Wimmera Bird Monitoring Report

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Executive summary

The Wimmera bird monitoring project monitored birds in diverse vegetation communities across the catchment four times per annum for five years. The data demonstrate that biodiversity values in the Wimmera are best defined by vegetation community type. Significant geographic variation is apparent in the biodiversity values of vegetation communities, which can be explained in part by biogeographic differences, but also by differences in habitat quality. The highest biodiversity values are associated with riparian and riverine habitats, and their adjacent woodlands. Relatively low biodiversity values are associated with large patches of heathlands and heathy woodlands, despite being floristically diverse.

This long term monitoring project has confirmed that the composition of bird communities varies significantly across the Wimmera catchment and because certain species are relatively more abundant in particular vegetation communities birds can be used as indicators of biodiversity. The results prove that bird monitoring can be used as a very effective method of assessing biodiversity values across the catchment, of identifying important habitat types and in highlighting and monitoring catchment condition.

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1. Introduction

The Wimmera Catchment Management Authority's Regional Catchment Strategy (RCS) (2003-2008) identified monitoring and evaluation as one of its core aspects. Monitoring requirements focussed on identifying baseline conditions which could be used to evaluate threats, condition and management of assets. The specific biodiversity assets that were identified for monitoring were native vegetation condition and extent, the distribution and abundance of fauna (particularly icon or threatened species) and threats to the region's assets, such as pest plants and animals.

Indicators of biodiversity present a valuable monitoring tool. Birds represent good indicators of biodiversity because they are highly visible, active during the day, their ecology and habitat requirements are generally well known, and their distribution and abundance can reflect environmental conditions (Birds Australia 2003).

In 2003, the Wimmera Catchment Management Authority (WCMA) commissioned Birds Australia (now BirdLife Australia) to prepare a scoping report which used birds as indicators of the health of the environment and to address catchment-wide management issues. The report indicated whether bird monitoring could provide a method to facilitate the integration of biodiversity issues into the regional planning process. The report compared bird survey data collected by Birds Australia during their first national bird atlas survey (1977–1981) with data collected during their second atlas survey (1998–2002). Differences in the reporting rates of species between the two atlas periods were then related to vegetation type, catchment condition, assets, management issues and threatening processes (Birds Australia 2003).

The results highlighted some significant changes to bird populations in the Wimmera region. Some species showed a decline in population, such as the Yellow-billed Spoonbill, Jacky Winter, Hooded Robin and Zebra Finch. Other species showed an increase in population, including the Black-tailed Native-hen, Long-billed Corella, Musk Lorikeet and Little Raven. These changes were considered to reflect changes in the biodiversity of the Wimmera environment, including fragmentation and loss of native vegetation, altered agricultural practices, hydrological changes and increased urbanisation (Birds Australia 2003).

One of the outcomes of the report was that the WCMA develop a long-term bird monitoring program to act as a basis for biodiversity monitoring within the catchment. The report recommended conducting regular bird surveys across a range of habitat types, land uses, and management practices. This would provide a means of measuring relative bird diversity and thus allow catchment biodiversity issues and threatening processes to be identified (Birds Australia 2003).

In 2004, the WCMA developed a regional monitoring project using birds as indicators of environmental health, based on the guiding principles established in the Birds Australia report (2003). The project was called the Wimmera Bird Monitoring Project (WBMP). The premise for the monitoring project was that birds are considered useful indicators of biodiversity. Healthy ecosystems are usually associated with greater bird diversity, which in turn, are associated with greater diversity of flora and fauna. Thus, a list of bird species can be representative of ecosystem health and catchment condition, and indicate the likelihood of the presence of other biota.

2. Aims

The aims fo the Wimmera Birds Monitoring Project were to:

- Relate observed differences in bird species composition to habitat and land use variables;
- Establish a strategy for gauging the success of on-ground management for protecting terrestrial biodiversity;
- Track the condition of WCMA assets as measured by bird communities.

3. Methods

3.1. Site Selection

Monitoring sites were selected randomly within a stratified framework of five parameters - bioregions, ecological vegetation class (EVC) groups, land tenure, vegetation patch size and degree of isolation. This was done to ensure design rigour and adequate coverage of bird populations and habitats across the catchment.

