

# grow west

## Birds and Landscape Change:

Benchmarking study of birds in revegetated sites near Bacchus Marsh, Victoria.



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# Birds and Landscape Change: benchmarking study of birds in revegetated sites near Bacchus Marsh, Victoria.

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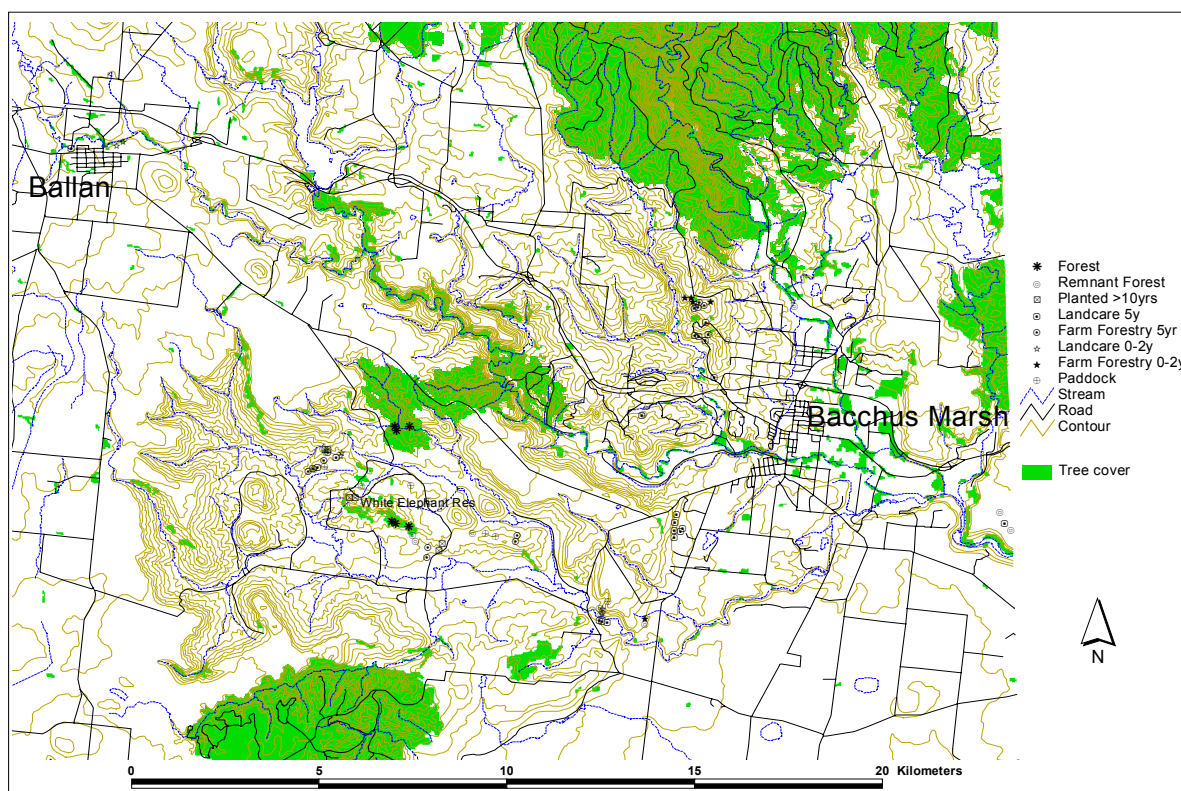
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## Summary

Bird surveys were conducted on 78 sites in the heavily cleared landscape near Bacchus Marsh (west of Melbourne, Victoria) to document the bird fauna in the early stages of the Grow West revegetation program. Surveys were conducted in summer 2005/06 and winter 2006. The sites represented eight habitats in the landscape (cleared farmland; landcare revegetation or farm forestry aged 0-2 years; landcare revegetation or farm forestry aged 4-8 years; revegetation aged 10-50 years; remnant forest patches in farmland; and extensive forest). Forest and woodland birds were most common in the latter three habitats, and their numbers increased with stand age in plantations. Open-country birds were most common in remnant forest patches (which they used for nesting and shelter) and were also common in paddocks (where they dispersed to feed), and less so in revegetation aged 0-2 years (with some exceptions, e.g. Richard's Pipit *Anthus novaeseelandiae*). Some bird species retain precarious footholds in the entire landscape, and were found at few sites in low numbers. Some of these species favoured revegetation aged 4-8 years (e.g. Zebra Finch *Taeniopygia guttata*) while others favoured forest sites or old revegetation. Implications for future landscape change are discussed.

## Introduction

This study was initiated as part of the Grow West program, an ambitious program being undertaken by the Port Phillip and Westernport CMA to help landholders re-establish native vegetation on private and public land in the low-rainfall heavily cleared landscape near Bacchus Marsh, in the low foothills west of Melbourne (Figure 1).



**Fig 1: Location of Grow West Program.**



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Loss of habitat is one of the main threats to biodiversity conservation in Australia as in most parts of the world. This process may be particularly severe in environments where new human colonists clear extensive tracts of land for agriculture, removing layers of perennial woody vegetation and replacing them with annual crops or grasses (often of exotic species), heavily grazed by domestic stock such as sheep and cattle. This is exactly what has happened over the last 150-200 years in the rolling hills and valleys west of Melbourne, including the current study area near Bacchus Marsh. Before European settlement, this area would have been dominated by grassy woodland, with some denser forest types in the hills and native grassland on volcanic plains at lower altitude. Most clearing happened in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, and produced a wide break between large remaining tracts of forest in the Lerderderg Gorge (connected to Wombat State Forest) and the drier environment of the Brisbane Ranges (north of Geelong). The clearing had many undesired consequences, including loss of habitat, invasion of exotic weeds, and severe soil erosion. Revegetation is often a key tool in addressing this threat, although much remains to be learned about its effectiveness in different situations (Hobbs 1993).

