitated in accordance with an agreed Farm Plan. As part of the Plan, a minimum percentage of 30 per cent of each farm should be set aside as native bushland and managed for wildlife values.[68] For many agricultural areas, other major issues of the region such as over-grazing, excessive burning, weed invasion and exotic pest control may have to be addressed in the Farm Plan. Where licences are involved, the minimum 30 per cent vegetation/revegetation requirement should be part of the licence agreement. The intention is that all properties should comply with the vegetation/revegetation and other requirements of the proposed Act.

Bushland would be fenced off to restrict grazing and contain native trees and understorey plants. The positions, sizes and shapes of the bushland would be dictated initially by where native vegetation occurs. Plantings are needed if no native vegetation occurs. Natural regeneration is preferred over plantings and plantings according to the Farm Plan are preferred over unplanned plantings. Plantings could increase the area of a vegetation patch, link patches of vegetation, and/or revegetate a river corridor.

The first priority is to retain what is left, even scattered trees in paddocks or degraded bushland remnants. Riparian areas should form the basis for the Plan, with fenced plantings of native tree and shrub species linking with existing remnants of vegetation. Remnants should be fenced off from stock and rehabilitated by natural revegetation or planting. Natural revegetation is generally quicker than planting and likely to include the right mix of local native species. The area reserved from farming should not just be the hillsides and ridge-tops with poorer soil and vegetation but include lower slopes and flats.

To achieve the minimum area of native bushland, the original remnants would usually have to be extended by plantings. There is no minimum patch size, but a desirable objective is a minimum of 10 hectares.[69] Native vegetation should not be 'tidied up' by removal of dead timber, which is an important resource for many native birds and other animals. Surface roughness and patchiness should be restored using rocks, logs, coarse litter and other debris.

Riparian vegetation is important wildlife habitat. Where creeks and drainage lines occur, the Farm Plan must address the issue of riparian vegetation, fencing off and revegetation with native species carried out where necessary. It is highly desirable that much of the

length of waterways is fenced off from stock; such fencing should be specified in the Farm Plan.

Some corridor plantings are valuable in linking remnants and allowing the movement of native birds and other animals. The best place for corridors is along creeks and drainage lines but landholders may choose to use an adjacent roadside or other corridor as a starting point for their own revegetation programs.

An excellent guide to enhancing revegetation activities for maximum benefits to wildlife is available.[70]

Measures of Success—Sustainability Indices and Focal Species

Revegetation efforts should be assessed to see if they have been successful in achieving their aims. Benefits for farmers include benefits for adjoining crops and pasture, for livestock production and provision of timber for firewood, fencing and brushwood. Other benefits could accrue from forestry: increased agricultural production from controlling land degradation both on-site and off-site; honey and beeswax collection; seed collection; aesthetics; habitat for animals that control pests; tourism and recreation; and other minor uses.[71]

From a conservation viewpoint, several methods can be used to assess the effectiveness of revegetation in improving the sustainability of existing remnants and in enhancing its value for wildlife. At the start of the program, remnant vegetation can be assessed using satellite imagery combined with on-ground inspections to determine its initial sustainability.[72] A high rating (Sustainability Index, SI, of 1) indicates highly sustainable remnant (with excellent chance of long-term survival) and woodland with high conservation value, through progressively lower ratings to SI 5, a remnant that is unsustainable under current management practice and with little conservation value. If remnant vegetation on farms is rehabilitated and enlarged, the Sustainability Index should improve, with more patches receiving a rating of SI 1 and SI 2; SI 3 trending towards SI 1 or SI 2, and SI 4 and SI 5 achieving at least a minimum sustainability of SI 3.

A second possible criterion is the continued presence of healthy populations of birds, as revealed by long-term studies. A species believed to be most limited by a particular factor (such as size and isolation) is referred to as a focal species. A measure of success would be the presence of focal species such as the rufous whistler and hooded robin.[73]

National Planning to Reverse Land and Water Degradation

The cost of degradation in rural landscapes has been estimated as at least $2 billion annually, and this figure is rising. Commonwealth expenditure relating to land and water degradation last year was around $500 million. This expenditure has increased awareness

and understanding of the problems but has not delivered strategic, long-term answers to problems such as salinity.