There are nine bioregions and 18 different EVC groups within the Wimmera region. Land tenure was divided into crown land and private, or freehold land. Vegetation patch size and degree of isolation followed the Birds Australia Atlas methodology (Barrett *et al*. 2003). The Patch Size categories (measured in hectares) used were: Small (<10 ha), Medium (10—100 ha) and Large (>100 ha). Degree of Isolation is a measure of the amount of native vegetation cover (as a percentage) within a radius of 1km around the site. The four categories used were: Isolated (<20%), Semi-Isolated (20—40%), Not Isolated (40—80%) and Continuous (>80%). An area with a 1km radius occupies 314.2 hectares meaning that large sites (>100 ha) cannot, by definition, be categorised as isolated. Similarly, small sites constitute such a small proportion of the total area (<4%) that they are unlikely to be categorised within continuous vegetation. Areas of no native vegetation were all considered to be continuous because they were all within cropped and/or grazed agricultural land lacking any native vegetation and in paddocks exceeding 300 ha in size. For riparian strips or narrow fringes around large wetlands, which can extend many kilometres, patch size was calculated for the strip of vegetation within a 1km radius around the site point. This was done to be consistent with isolation definitions. Patch size and Isolation were not calculated for sites in the No Native Vegetation EVC group.

Initial site selection used existing spatial data in a geographic information system (ArcGIS®), to identify 250 sites across the Wimmera region. To ensure a degree of statistical rigour in the selection process, a sub-set of 200 sites was selected randomly from these, within a stratified framework of the site parameters. All sites were assigned a number, starting at 8000. The site numbers were supplied by Birds Australia and the sites integrated into their Atlas of Australian Birds database. One site was subsequently deleted because the vegetation patch selected was found to no longer exist. The breakdown by parameters of the 199 chosen survey sites is shown in

Table **3-1**. It was not possible to select an even representation of sites with all site parameters. This is due to geographic constraints within the region (e.g. no rocky escarpments in the West Wimmera), the absence of certain EVC groups in some bioregions, the lack of small or isolated patches of heathy woodland, etc. The distribution of bird monitoring sites across the catchment is shown in Figure and Figure 3-2.