Local landholders and government agencies have initiated various programs to rectify these consequences in the Bacchus Marsh area. Measures have included revegetation of selected areas, initially to alleviate soil erosion. The former Soil Conservation Authority was active in these programs from the 1940s, and helped re-establish native woody vegetation in strategic areas such as the White Elephant Reserve. The current Grow West project builds and expands on previous efforts, on a larger scale. It aims to address many of the issues mentioned above, with a special focus on reducing weed infestations (notably Serrated Tussock-Grass *Nassella trichotoma*), reducing soil erosion and restoring biodiversity.

The Grow West project team identified the need to monitor effects of the program, so that its benefits could be assessed in future. One aspect was to establish a bench-mark of current biodiversity values, with special reference to vertebrate fauna. The team decided to focus on diurnal birds, because birds are highly mobile and may be expected to colonise suitable habitat relatively quickly: hence benefits could be seen in shorter time-frames than would be expected for less mobile fauna. The Arthur Rylah Institute for Environmental Research was commissioned to undertake this work, complementing concurrent work by them on fauna in commercial eucalypt plantations elsewhere in the state.

In developing the brief, it was decided that the bird study should do more than simply establish bench-marks for bird populations on sites that had been newly revegetated under the Grow West program. The existence of older revegetated areas offered an opportunity to assess how bird populations had responded to the development of that vegetation over time, through a retrospective or chronosequence approach. It was also recognised that data should be collected on sites that would remain as cleared farmland, and on sites that contained native woody vegetation. The overall aim was to describe the bird fauna of a bench-mark set of sites, and also to describe the bird fauna of eight classes of sites, namely:

- Cleared farmland (mainly pasture)
- Young revegetation established in 2005-06, as farm forestry plantations
- Young revegetation established in 2005-06, for amenity purposes (landcare)
- Revegetation or plantations established ~5 years ago (4-8 years), as farm forestry plantations

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- Revegetation or plantations established ~5 years ago (4-8 years), for amenity purposes (landcare)
  - Older revegetation established 10-50 years ago (all for amenity purposes)
  - Native forest or woodland (small remnants in farmland)
  - Native forest or woodland (extensive areas, including remnants now embedded in old revegetation in the White Elephant reserve).

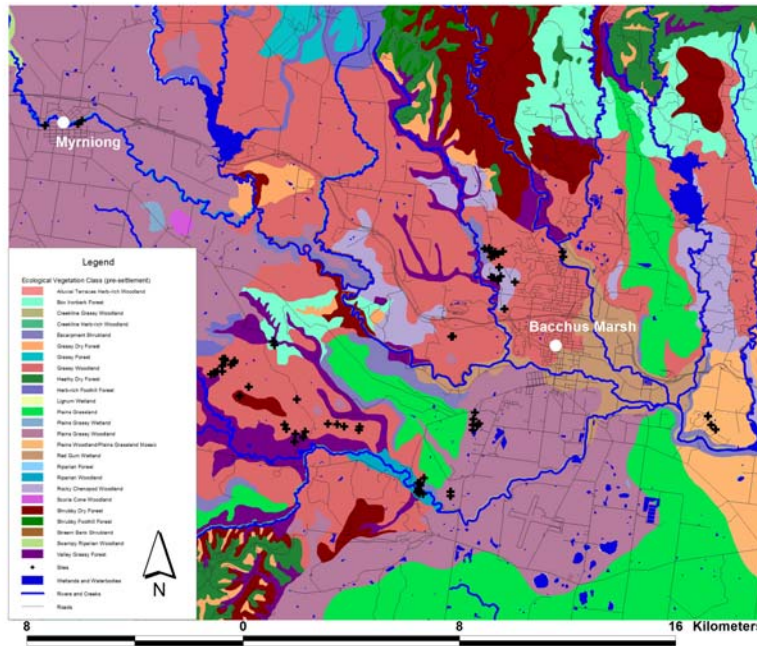
In practice, few small remnants were found within the study area, and the two adjacent areas of extensive forest (Lerderderg Gorge and Brisbane Ranges) differed greatly in terms of natural vegetation (Ecological Vegetation Class) and geomorphology. Hence a decision was made to select sites mainly in areas of comparable landform and geology. Some such areas were located on public and private land on the south-western fringe of the Lerderderg Gorge, but no observations were made in more disparate areas of forest such as the Brisbane Ranges or Long Forest.

### **Study Area**

The study area is centred on Bacchus Marsh, north-west of Melbourne, Victoria, and includes rolling hills and valleys above the volcanic Werribee Plains. Elevations vary from 100 to 500 m above sea level. Geology is complex, including basalt lava flows from volcanic activity ~6,000 years ago, and ancient (Pre-Cambrian) sediments. A fault line crosses the study area.

The climate is temperate, with warm to hot summers and cool winters. Rainfall is generally low, <500 mm per year, and falls mainly in winter and spring.

Before European settlement the vegetation was dominated by Grassy Woodland and Plains Grassy Woodland (Ecological Vegetation Classes, as recorded in the DSE database), with Grey Box *Eucalyptus microcarpa* and Yellow Gum *E. leucoxylon* as dominant tree species (Figure 2). Riparian Woodland grew along watercourses, with River Red Gum *E. camaldulensis* as the dominant tree species. Much of the grassy woodland has been cleared, though some remains near Ingliston, on private and public land adjacent to the Lerderderg Gorge.



**Figure 2. Pre-1750 Ecological Vegetation Classes near Bacchus Marsh, as estimated from geology, topography and remaining native vegetation (DSE data).**

## Methods

Sites were selected in consultation with Grow West staff and landholders. Altogether 78 sites were included in the study, representing the eight main habitats (Appendix 1).

Surveys of diurnal birds were conducted at each site, using a timed area-search method (Loyn 1986), covering 1 ha in 10 minutes. The observer walked around the site, noting numbers of individual birds of each species heard or seen, on or off the site. When more than one search was conducted at a site in a particular season, mean values were used in analysis. Notes were also made of birds seen or heard in the region but not on formal counts.