Even the expenditure of $200 million per annum by Commonwealth and State Governments announced in the Prime Minister's Salinity Action Plan in October 2000 is nowhere near the $6.5 billion in Government and private expenditure that the Australian Conservation Foundation and National Farmers Federation Report estimated is needed annually to combat salinity and other land and water degradation problems. The report 'Repairing the Country' prepared on behalf of ACF and NFF estimates that an investment of $6.5 billion per year for 10 years is required to implement the changes required to manage our land, water and vegetation sustainably. This consists of a capital investment of $60 billion and an ongoing maintenance program of $0.5 billion per year. Government expenditure of approximately $3.7 billion per annum over the next decade is needed, plus strategic partnerships with the community and the private sector.[74]

Some respected business and financial leaders are urging much greater incentives to halt land and water degradation and salinity, and to encourage efficient production by modern agribusinesses.[75] Former Reserve Bank Governor, Bernie Fraser, has urged the Government to reduce taxes on employment and investment and replace them with taxes on pollution and other practices with detrimental environmental effects.[76]

The implementation of Farm Plans throughout Australia is one step towards achieving ecologically sustainable development (ESD) in our rural lands. If we fail to take up the challenge, our rural productivity and biodiversity are highly likely to decline still further.

Conclusion

Australia is a biodiversity 'hot spot' with a high proportion of endemic species. Eighty-nine percent of the world's reptile species, 82 per cent of mammals and 43 per cent of birds occur only in Australia. Evidence has been presented that biodiversity is in decline in Australia, with all vertebrate groups affected.

Birds can be used as indicators of the health of the environment as there are large data sets on birds. A major wave of declines in previously-common birds is now occurring in the temperate agricultural zone, where land clearance has effectively ceased. The main reason for the declines is loss of habitat caused by over clearing of land for agriculture. The habitat fragments that remain after clearing are subject to further degradation, thus making them effectively smaller over time.

There is a lag between clearing and subsequent loss of bird species. This lag occurs because birds may be able to survive in fragments for some time but are lost when a further stress such as drought occurs. The fragmented patch of vegetation is not able to provide for their long term survival. Declines in woodland birds are often manifest as local extinctions leading to regional extinctions and contraction of range.

As a result of over-clearing, the evidence suggests clearly that much of the agricultural zone is experiencing land degradation in the form of salination, waterlogging, overgrazing, erosion, feral and woody weed invasions, loss of soil fertility and structure, acidification, soil compaction and changed hydrological dynamics. Despite land degradation, overall agricultural productivity, however, has not declined, as farming shifts to new areas or farmers crop and graze their better land more intensively. The underlying problem of land degradation means that productivity is not sustainable. Thus over-clearing of land results in a of loss of biodiversity and unsustainability of agriculture.

In a new approach, landholders could be required to develop Farm Plans under proposed Sustainable Agriculture legislation in the States and Territories, to ensure cost-effective measures to rehabilitate the land.

The focus of the Farm Plan is farm productivity in perpetuity. The intention is that farm land be restored and rehabilitated in accordance with an agreed Farm Plan. As part of the Plan, a minimum percentage of 30 per cent each farm should be set aside as native bushland and managed for wildlife values, with benefits for biodiversity and for agricultural sustainability.

Appendix 1: Bird Surveys Carried out by *Birds Australia*

The largest bird interest group in Australia is *Birds Australia* with approximately 6000 members. This organisation has been able to marshall thousands of volunteers to carry out bird surveys. Their main surveys have been the First and Second Atlases of Australian Birds, the Australian Bird Count, Birds on Farms and the Nest Record Scheme. The survey for the first Atlas was carried out in the period 1977–1981 culminating in a published report.[77] The Second Atlas (1997–2001) is currently underway, with a final report to Environment Australia planned for soon after August 2001. The Second Atlas, with data collected for each 1 degree grid square across Australia, is being carried out by some 5000 volunteers supported by Government funding from the Natural Heritage Trust. Such large, important datasets would be impossibly expensive to finance through normal research channels. It is important to recognise that Atlas data is not simply 'presence' but also an estimate of 'abundance'. The two Atlases therefore provide an excellent comparison of the changes that have occurred over the intervening 20 years and already some trends are emerging.

Appendix 2: Characteristics of Declining Woodland Birds and Regional Variations in Declining Species

It is important to note that declining woodland birds are not rare or threatened species, but rather those that were 'common' not long ago. Sedentary species tend to be harder hit by extensive land clearance than mobile species. The most affected species are characterised by feeding and dwelling on the ground and/or in low shrubs. Historically, they had large ranges, which are now being greatly reduced, at least in the sheep-wheat belt. They are now at risk of local extinction across extensive parts of the landscape. The pattern of events appears to be a decrease in local populations, leading to extinction in those areas, and contraction of the range to the most favoured locality for the birds. For instance, grey-crowned babblers are extinct in South Australia, very rare in Victoria and are declining at the edges of their range in NSW, but are still common in Queensland. Thus they are retreating to their most favoured habitat. Figure 6 shows the extent of woodlands in Australia.