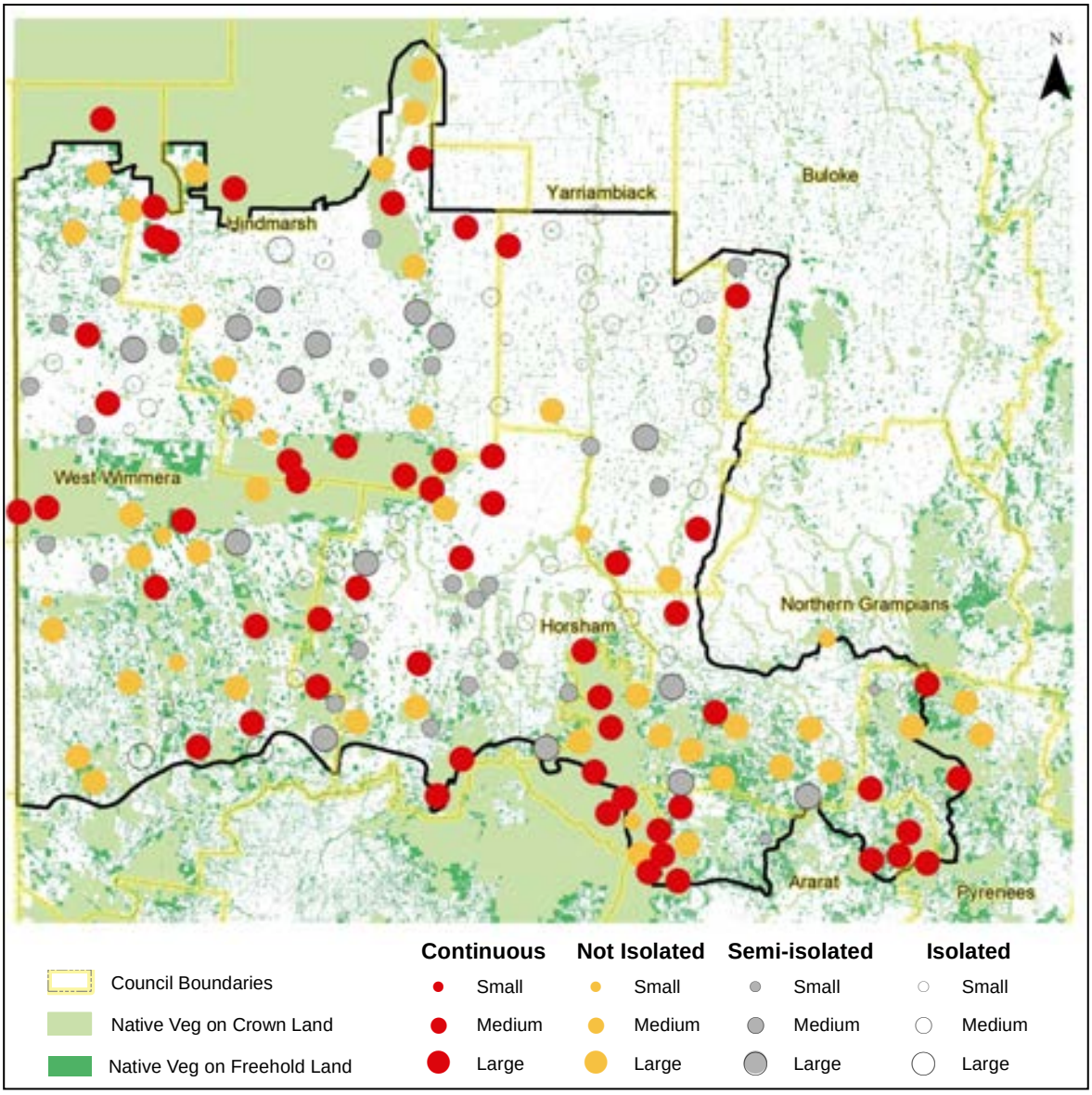

Figure 3-1. Distribution of bird monitoring sites across the Wimmera catchment. Map shows the site parameters of land tenure, degree of isolation, patch size (Small, Medium, Large) and local council boundaries.

Table 3-1. Breakdown of the five site parameters used to identify the bird monitoring sites.

Bioregion	N sites	EVC Group	N sites	Land Tenure	N sites
Central Victorian Uplands	5	Box Ironbark Forests/Woodlands	6	Crown Land	85
Dundas Tablelands	4	Dry Forests	16	Freehold Land	114
Glenelg Plain	2	Foothill Forests	1		
Goldfields	24	Heathlands	7		
Greater Grampians	18	Heathy Woodlands	13	**Total**	**199**
Lowan Mallee	24	Herb-rich Woodlands	5		
Murray Mallee	23	Lower Slopes or Hills Woodlands	14	**Patch Size**	**N sites**
Wimmera	99	Lowland Forests	1	Large	98
		Mallee	21	Medium	64
		Montane	2	Small	19
		Plains Grasslands/Chenopod Shrubland	20	(NNV)	18
		Plains Woodland or Forest Plains Woodland	22		
		Riparian and/or Swampy Scrubs or Woodland	4	**Total**	**199**
		Riparian Forests or Woodlands	3		
		Riverine Grassy Woodlands or Forests	18	**Isolation**	**N sites**
		Rocky outcrop or escarpment Scrubs	6	Isolated	53
		Salt-tolerant and/or succulent Shrublands	6	Not Isolated	50
		Wetland Freshwater	13	Semi-isolated	41
		Wetland Saline	3	Continuous	37
		No Native Vegetation (NNV)	18	(NNV)	18
Total	**199**		**199**		**199**