Basic habitat data were collected at each site, and locations were recorded using GPS. Sketch maps were prepared, and photographs taken from the centre of each site.

Surveys were conducted from 23 November 2005 to 19 January 2006 (summer), and from 23 May to 29 June 2006 (winter). One forest site (GW31) and one paddock site (GW176) were surveyed in summer and not winter. One 10+ year planted site (GW73) and a second paddock site (GW178) were surveyed in winter not summer. The two paddock sites were close enough to each other to be considered as a single site in subsequent analysis. All other sites were surveyed in both seasons, with 95 surveys completed in summer and 93 surveys completed in winter.

## Analysis

Bird species were classified into guilds on the basis of their main habitats, feeding modes, nest sites, migratory behaviour and local status (Appendix 2). For each search, the numbers of birds in each guild was calculated by summing the number of individual birds of each species that constituted the guild. Some guilds were represented by too few individual birds (e.g. brood parasites) to be considered in formal analysis.

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Sites were categorised according to the eight main habitats. Mean values of each species and guild were calculated for each site in summer and winter separately, and for the combined seasons.

Data on major guilds were analysed further using analysis of variance. The dependent variable in each case was the mean number of birds per site-search for each season. Explanatory variables were site and season (“site stratum”) and then habitat and seasonal interaction (“habitat stratum”). Thus the analysis considered two seasons (summer and winter), eight habitats (cleared farmland, 0-2 year landcare plantings, 0-2 year farm forestry plantings, 4-8 year landcare revegetation, 4-8 year farm forestry, 10+ year landcare revegetation, native forest remnants in farmland and extensive or embedded native forest) and the interaction between habitat and season.

A secondary analysis was also done for 45 sites with 0-2 year plantings and 4-8 year revegetation. This used generalised linear modelling to examine effects of plantation purpose (landcare or farm forestry) on mean density (abundance) of each guild. Data from both seasons were combined for that analysis.

## **Results**

Altogether 106 bird species were observed in the region during the study (Appendix 2). Of this total, 83 species were observed on sites during formal counts. The remaining 23 species were observed off-site or incidentally during the course of the study.

### Responses to Habitat

Mean densities of species and guilds in each habitat are shown in Appendix 1. Total bird density was higher in remnant forest patches than elsewhere ( $p < 0.001$ ), and these patches supported a combination of bird species classed as forest and woodland birds or as open country birds. Sites revegetated 10-50 years ago supported higher total bird densities than extensive forest, but younger age-classes of plantation supported fewer birds. Forest and woodland birds dominated the fauna of all plantations older than the 0-2 year age-class, whereas open country birds dominated the fauna of paddocks and 0-2 year plantations. These groups are considered separately below. Some guilds tended to be more common in landcare revegetation than farm forestry plantations of equivalent age (Appendix 1). However, none of these differences were significant at conventional levels of  $P < 0.05$ .

Forest and woodland birds were most numerous in the two classes of native forest (remnants and extensive forest) and in the sites revegetated 10-50 years ago ( $p < 0.001$ ). Among these three habitats, observed densities were lower in extensive forest than in remnants or sites revegetated 10-50 years ago. However, the species composition in sites revegetated 10-50 years ago was more similar to extensive forest than to remnants. The commonest forest and woodland birds in remnant forest patches were White-plumed Honeyeater *Lichenostomus penicillatus* (especially where there were River Red Gums), Red-browed Finch *Neochmia temporalis* and Superb Fairy-wren *Malurus cyaneus*, and only the latter was common in plantations or extensive forest (Fig 3).





**Fig 3: The White-plumed Honeyeater, Red-browed Finch and Superb Fairy Wren, (Photos: © The State of Victoria, Department of Sustainability and Environment/McCann) (L-R) were among the more common forest and woodland birds in remnant patches**

In contrast, the other two habitats supported a more diverse suite of insectivores and other species (Appendix 1). Forest and woodland birds were substantially less common in sites planted 4-8 years ago, and even more scarce in paddocks and sites planted 0-2 years ago. Similar patterns were shown by many of the constituent species (Appendix 1).

Insectivorous forest and woodland birds that feed from shrub layers, damp ground or open ground among trees tended to be less common in remnant forest patches than in extensive forest or in sites revegetated 10-50 years ago. Bark-foraging insectivores were scarce in the general landscape, and only found in extensive forest and 10-50 year plantations. Hollow nesters were dominated mainly by parrots and cockatoos classed as open country birds, and are discussed with them below.

Open-country birds were most common in patches of remnant forest, and least common in extensive forest where none was recorded during these surveys. They were also common in paddocks, and became progressively less common in older ages of plantation (Appendix 1). The pattern varied between constituent guilds and species. Two ground-nesting birds (Richard's Pipit *Anthus novaeseelandiae* and the introduced Skylark *Alauda arvensis*) were more commonly found in 0-2 year plantations than in paddocks, although they occurred widely in paddocks as well, and an aerial insectivore (Welcome Swallow *Hirundo neoxena*) was markedly more common in paddocks than other habitats. Many open-country birds feed in paddocks but depend on trees or shrubs for shelter and nesting, and they were common in patches of remnant forest. Examples include Yellow-rumped Thornbill *Acanthiza chrysorrhoa* and many of the parrots and cockatoos. The latter formed a high proportion of hollow nesters, which were markedly more numerous in patches of remnant forest than in other habitats. Many open country birds occurred in 0-2 year plantations, but at lower densities than in open paddocks (Appendix 1). Only a few species persisted into older plantations: the main examples were Willie Wagtail *Rhipidura leucophrys*, Australian Magpie *Gymnorhina tibicen* and four introduced bird species (Skylark, House Sparrow *Passer domesticus*, European Goldfinch *Carduelis carduelis* and Common Starling *Sturnus vulgaris*).