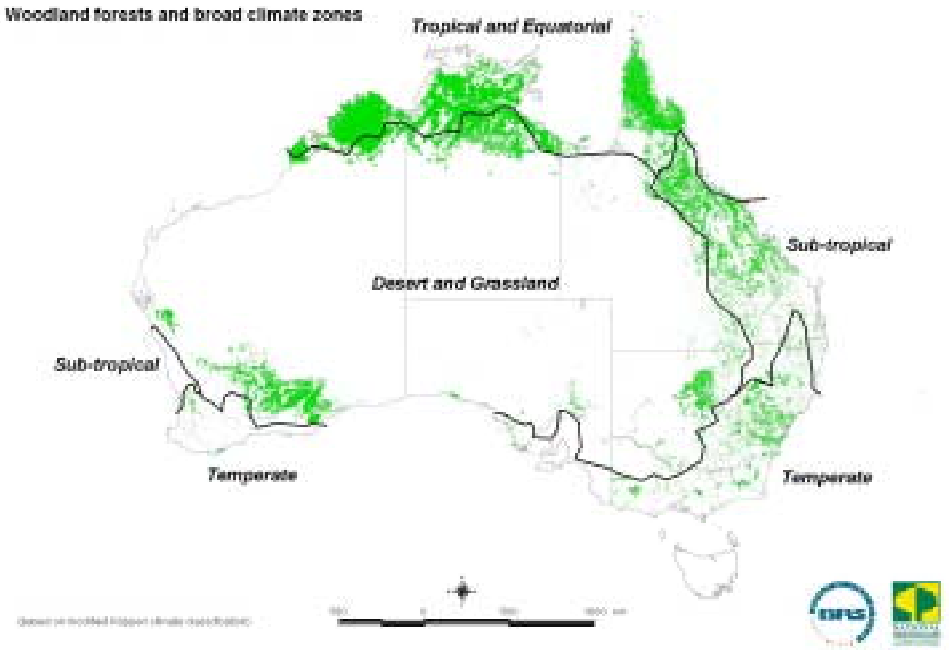

Figure 6: Distribution of Woodland Forests, by crown cover density
Source: National Forest Inventory (1997) and Bureau of Rural Sciences.

When present bird distribution and abundance has been compared with the extensive data from the First Atlas over an area of 285 square kilometres in the heart of the sheep-wheat belt, Reid[78] concluded that most woodland birds face serious problems in at least parts of their range as a consequence of wholesale clearing for agriculture. Altogether, 85 species or 35 per cent of native landbirds in the sheep-wheat belt were identified in at least one study to be locally extinct, declining or otherwise at risk.[79] On the New England

Tablelands of NSW, 47 per cent of landbird species found in dry forests and woodlands are in decline.[80]

In rural Victoria, 41 species of land bird are threatened and at least another 57 land bird species are declining, with local extinctions.[81] Victoria has decided to list the entire Victorian temperate-woodland bird community as threatened. The community includes 24 woodland-dependent birds, several of which have already been recommended for listing as Threatened.

The pattern of declines noted in the eastern States is repeated in the agricultural zone of Western Australia. Of 109 species of birds recorded in the WA wheatbelt, 50 per cent of all birds and 88 per cent of resident passerines have declined in range or abundance since European settlement.[82] Two species, Gilbert's whistler and thick-billed grasswren, have been lost from the wheatbelt, and different districts are showing individual losses. Three districts have lost 15 species of a recorded total of 131 with a further 24 declining in range and/or abundance. The previously-common purple-crowned lorikeet, restless flycatcher and yellow-plumed honeyeater are now rare vagrants in one district.[83]

About one third of the 300 species of native birds in the Mount Lofty Ranges near Adelaide are in serious decline.[84] The brown treecreeper, scarlet robin, restless flycatcher, diamond firetail and black-chinned honeyeater are now rarely seen. The list of decliners also includes the southern boobook, tawny frogmouth, sacred kingfisher and white-winged triller, while several Mount Lofty endemics such as the local forms of southern emu-wren, spotted quail-thrush and chestnut-rumped heathwren are classed as Critically Endangered or Endangered. Remnant vegetation in the Mount Lofty Ranges is less than 10 per cent of the original.

In Queensland, the Southern Brigalow Belt bio region is home to 328 species of birds; three of the species are listed as Endangered and 21 as Vulnerable or Rare. The paradise parrot is now extinct, and there have been local extinctions of squatter pigeons, turquoise parrots and black-throated and star finches.