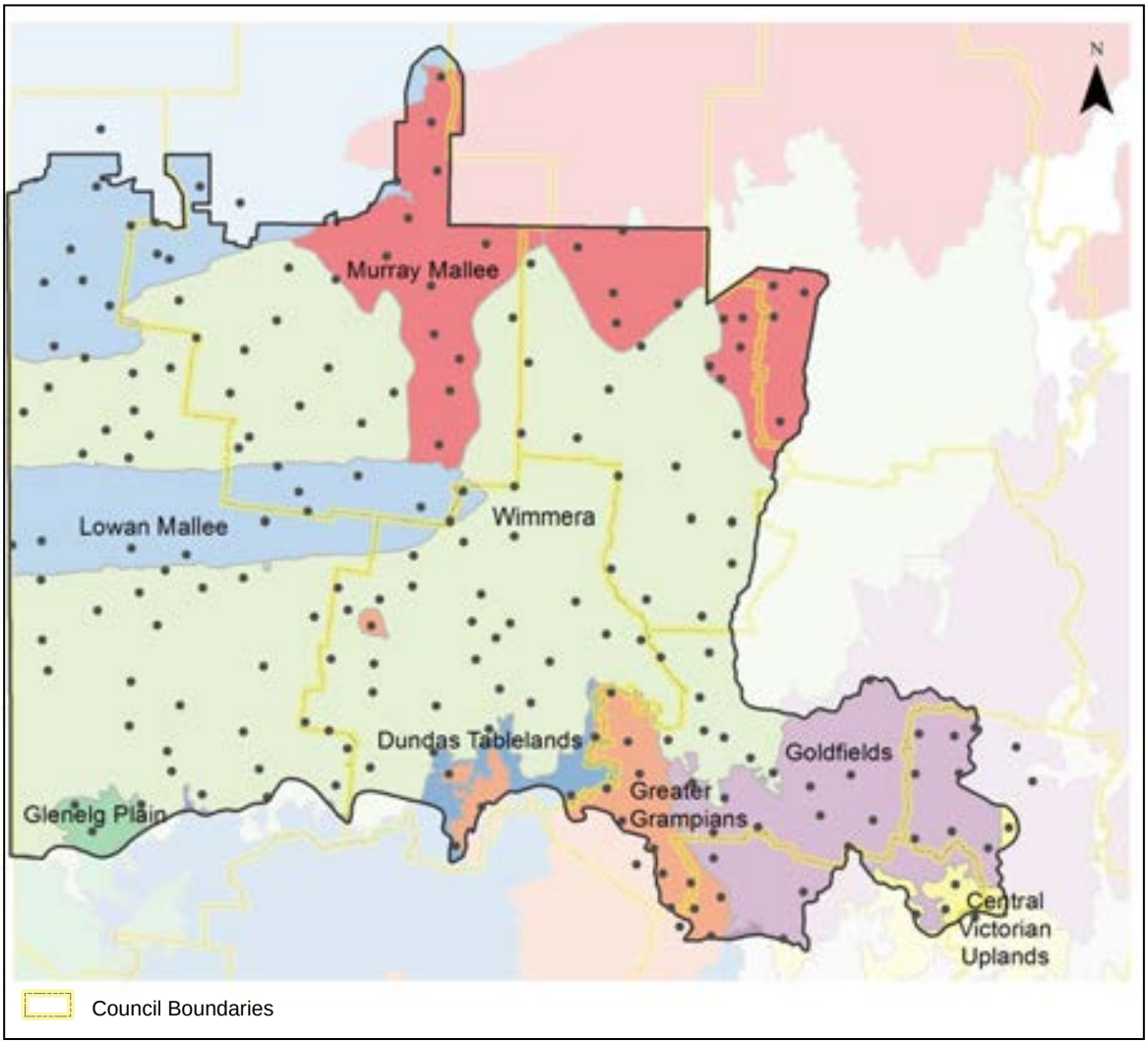

Figure 3-2. Distribution of bird monitoring sites across the Wimmera catchment, showing sites in relation to the bioregions (labelled) and council boundaries.

3.2. Bird Surveying

The bird monitoring project employed the Birds Australia 20 minute/ two hectare atlas survey methodology (see Barrett *et al*. 2003). At each monitoring site, a two hectare survey site was identified. Usually, these were rectangular, 100 x 200 metres in size, though shapes varied depending on local topography, vegetation, roads or fence lines.