The introduced species only occurred where the plantations contained open grassy areas. Altogether introduced birds formed 5% of the total bird community observed in paddocks, 26% in 0-2 year plantations, 20% in 4-8 year plantations, 5% in 10-50 year plantations, 20% in remnants and 0% in extensive native forest or forest patches patches embedded in older plantations.

#### Effects of Season

Mean counts for summer and winter are shown in Appendix 2, based on 76 sites that were surveyed at each season. Slightly more birds were recorded per count in winter than summer, but the difference was not significant at conventional levels ( $p > 0.05$ ). Few guilds

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showed a marked seasonal change, with the obvious exception of summer visitors (Appendix 2).

Some species were mainly summer visitors to the study area (Appendix 2) and two species were winter visitors (Flame Robin *Petroica phoenicea* and Spiny-cheeked Honeyeater *Acanthagenys rufogularis*). One anomalous observation may indicate that migration was still in progress during one of the early winter surveys. Large flocks of Welcome Swallows (100, and 40 on a subsequent count) and a few Tree Martins *Hirundo nigricans* were observed at a farmland site in winter (22 May 2006), perching in a retained tree and foraging over the crop. They were not visibly migrating at the time, but could well have paused at this site during a longer migration (perhaps from Tasmania, where both species are rare or absent in mid winter). This record inflated the winter counts for these species and the guild of aerial foragers in cleared farmland.

Significant interactions were found between season and habitat for forest and woodland birds ( $p < 0.001$ ) and four feeding guilds (Appendix 3). Forest and woodland birds showed a marked contrast in seasonal pattern between remnant forest patches in farmland and extensive forest: they were more common in summer than winter in extensive forest, the reverse applied in remnant forest patches and little seasonal change was observed in plantations or paddocks. Canopy-foraging insectivores also declined for the winter in extensive forest, and increased in remnant forest. In addition, they declined for the winter in older plantations and increased in younger plantations ( $P < 0.001$ ). Insectivores that feed from tall shrubs showed winter decreases in extensive forest and older plantations, and winter increases in remnant forest ( $P < 0.001$ ). Nectarivores were more common in winter than summer in all habitats, but the magnitude of the change varied between habitats and was greatest in older plantations ( $P = 0.015$ ). Birds that feed on seeds taken close to the ground showed winter increases in remnant forest and older plantations and winter decreases in young plantations and paddocks ( $P < 0.001$ ): this guild was scarce in extensive forest.

Some species used habitats differently in the two seasons, generally moving to more open areas in the winter. For example, three Jacky Winters *Microeca fascians* were found with Flame Robins catching insects in pasture close to trees during a winter survey, whereas otherwise this species was only recorded as a scarce resident in open forest habitats.

## Discussion

The study has given a snapshot of the bird community in a heavily cleared landscape where the Grow West program has accelerated a process to restore tree cover in selected areas. Long term benefits can be expected from the program, for biodiversity as well as for other aspects of landscape health and sustainability. Long term monitoring is needed to assess these benefits, and the current project has helped spawn a new monitoring project to be run by Birds Australia, as part of a broader national monitoring program (M. Antos and M. Weston, pers. comm.). This will involve repeated assessment of bird populations at many of the sites included in the current study.

Results of the current study allow some comments to be made about the state of the bird community in this landscape, and the significance of seasonal patterns. They also allow predictions to be made about likely changes over time, based on the use of different types of habitat and successional stages of revegetation. These topics are considered below. Further analysis is planned to assess effects of particular habitat and landscape variables on

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bird fauna within plantations, as part of a broader study of fauna in eucalypt plantations, by ARI with support from the national Joint Venture Agroforestry Program and Natural Heritage Trust. Some comparisons are made below with data collected from eucalypt plantations and adjacent habitats elsewhere in the State.

### Bird Community

A picture of the bird community is given in the Appendices in this report. Here it is useful to draw attention to some of the species that were common in particular habitats, or that were surprisingly scarce or absent from the whole landscape. The mix of species in the general landscape was much as expected from published information about the birds in this part of Victoria (e.g. Emison *et al.* 1987; Hewish *et al.* 2006).

The commonest species in revegetated sites were Superb Fairy-wren, New Holland Honeyeater *Phylidonyris novaehollandiae* and Brown Thornbill *Acanthiza pusilla*. Other common birds included Yellow-rumped Thornbill, Tree Martin, Red-browed Finch, Spotted Pardalote *Pardalotus punctatus*, Rufous Whistler *Pachycephala rufiventris*, Silveryeye *Zosterops lateralis* and Weebill *Smicrornis brevirostris*, and the introduced European Goldfinch. Weebills were most common in remaining forest and old revegetation in the White Elephant Reserve, though small numbers were found at a range of sites. Tree Martins occurred mainly in association with large remnant trees, which provided the hollows needed for nesting, although they foraged widely over a range of habitats.

Several birds typical of dry woodland habitats were found locally in small numbers. They included Brown Treecreeper *Climacteris picumnus*, Restless Flycatcher *Myiagra inquieta*, Jacky Winter, Speckled Warbler *Chthonicola sagittata*, White-winged Chough *Corcorax melanorhamphos* and Diamond Firetail *Stagonopleura guttata*. Most were in remnant forest but Restless Flycatchers were observed mainly in 4-8 year revegetation. Speckled Warblers were found in remnant Grey Box

woodland on the White Elephant Reserve, interspersed with areas revegetated up to 50 years ago. Two groups of White-winged Choughs were found in the White Elephant Reserve, presumably using remnant forest and revegetated areas within their large home range: this species was not observed during formal counts. Several forest birds (e.g. White-throated Treecreeper *Cormobates leucophaeus*, Scarlet Robin *Petroica multicolor*, Striated Thornbill *Acanthiza lineata* and Buff-rumped Thornbill *A. reguloides*) were found locally in small numbers, mainly in the more extensive remaining tracts of forest or in older plantations.