The structure of savannahs ranges from open forests, through very open woodlands to open grasslands. The subtropical savannahs—grasslands with varying tree cover, occurring in Queensland and northeastern NSW, and including the Southern Brigalow Belt—have largely been cleared over the last 50 years, a process that is still continuing.[85] At least seven species of ground-feeding granivorous birds have substantially disappeared from these areas. These are:

Squatter pigeon	Black-throated finch	Diamond firetail
Paradise parrot (extinct)	Crimson finch	
Turquoise parrot	Star finch	

At least six of the seven were in decline in the nineteenth century or the first half of the twentieth century, the pastoral era prior to widespread clearance. Undoubtedly the full effects of recent clearing have yet to be revealed and further losses are likely.

The tropical savannahs of Queensland and the NT have largely escaped clearing up to the present. However, the declines associated with pastoralism noted in sub-tropical savannahs are now being seen in the tropical savannahs, and 15 species of birds are in decline:[86]

Emu	Black treecreeper
Chestnut-backed button-quail	Purple-crowned fairy-wren
Common bronzewing (decline in WA and NT only)	White-browed robin (decline in WA only)
Flock bronzewing	Star finch
Partridge pigeon	Crimson finch (decline in Queensland only)
Wonga pigeon	Chestnut-breasted mannikin (decline in Queensland only)
Princess parrot	Gouldian finch
Golden-shouldered parrot	

The bird species affected are those that feed on the ground or among herbage; many are seed-eaters. For once, land clearing is not to blame. The problems are most intense where cattle grazing is also most intense. Even quite low-intensity cattle grazing can affect seed production by grasses. In addition, the Aboriginal burning regime produced a finer-scale mosaic of burnt and unburnt patches that the present wholesale annual burning of many areas. Thus the causes of bird declines in tropical savannahs appear to be quite different from those in more temperate areas—they appear to be associated with pastoral activity and changes to Aboriginal burning regimes. However, the prospect of large increases in land clearing in northern Australia will undoubtedly have further repercussions on biodiversity. The current developments are not sustainable and it is very doubtful that they will prove viable in the longer term.

Losses are not confined to agricultural areas—preliminary data from the Second Atlas shows that the scarlet robin is only half as likely to be seen now in the forests and woodlands of southeastern Australia, generally coastwards of the Divide, as it was 20 years ago.[87] The Second Atlas data also shows that banded lapwing, black-shouldered kite, brown falcon, red-browed treecreeper, wedge-tailed eagle and emu are less common than 20 years ago, with regional variation.

Appendix 3: Why are Species Lost from Habitat Fragments?

The processes by which loss and fragmentation of habitat bring about bird declines are reasonably well understood. They stem from a consideration of the theory of island biogeography. Studies of islands have shown that species are lost from a recently-separated island in inverse proportion to its size and distance from the mainland. As applied to native vegetation habitat fragments—'islands' in a sea of agricultural land—we see that more bird species will be lost in smaller fragments and in those that are further from a large patch of similar habitat. When an 'island' is separated from the 'mainland', it initially contains more species than it is capable of holding. Species are lost over time, a process called species 'relaxation', until an equilibrium is reached, when there is no net loss of species. An alternative term is 'extinction debt'.

When an 'island' is separated, it contains only some of the complexity of the original; some animals and plants will be missing simply due to chance. Thus the new ecosystem will be less complex than the original, and so by its very nature is able to support fewer species, which are then lost from the system over time. For habitat 'islands', it is found that the edges become progressively degraded, thus reducing the effective size of the patch still further. The remaining fragmented patches of native vegetation are further degraded by various physical (temperature, wind), chemical (pesticide and fertiliser overspray) and biological (natural and exotic predators, people) agents at their edges, thus making them progressively smaller.

The proximate reasons for species loss from fragments vary between species, but important factors include:

- the inability of sedentary species to colonise or recolonise distant patches
- easier access for exotic and natural predators, requirement for a large and complex patch for survival
- lack of sufficient good habitat to act as a refuge in hard times, and
- too few individuals to form a genetically viable population.

The hooded robin has been identified as being at risk in all studies carried out in the sheep-wheat belt of NSW. Its habitat requirements are somewhat demanding; it needs complex areas of at least 100 ha, with plenty of fallen timber, for continued survival. Habitat fragmentation and the 'tidying up' of patches of bush by farmers contribute to its decline. Similarly, the speckled warbler requires a large, complex, 'untidy' area of some 100 ha for survival.