Bird surveys involved walking randomly through the 2 ha site, recording all bird species present within the site during the 20 minute survey period. Counts of individuals were not made, only the presence of each species recorded. Birds flying over the site were included. Birds heard from within the 2 ha site that were calling from beyond the site boundary were not included.

Community participation was an integral component of the monitoring project. Volunteer bird-watchers were recruited to undertake the majority of the surveys. Where coverage was deficient, due to remoteness or lack of volunteers, site surveys were undertaken by the project co-ordinator. Sites were surveyed four times per year, i.e. once per season. The survey months were January (Summer), April (Autumn), July (Winter) and October (Spring). Survey data were recorded on the Birds Australia Atlas data sheets and submitted to the Wimmera CMA for entry and analysis. All data sheets were then forwarded onto Birds Australia for incorporation into their national Atlas of Australian Birds.

The scientific names of all birds referred to in this report are listed in Appendix 1.

3.3. Data Analysis

Two measures of bird populations can be calculated from the survey data: bird species richness and relative abundance. Species richness is expressed as the mean number of bird species recorded per bird survey and represents a measure of the diversity of birds recorded. Sites with high species richness are considered to be indicative of higher levels of biodiversity than sites with low species richness. Relative abundance is a measure of how often a species is recorded at a site and is expressed as the 'reporting rate' of a species. For example, a species recorded in eight out of ten surveys (in 80% of surveys), is said to have a higher relative abundance than a species recorded only twice out of ten surveys (20% of surveys). Species with high reporting rates are thus considered to be relatively more abundant than species with low reporting rates.

Species richness and relative abundance vary depending on the parameters of a site and are considered the 'response variables'. The five site parameters, as well as season and climate, all influence the presence or absence of birds at a site and are considered the 'predictor variables' (Clarke & Warwick 2001).

Species richness and relative abundance values were calculated for each site and analysed against the five site parameters. Sites that were visited less than four times were considered to have an insufficient sample size and were excluded from the statistical analyses. Statistical analysis of means was carried out using the methods described in Fowler & Cohen (1996). When comparing the means of two samples, the parametric *t*-test was performed on small samples (less than 30 observations), or *z*-test on larger samples (over 30 observations). When comparing the means of more than two samples, an ANOVA test was performed. Where the variance of the means was too high for a parametric test, the non-parametric Kruskal-Wallis test or Mann-Whitney*U*-test was used.

Analysis of means can show differences in overall species richness between the different site parameters, but cannot examine the composition of species which contribute to the overall richness measured. Another method of analysing the bird survey results is to examine the relative abundance of bird species across sites. Statistical analysis of the similarities and differences in the relative abundance of species between bird monitoring sites was undertaken using analysis of similarity (ANOSIM) in the PRIMER software package (Clarke & Warwick 2001). To identify which bird species contributed to the differences between sites, a similarity percentage (SIMPER) was used based on the contributions of variables to the Bray-Curtis similarity matrix (on square-root transformed data) in the PRIMER software package (Clarke & Warwick 2001). For all statistical analyses, a significance level of $p = 0.05$ was employed.

4. Results

The bird monitoring project began in September 2004 and was scheduled to run for five years. The first surveys were conducted in October (Spring) 2004. Because the project had only just commenced and few surveys were undertaken during the first survey month, it was decided to extend the survey period by one season so that five full calendar years could be covered. Thus, the last survey month was October 2009, giving 21 survey months in total.

Surveys were undertaken at 168 sites across the Wimmera. Over 100 volunteers were involved with the project and 1608 surveys were completed. Some volunteers, who had previously been monitoring sites in the Wimmera for Birds Australia (Birds on Farms, 1995-1997; new Atlas of Australian Birds, 1998-2002), offered to resume surveying at these sites. These sites already had allocated site numbers and these were also used by WCMA. Appendix 2 shows the site parameters and bird survey results for each site surveyed.

A total of 184 bird species was recorded during the survey period. Table 4-1 shows the 20 most widespread species, based on the number of surveyed sites in which the species was recorded.

Table 4-1. Twenty most widespread species recorded during the bird monitoring project, ranked on the number of sites (out of 168) in which each species was recorded.