**Fig 4: A number of species were found which are common on a statewide basis but are regarded as maintaining a precarious foothold at the local level: (L-R) White-throated Treecreeper, Scarlet Robin, Buff-rumped Thornbill, (Photos: © The State of Victoria, Department of Sustainability and Environment/McCann).**

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They are common species state-wide, but maintain a precarious foothold locally. Many of both groups of species are likely to benefit over time from increased forest cover through the Grow West project (Fig 4).

One nationally endangered species, the Swift Parrot *Lathamus discolor*, was observed during the study on 29 May 2006. At least five of these birds were heard calling and then seen in planted trees in a residential garden close to sites on Morton's Road in Pentland Hills (C. Silveira). The trees included Manna Gums *E. viminalis*, Yellow Gums *E. leucoxylon* and Lemon-scented Gums *E. citriodora*, all planted in 1981 (A. Evans pers. comm.), as well as possibly some remnant Grey Gums *E. cypellocarpa*. Unfortunately it was not possible to confirm what the birds were feeding on. Swift Parrots are winter visitors to Victoria from Tasmanian breeding areas, and their main winter food includes lerps and the blossom of various eucalypts with Yellow Gum a highly favoured species (Higgins 1999).

Common birds in open country included Galah *Cacatua roseicapilla*, Red-rumped Parrot *Psephotus haematonotus*, Richard's Pipit, Australian Magpie, Little Raven *Corvus mellori* and the introduced Skylark. Some less common birds such as Rainbow Bee-eater *Merops ornatus*, Brown Songlark *Cinchoramphus cruralis* and White-fronted Chat *Epthianura albifrons* were encountered locally in open habitats and Zebra Finches were found in several sites, mostly with sparse revegetation aged 4-8 years. Many revegetated sites contained mosaics of open and shrubby areas, quite different from the uniform structures often associated with commercial plantations, and these will benefit some species.

Birds of prey were common and diverse (12 species) over much of the area, making obvious use of the mosaic of habitats and landforms. Wedge-tailed Eagles *Aquila audax* were conspicuous; Brown Falcons *Falco berigora* and Australian Kestrels *F. cenchroides* were common and other species were Little Eagle *Hieraaetus morphnoides*, Swamp Harrier *Circus approximans*, Whistling Kite *Haliastur sphenurus*, Black Kite *Milvus migrans*, Black-shouldered Kite *Elanus axillaris*, Brown Goshawk *Accipiter fasciatus*, Collared Sparrowhawk *A. cirrhocephalus*, Peregrine Falcon *F. peregrinus* and Australian Hobby *F. longipennis*. Some birds were notable by their rarity or absence from the entire landscape, although they are common in similar landscapes elsewhere in the State. No Noisy Miners *Manorina melanocephala* or Grey Butcherbirds *Cracticus torquatus* were observed: these species are often found together in fragmented forests in farmland (Loyn 1987, 2002; Grey *et al.* 1997), and have a patchy distribution in western Victoria (Emison *et al.* 1987; Hewish *et al.* 2006). Laughing Kookaburras *Dacelo novaeguineae*, White-winged Choughs and Grey Currawongs *Strepera versicolor* were rare, and the latter two were mainly found in the White Elephant Reserve. Australian Ravens *Corvus coronoides* were not recorded, and are apparently confined to extensive forest tracts in the general area (e.g. Brisbane Ranges and Long Forest, M. Hewish pers. obs.). Some birds that are common in wetter forests (including Wombat Forest to the north) were absent or rare: examples include White-eared and Crescent Honeyeaters, and Pied Currawong. These species all occur as winter visitors in dry forest or woodland south of Wombat State Forest, including Lerderderg Gorge (M. Hewish pers. obs.), but apparently not in the study area.

#### Seasonal Patterns

Several studies have identified a seasonal pattern involving winter exodus of small insectivores from forests, especially wet forests (Loyn 1985; Emison *et al.* 1987). Some species vacate forests completely in winter (e.g. Flame Robin) while others vacate wet



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forests but can be found all year in drier or more open habitats (e.g. Golden Whistler *Pachycephala pectoralis* and Grey Fantail *Rhipidura fuliginosa*). Similar observations have been made locally in the Long Forest (Hewish *et al.* 2006), with several species moving into more open habitats for the winter: these include Common Bronzewing *Phaps chalcoptera*, Crimson Rosella *Platycercus elegans*, Eastern Spinebill *Acanthorhynchus tenuirostris*, Jacky Winter, Scarlet Robin, Golden Whistler, Grey Shrike-thrush *Colluricincla harmonica* and Restless Flycatcher. The present study identifies remnant vegetation patches and (for some species) young eucalypt plantations as two habitats that may help support these birds over winter (Fig 5). These open habitats tend to be sunnier than extensive forests, and may support higher levels of insect activity even on cool or cloudy days. But in summer, the extensive forests are likely to provide higher levels of productivity and diversity needed to sustain breeding populations.



**Fig 5: Species such as the Golden Whistler and the Scarlet Robin, (Photos: © The State of Victoria, Department of Sustainability and Environment/McCann) (L-R) may be supported over winter by small remnant patches and young plantations.**

These results show that establishing new areas of tree cover under the Grow West program, may have benefits beyond the boundaries of the revegetated areas, by providing habitat for birds that have seasonally vacated areas of extensive forest in the broader landscape.

#### Likely Changes over Time

Before European settlement, much of the study area is believed to have been covered by various types of Grassy Woodland, as well as some open treeless plains. This habitat has been heavily cleared and modified in many parts of Australia (McIntyre *et al.* 2002). Some of its characteristic bird species have declined greatly (Ford and Barrett 2001), and early concern about this decline was raised with specific reference to Toolern Vale on the edge of our study area (Robinson 1993). Some of these species are still present in the landscape, but locally and in extremely low numbers, as discussed above.