Although the requirements for some species may seem excessive, it must be remembered that the birds have been able to survive good and bad periods in the past by expanding their ranges in good seasons and contracting to 'refuge' localities in bad periods. When

much of their habitat has been removed, the birds are able to survive in small patches only until conditions worsen, when they are likely to die out in that locality. There is much anecdotal evidence of local extinctions following a bad drought, for instance. Birds such as the brown treecreeper are sedentary, and males rarely disperse from their natal area. They are virtually unable to recolonise habitat that is fragmented and are particularly vulnerable to local extinction in small habitat patches.

As habitat fragmentation continues, populations of sedentary species are themselves fragmented into smaller, more isolated units. These smaller populations then become more vulnerable to stress events such as drought, during which food shortage may lead to the death of adults or failure to breed. Once breeding fails, the probability of recruitment of new birds is extremely low, the chance of immigration being reduced by the isolation of the patch. Thus habitat fragmentation is the prime cause of decline and local extinction, with additional stresses such as droughts or failure of trees to flower delivering the final blow. Isolated populations have been shown to disappear from local areas following the 1981–83 drought.

The pattern of losses are often occurring very rapidly, in the space of a few decades. There are two reasons for the observed lag between land clearing and bird losses—birds are able to subsist in small fragments for some time before a catastrophic event causes them to die out, and small Australian passerines are often long-lived, a lifespan of 10 years being not unusual.

Many of Australia's birds are nomadic, in response to a generally favourable but erratic climate, bringing on the blossoming of trees and shrubs at different places and different times. Unfortunately, there are signs that the land-clearing presently occurring, especially in Queensland, will have disastrous effects on birds, with special impacts on a group little touched up to now—the honeyeaters. Thus the impact of over-clearing is not likely to be restricted to locally or regionally-occurring birds, but will have severe and detrimental effects on nomadic and migratory species such as honeyeaters, lorikeets, swift parrot, rufous whistler and white-throated warbler.

Appendix 4: Threatened, Endangered and Vulnerable Land Birds in NSW

Thirty-seven species of land birds are listed as Threatened (Endangered, E or Vulnerable, V) under NSW legislation.[88] These are:

Malleefowl (E)	Powerful owl (V)
Osprey (V)	Barking owl (V)
Square-tailed kite (V)	Masked owl (V)
Black-breasted buzzard (V)	Grass owl (V)
Red goshawk (E)	Striated grasswren (V)
Grey falcon (V)	Thick-billed grasswren (E)
Australian bustard (E)	Shy heathwren (V)
Plains-wanderer (E)	Redthroat (V)
Bush stone-curlew (E)	Regent honeyeater (E)
Flock bronzewing (E)	Purple-gaped honeyeater (V)
Squatter pigeon (E)	Painted honeyeater (V)
Red-tailed black-cockatoo (V)	Pied honeyeater (V)
Glossy black-cockatoo (V)	Pink robin (V)
Major Mitchell's cockatoo (V)	Southern scrub-robin (V)
Purple-crowned lorikeet (V)	Chestnut quail-thrush (V)
Superb parrot (V)	Red-lored whistler (E)
Regent parrot (E)	Gilbert's whistler (V)
Swift parrot (V)	Black-throated finch (E)
Turquoise parrot (V)	

Of these, 17 species occur in woodland.

Appendix 5: Bird Species with Stable or Increasing Populations in NSW

Twenty-nine native and seven introduced species have been diagnosed as stable or increasing in the NSW sheep-wheat belt.[89] The list is (introduced species are indicated*):

Nankeen kestrel	Yellow-throated miner	Australian magpie
Crested pigeon	White-plumed honeyeater	Pied currawong
Peaceful dove	Brown songlark	Australian raven
Galah	Rock dove*	Little raven
Little corella	Spotted turtle-dove*	White-winged chough
Sulphur-crested cockatoo	Skylark*	Richard's pipit
Cockatiel	House sparrow*	Zebra finch
Eastern rosella	Magpie-lark	Welcome swallow
Bluebonnet	Willy wagtail	Fairy martin
Red-rumped parrot	Black-faced cuckoo-shrike	European goldfinch*
Yellow-rumped thornbill	Black-faced woodswallow	Common blackbird*
Noisy miner	Pied butcherbird	Common starling*

This list should be viewed with some caution as two species, namely black-faced woodswallow and Richard's pipit, are in decline in some areas. Possible reasons for these losses are droughts and a general loss in complexity in agricultural land. Dying trees cut for firewood could adversely affect the black-faced woodswallow and other species. Another possibility is that these species may not be able to adapt to the intensification of agriculture that is now occurring in some marginal areas.

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