Species	Number of sites recorded
Australian Magpie	132
Galah	106
Australian Raven	93
Red Wattlebird	90
Red-rumped Parrot	88
Striated Pardalote	84
Brown Treecreeper	83
White-plumed Honeyeater	83
Willie Wagtail	81
Eastern Rosella	77
Long-billed Corella	76
Welcome Swallow	74
Sulphur-crested Cockatoo	71
Crested Pigeon	70
Grey Shrike-thrush	69
Crimson Rosella	68
Superb Fairy-wren	66
Laughing Kookaburra	65
Musk Lorikeet	62
Noisy Miner	56

Australian Magpie was the most frequently recorded and most widespread species recorded during the bird surveys. Other species found to be widespread across the Wimmera include Galah, Australian Raven and Red-rumped Parrot (all ground-feeding species), Red Wattlebird and Striated Pardalote (which feed predominantly in foliage).
Interestingly, Brown Treecreeper, a declining woodland species, was found in nearly half of sites surveyed. Of the 20 species listed in Table 18 are considered sedentary, one (Musk Lorikeet) is nomadic, and one (Welcome Swallow) is a partial migrant.

The abundance of species recorded during the bird monitoring project can be determined by calculating their reporting rate (see Methods). Table shows the 20 most abundant species recorded across the Wimmera, based on their calculated reporting rates.

Table 4-2. Twenty most abundant species recorded during the bird monitoring project, ranked on the reporting rate (n=1608) calculated for each species.

Species	Reporting rate (%)
Australian Magpie	47.1
Galah	36.8
Red-rumped Parrot	32.8
White-plumed Honeyeater	32.5
Brown Treecreeper	31.8
Sulphur-crested Cockatoo	24.7
Willie Wagtail	23.5
Superb Fairy-wren	22.1
Striated Pardalote	21.8
Crimson Rosella	19.5
Red Wattlebird	19.3
Long-billed Corella	18.1
Australian Raven	17.8
Eastern Rosella	17.1
New Holland Honeyeater	17.0
Grey Shrike-thrush	14.9
Crested Pigeon	14.5
Noisy Miner	13.8
Laughing Kookaburra	12.6
Musk Lorikeet	11.3

Australian Magpie was the most frequently recorded species, found in nearly half of all surveys conducted. Comparing the 20 most widespread species (Table) with the 20 most abundant species (Table) shows that 19 of the 20 most abundant species are also the most widespread, although the ranking order differs. Welcome Swallow was found to be a widespread species across the Wimmera but is not ranked among the most abundant, possibly reflecting the part-migratory nature of this species. New Holland Honeyeater is the only species ranked in the top 20 most abundant species but not ranked in the top 20 most widespread.

The mean number of birds per survey (species richness) was calculated for each site (see Appendix 1). Differences in bird species richness between sites can be displayed by plotting the mean number of birds per survey on a map of the catchment.

Figure shows the geographic distribution of species richness across the catchment. The results have been grouped into quartiles of 0—4, 4.1—7, 7.1—10 and over 10 + birds per survey.