Some of these species may benefit from increased tree cover over time. However, most remained rare in revegetation aged 4-8 years, and would be expected to benefit more when replanted areas grow to a much older stage (as with the 50-year stands in the White Elephant Reserve). The best chance of catering for these birds is to manage selected plantings specifically to provide the desired open forest structures over a time-period of 20-50+ years. This may be expected to happen with landcare amenity plantations, but not with farm forestry plantations, which will generally be harvested at an earlier stage. This is the most fundamental difference between the two types of plantation, and the present results suggested that there were rather few differences in habitat value of the two types of plantation in the early years. Some forest birds will clearly benefit from plantation establishment at an earlier stage, and many forest birds were more common in 4-8 year regrowth than in younger stands. One species that favours stands of that age elsewhere in the State is the White-eared Honeyeater (Loyn *et al.* in review): this species was notable by its absence in the current study. Connectivity may be an issue for some birds, especially

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the small insectivores, as their capacity to cross large areas of cleared land is not known in many cases. The Grow West program may help some species colonise new habitat over time by providing new connections.

The landscape is expected to remain essentially agricultural, and open-country birds will continue to be common. However, it is important to note that most of those birds depend on remnant vegetation for shelter and nest sites, and remnant patches of forest (as well as newly planted areas when they are old enough) will continue to be an essential part of the habitat for many species. Other species favour mosaics of shrubs and open country (Zebra Finch being one example) and may benefit from continued replenishment of such habitats through rotational management of selected plantations. We also note that recently established plantations support fewer open-country birds than cleared farmland, as many of these species feed from sparse or short swards of grass rather than the dense stands of grass that typically develop when new plantations are protected from grazing. However, the young plantations appear to be attractive to at least two ground-nesting birds (Richard's Pipit and the introduced Skylark), which may benefit from the increased cover of grasses and shrubs (Fig 6). Hence the initial effect of plantation establishment may be to reduce numbers of many open-country birds, while providing improved habitat for particular species such as these ground-nesters.



**Fig 6: Young plantations appear to favour ground nesting birds such as Richard's Pipit, (Photos: © The State of Victoria, Department of Sustainability and Environment/McCann).**

#### Comparisons with Studies Elsewhere

Our studies of plantations elsewhere in the State have focused mainly on commercial eucalypt plantations (Loyn *et al.* in review), and other studies have examined plantations established for a range of purposes in different parts of Australia (e.g. Law and Dickman 1998; Law and Kavanagh 1998; Ryan 2000; Klomp and Grabham 2001; Kavanagh *et al.* 2001; Rossi 2003; Hobbs *et al.* 2003; Catterall *et al.* 2004; Kinross 2004; Vesk and Mac Nally 2006). The current results highlight some important differences, which will be analysed further. One that deserves comment in this report relates to the proportion of introduced birds. Introduced birds were found to be a very minor component of commercial plantations elsewhere, but were quite common in some of the plantations examined in this study. This was especially true when the plantations contained open grassy areas where particular tree or shrub species had regenerated poorly. Their use by introduced birds is likely to decline as the stands develop, and evidence for this came from the current results, so this situation should not be viewed as necessarily undesirable. Indeed, the open structures may prove useful to various bird species when the stands develop over time, as discussed above.

Further analysis will be undertaken to examine ways in which plantation management can benefit certain groups of native birds in various types of landscape, using data from this and other studies.

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## Acknowledgements

Many landholders provided willing access to their properties, and in many cases their hard work in planting trees provided the habitats we studied. Jennifer Sheridan (Department of Primary Industries) commissioned the project and participated in it through site selection. John Forrester and other DPI/ Grow West staff at Bacchus Marsh provided support and interest. Allan May of Moorabool Shire encouraged us to work on Shire land. Richard Hartland happily shared his knowledge and showed us round the White Elephant Reserve, and PV staff at Bacchus Marsh provided advice on nearby parks. Funds were provided to Grow West by the Natural Heritage Trust.

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**Appendix 1. Mean abundances of bird species and guilds (birds per 100 counts) in eight main habitats on 78 sites near Bacchus Marsh, Victoria, across two seasons (summer and winter) 2005-06.**

- # pad = paddock
- ff = farm forestry
- lc = landcare
- rem = remnant forest patch in farmland
- for = extensive forest or remnant embedded in older revegetation (White Elephant Reserve).

P values are given for guilds, showing significance of difference between habitats, unless data were inadequate for formal analysis (##).

Habitat #:	pad	ff	lc	ff	lc	lc	rem	for
Plantation age (years):		0 to 2	0 to 2	4 to 8	4 to 8	10+		
Species								
Common Bronzewing	0	27	0	7	20	38	4	0
Dusky Moorhen	0	0	0	0	0	0	4	0
Masked Lapwing	5	0	16	0	0	0	15	0
Straw-necked Ibis	0	0	0	0	7	0	0	0
White-faced Heron	0	0	5	0	0	0	0	0
Australian Wood Duck	0	0	37	0	0	0	0	0
Pacific Black Duck	0	0	5	0	0	0	0	0
Brown Goshawk	0	0	0	0	2	0	0	0
Wedge-tailed Eagle	0	9	5	0	0	0	0	0
Little Eagle	0	9	0	7	2	0	0	0
Whistling Kite	0	0	0	3	0	0	0	0
Black Kite	0	9	0	0	0	0	0	0
Australian Hobby	0	0	0	3	0	0	4	0
Brown Falcon	5	0	0	7	0	0	7	0
Australian Kestrel	15	0	0	0	6	0	0	0
Purple-crowned Lorikeet	0	0	0	0	7	31	26	0
Sulphur-crested Cockatoo	5	0	0	0	0	0	74	0
Long-billed Corella	0	0	0	0	0	0	52	0
Galah	10	0	21	0	4	0	38	0
Crimson Rosella	5	0	26	24	15	100	35	20
Eastern Rosella	15	0	0	0	0	0	44	0
Red-rumped Parrot	50	0	0	3	7	0	174	0
Fan-tailed Cuckoo	0	0	0	0	0	0	0	10
Horsfield's Bronze-Cuckoo	5	9	0	3	0	0	0	0
Shining Bronze-Cuckoo	0	0	0	0	0	8	0	0
Welcome Swallow	505	0	32	0	15	8	37	0
Tree Martin	70	0	26	41	43	8	56	0
Fairy Martin	0	45	0	0	0	0	0	0
Grey Fantail	0	0	21	3	4	46	22	100
Willie Wagtail	20	0	32	3	2	15	41	0
Restless Flycatcher	0	0	0	7	0	8	0	0
Jacky Winter	0	0	0	0	0	0	11	0
Scarlet Robin	0	0	0	0	0	0	4	0
Flame Robin	10	0	0	3	4	0	0	0
Yellow Robin	0	0	0	7	4	23	0	30
Golden Whistler	0	0	5	7	4	0	7	0

<b>Habitat #:</b>	<b>pad</b>	<b>ff</b>	<b>lc</b>	<b>ff</b>	<b>lc</b>	<b>lc</b>	<b>rem</b>	<b>for</b>
<b>Plantation age (years):</b>		<b>0 to 2</b>	<b>0 to 2</b>	<b>4 to 8</b>	<b>4 to 8</b>	<b>10+</b>		
<b>Species</b>								
Rufous Whistler	0	0	0	7	0	54	11	20
Grey Shrike-thrush	0	0	0	7	6	15	11	0
Magpie-lark	0	0	0	0	0	0	19	0
Crested Shrike-tit	0	0	0	0	0	0	4	0
Black-faced Cuckoo-shrike	0	0	0	0	0	0	4	0
Weebill	0	0	0	14	26	54	0	10
Southern Whiteface	15	0	0	3	0	0	0	0
Striated Thornbill	0	0	0	0	13	0	0	60
Yellow Thornbill	10	0	21	0	20	31	22	0
Brown Thornbill	0	0	21	55	6	123	11	170
Buff-rumped Thornbill	0	0	0	0	0	46	4	60
Yellow-rumped Thornbill	160	0	116	21	122	46	107	0
White-browed Scrubwren	0	0	16	21	4	0	7	30
Speckled Warbler	0	0	0	0	0	0	4	20
Brown Songlark	0	0	0	0	4	0	0	0
Little Grassbird	0	0	0	0	0	0	4	0
Superb Fairy-wren	5	0	100	169	211	177	174	200
Dusky Woodswallow	0	0	0	0	0	0	19	0
Brown Treecreeper	0	0	0	0	0	0	7	0
White-throated Treecreeper	0	0	0	0	0	8	4	80
Mistletoebird	0	0	0	0	0	8	0	40
Spotted Pardalote	0	0	0	14	28	62	89	80
Silveryeye	0	0	68	10	42	38	159	0
White-naped Honeyeater	10	0	0	0	0	8	30	0
Brown-headed Honeyeater	0	0	0	0	13	31	52	40
Eastern Spinebill	0	0	0	0	0	0	0	70
Yellow-faced Honeyeater	0	0	0	10	2	77	33	80
White-plumed Honeyeater	10	45	0	10	21	15	222	0
New Holland Honeyeater	40	0	11	38	36	477	130	0
Red Wattlebird	10	0	21	10	11	46	52	0
Spiny-cheeked Honeyeater	0	0	0	0	4	0	7	0
Richard's Pipit	20	127	0	41	2	0	0	0
Diamond Firetail	0	0	0	0	0	0	4	0
Zebra Finch	0	0	0	0	13	23	0	0
Red-browed Finch	0	45	105	31	39	54	215	0
Australian Magpie	20	0	32	24	15	38	38	0
Little Raven	0	0	0	0	0	8	0	0
Striated Pardalote	5	0	5	3	7	23	48	10
Spotted Turtle-Dove	0	0	0	0	2	8	4	0
Blackbird	0	0	21	7	6	23	7	0
Skylark	5	218	0	97	63	0	0	0
House Sparrow	10	0	63	17	41	0	337	0
European Goldfinch	15	18	32	31	56	62	19	0
European Greenfinch	0	9	0	0	2	0	0	0
Common Myna	0	0	0	0	4	0	22	0
Common Starling	0	55	0	0	17	8	115	0
<b>Guilds</b>								
<b>Total birds (P&lt;0.001)</b>	<b>965</b>	<b>655</b>	<b>871</b>	<b>701</b>	<b>967</b>	<b>1833</b>	<b>2640</b>	<b>1067</b>

Forest & woodland birds (P<0.001)	204	130	421	455	583	1621	1444	1067
Open-country birds (P<0.001)	777	505	357	236	374	213	1167	0
Bark-foraging insectivores (P<0.001)	0	0	0	0	0	8	15	83
Canopy-foraging insectivores (P<0.001)	13	10	29	44	79	208	175	250
Insectivores from tall shrubs (P<0.001)	6	0	36	49	27	138	47	158
Insectivores from damp ground or low shrubs (P=0.676)	0	0	29	33	13	46	13	42
Insectivores from open ground (may be far from trees) (P=0.260)	291	415	182	186	215	100	332	0
Insectivores from open ground among trees (P=0.009)	6	0	111	168	201	217	161	292
Nectarivores (P<0.001)	81	40	29	68	96	721	556	208
Seed-eaters feeding close to ground (P<0.001)	131	110	200	68	193	192	985	0
Seed-eaters at all levels (P<0.001)	6	0	14	20	8	117	30	17
Carnivores (##)	22	30	14	20	8	17	7	0
Large or medium hollow nesters (P<0.001)	106	0	93	24	37	150	505	17
Small hollow nesters (P=0.224)	98	110	36	43	83	46	229	92
Brood parasites (##)	6	10	0	2	0	4	0	8
All hollow nesters (P<0.001)	204	110	129	67	120	196	734	108
Summer visitors (P=0.912)	79	60	50	40	62	88	119	92
Introduced birds (P=0.008)	34	315	111	143	203	96	500	0
Uncommon birds (<850 records in Emison et al 1987) (##)	0	10	0	4	10	33	34	8

**Appendix 2. Mean abundances of bird species and guilds (birds per 100 counts) in two seasons (summer and winter) across 78 sites near Bacchus Marsh, Victoria, 2005-06.**

P values are given for guilds, showing significance of seasonal difference, unless data were inadequate for formal analysis (##). Note that some guilds also showed habitat x season interactions (Table 3).