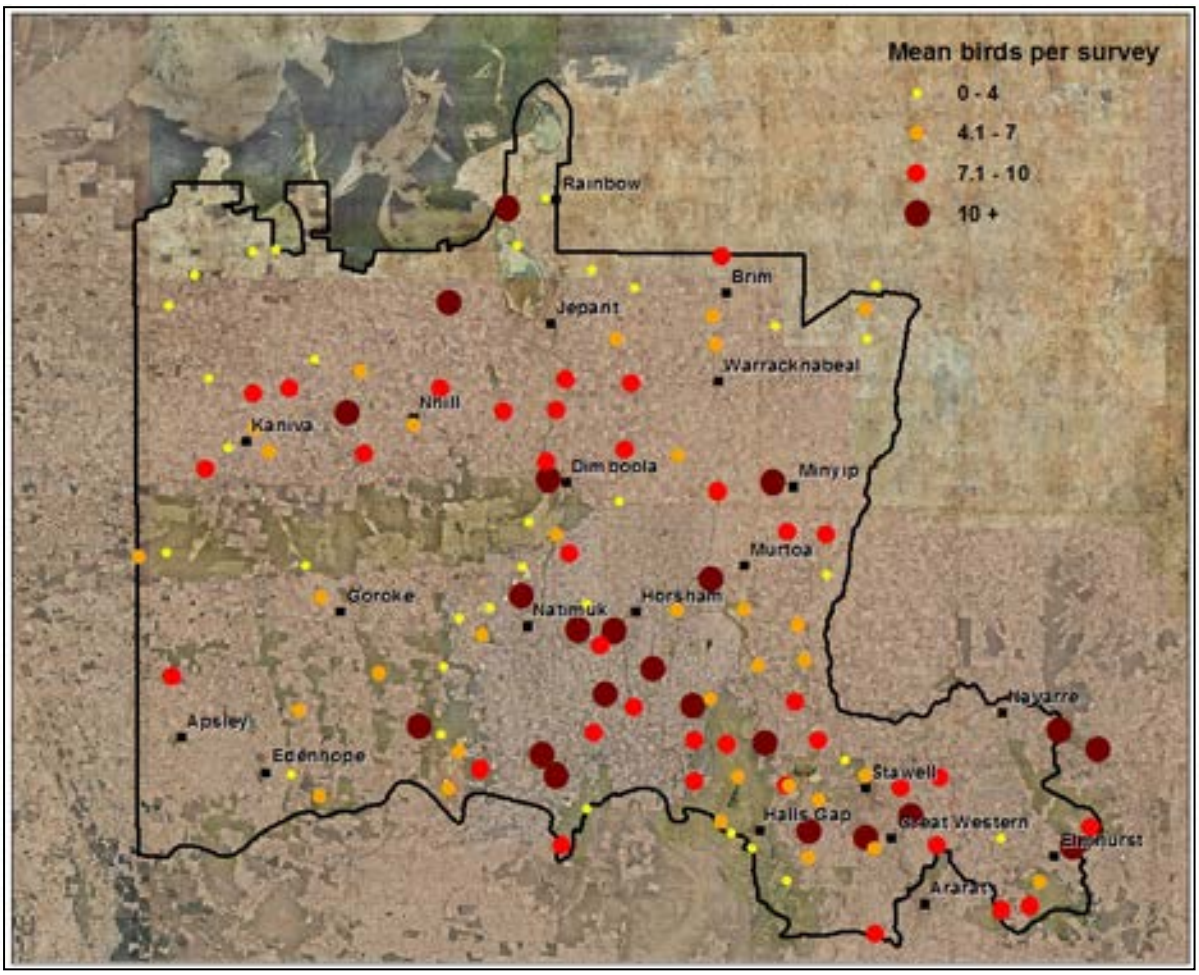

Figure 4-1. Mean number of birds per survey recorded at survey sites across the Wimmera.

The results displayed in

Figure show that bird species richness is not evenly distributed across the catchment. The most diverse sites are clustered in the central and south-eastern parts of the catchment. Species richness is low in the south-west Wimmera and within the Little Desert and Grampians National Parks. The region with the highest species richness lies between these two large parks, in an area dissected by numerous north-south orientated watercourses. The reasons for the disparate distribution of species richness can be explored by examining the parameters that define each site.

The bird monitoring project defined survey sites according to five site parameters (see

Table **3-1**). The differing influences that these five site parameters have on biodiversity values across the catchment can be examined. For the purposes of statistical rigour, sites surveyed less than four times are not included in the following analyses. Excluding sites surveyed less than four times, bird data were collected from 1485 surveys and from 121 sites.

4.1 Vegetation Community (EVC group)

The habitat requirements of birds in the Wimmera can be determined by examining the bird species richness for the 18 different vegetation communities (EVC groups). Table 4-3 shows the mean birds per survey results for each of the 18 different EVC group categories. Sites where less than four surveys were undertaken are not included in the analysis.

Table 4-3. Species richness (mean birds per survey) recorded for each of the EVC groups. Standard Deviation, number of surveys completed and number of sites surveyed are also shown.