<b>Season:</b>	<b>Summer</b>	<b>Winter</b>
Common Bronzewing	5	18
Dusky Moorhen	1	0
Masked Lapwing	7	3
Straw-necked Ibis	5	0
White-faced Heron	1	0
Pacific Heron	0	0
Australian Wood Duck	9	0
Pacific Black Duck	1	0
Brown Goshawk	1	0
Wedge-tailed Eagle	1	1
Little Eagle	1	3
Whistling Kite	1	1
Black Kite	0	1
Australian Hobby	1	1
Brown Falcon	4	1
Australian Kestrel	8	0
Purple-crowned Lorikeet	5	14
Sulphur-crested Cockatoo	3	25
Long-billed Corella	0	18
Galah	13	11
Crimson Rosella	20	18
Eastern Rosella	11	9
Red-rumped Parrot	39	36
Fan-tailed Cuckoo	1	0
Horsfield's Bronze-Cuckoo	3	0
Shining Bronze-Cuckoo	1	0
Welcome Swallow	26	75
Tree Martin	80	1
Fairy Martin	7	0
Grey Fantail	16	13
Willie Wagtail	12	13
Restless Flycatcher	1	3
Jacky Winter	0	8
Scarlet Robin	0	3
Flame Robin	0	5
Yellow Robin	9	1
Golden Whistler	0	4
Rufous Whistler	12	0
Grey Shrike-thrush	5	4
Magpie-lark	4	3
Crested Shrike-tit	1	0
Black-faced Cuckoo-shrike	1	0
Weebill	14	14
Southern Whiteface	0	5
Striated Thornbill	8	13
Yellow Thornbill	13	15
Brown Thornbill	46	17
Buff-rumped Thornbill	13	9
Yellow-rumped Thornbill	51	99



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<b>Season:</b>	<b>Summer</b>	<b>Winter</b>
White-browed Scrubwren	9	9
Speckled Warbler	1	1
Brown Songlark	0	3
Little Grassbird	1	0
Superb Fairy-wren	170	108
Dusky Woodswallow	7	0
Brown Treecreeper	1	1
White-throated Treecreeper	9	7
Mistletoebird	3	0
Spotted Pardalote	20	49
Striated Pardalote	7	18
Silvereye	23	62
White-naped Honeyeater	0	13
Brown-headed Honeyeater	10	28
Eastern Spinebill	4	1
Yellow-faced Honeyeater	15	18
White-plumed Honeyeater	27	69
Crescent Honeyeater	0	1
New Holland Honeyeater	39	119
Red Wattlebird	4	49
Spiny-cheeked Honeyeater	0	4
Noisy Friarbird	0	1
Richard's Pipit	20	13
Diamond Firetail	1	0
Zebra Finch	7	5
Red-browed Finch	37	55
Australian Magpie	28	14
Little Raven	1	0
Spotted Turtle-Dove	3	1
Blackbird	9	3
Skylark	34	64
House Sparrow	70	82
European Goldfinch	36	24
European Greenfinch	1	1
Common Myna	7	4
Common Starling	21	32

	<b>Summer</b>	<b>Winter</b>	<b>Significance of seasonal difference (P)</b>
Total birds	1083	1324	0.072
Forest & woodland birds	652	771	0.157
Generalists	3	5	0.124
Open-country birds	405	546	0.521
Water birds	27	3	0.297
Aerial insectivores	120	84	0.136
Bark-foraging insectivores	12	7	0.521
Canopy-foraging insectivores	82	108	0.297
Insectivores from tall shrubs	60	36	0.037
Insectivores from damp ground or low shrubs	26	14	0.136
Insectivores from open ground (may be far from trees)	176	255	0.137
Insectivores from open ground among trees	186	124	0.048
Nectarivores	105	318	<.001
Seed-eaters feeding close to ground	225	286	0.201
Seed-eaters at all levels	20	18	0.803
Carnivores	18	9	##
Large or medium hollow nesters	107	135	0.472
Small hollow nesters	126	64	0.073
All hollow nesters	232	199	0.569
Brood parasites	5	0	##
Summer visitors	127	17	<.001
Introduced birds	180	211	##
Uncommon birds (<850 records in Emison et al 1987)	7	18	##

**Appendix 3. Mean abundances of major groups of birds (birds per count) in winter 2005, expressed as percentages of values over summer 2005-06, in six main habitats near Bacchus Marsh. Landcare and farm forestry plantations are combined. Data are only shown for major guilds with significant interactions between habitat and season ( $P < 0.05$ ).**

Habitat	paddock	0-2 yr plantation	5 yr plantation	10+ yr plantation	forest remnant	forest	P (habitat x season)
Total birds	292	93	98	114	185	41	0.002
Forest & woodland birds	123	125	107	122	219	41	<0.001
Open-country birds	355	97	87	65	158	#	0.071
Canopy-foraging insectivores	#	152	387	32	495	25	<0.001
Insectivores from tall shrubs	#	67	94	43	417	12	<0.001
Nectarivores	#	297	244	368	288	127	0.015
Seed-eaters close to ground	17	63	66	361	231	#	<0.001
Large or medium hollow nesters	0	0	165	261	209	0	0.013