Vegetation community (EVC group)	Mean birds / survey	Stand. Dev.	Number of surveys	Number of sites
Box Ironbark Forests/Woodlands	8.61	4.807	38	3
Dry Forests	7.31	3.633	58	7
Heathlands	4.71	3.746	59	5
Heathy Woodlands	6.75	3.899	129	9
Herb-rich Woodlands	11.76	5.764	72	5
Lower Slopes or Hills Woodlands	8.26	4.064	82	8
Lowland Forests	3.33	1.633	6	1
Mallee	4.28	2.986	32	4
No Native Vegetation	2.29	2.247	146	12
Plains Grasslands/Chenopod Shrubland	6.94	3.556	120	10
Plains Woodland or Forest Plains Woodland	9.52	4.941	204	16
Riparian and/or Swampy Scrubs or Woodlands	10.21	4.697	57	4
Riparian Forests or Woodlands	10.16	2.078	55	3
Riverine Grassy Woodlands or Forests	8.68	3.551	171	13
Rocky Outcrop or Escarpment Scrubs	5.54	1.895	63	6
Salt-tolerant and/or succulent Shrublands	2.77	2.036	51	5
Wetland Freshwater	6.80	3.646	123	9
Wetland Saline	2.95	2.718	19	1

Herb-rich Woodlands was the vegetation community which supported the greatest bird species richness, with an average of 11.76 birds recorded per survey. Three of the top six EVC groups for species richness are associated with watercourses (Riparian and/or Swampy Scrubs or Woodland, Riparian Forests or Woodlands and Riverine Grassy Woodlands or Forests). The EVC group Plains Woodland or Forest Plains Woodlands had the most number of surveys and the largest number of sites represented, and had a mean species richness of 9.52. In contrast, Heathlands and Mallee vegetation had very low species richness. Sites with no native vegetation present had the lowest species richness, with only 2.29 birds recorded per survey.

4.2 Land Tenure

Bird species richness data can be analysed according to the land tenure of the vegetation patch in which the site was located. The two categories of land tenure are crown land and freehold. Crown land includes sites in national park, reserves and crown land frontages on waterways. Freehold sites were mostly in remnants in agricultural land, and included a few sites protected under Trust for Nature conservation covenants. All sites of no native vegetation were on freehold land.

The mean number of birds per survey for sites on crown land was 6.84 (SD=4.012; n=689). The mean number of birds per survey for sites on freehold land was 7.52 (SD=5.119; n=796). The difference between the two means is not statistically significant (P=0.785).

The results for land tenure can also be analysed to determine differences in bird species richness within EVC groups.

Table **4-4** shows the bird survey results for land tenure within each EVC group.

Table 4-4. Bird survey results for the two land tenure categories for the different EVC groups. Standard deviation, number of surveys and statistical difference are also shown.

EVC group (Vegetation community)	Land Tenure	Mean birds / survey	Stand. Dev.	Number of surveys	Diff.
Box Ironbark Forests/ Woodlands	Crown Land	10.48	4.753	25	Sig.
	Freehold Land	5.00	2.160	13	
Dry Forests	Crown Land	6.54	3.493	39	Not sig.
	Freehold Land	7.31	3.551	32	
Heathlands	Crown Land	5.18	3.909	49	Not Sig.
	Freehold Land	2.40	1.350	10	
Heathy Woodlands	Crown Land	4.87	2.746	78	Sig.
	Freehold Land	9.63	3.655	51	
Herb-rich Woodlands	Crown Land	8.63	3.700	41	Sig.
	Freehold Land	15.90	5.412	31	
Lower Slopes or Hills Woodlands	Crown Land	6.77	2.320	26	Not Sig.
	Freehold Land	8.95	4.510	56	
Lowland Forests	Crown Land	3.33	1.633	6	-
	Freehold Land	-	-	-	
Mallee	Crown Land	2.76	1.437	17	Sig.
	Freehold Land	6.00	3.381	15	
No Native Vegetation	Crown Land	-	-	-	
	Freehold Land	2.29	2.247	146	
Plains Grasslands/ Chenopod Shrublands	Crown Land	8.16	3.287	25	Sig.
	Freehold Land	6.62	3.571	95	
Plains Woodlands or Forests Plains Woodland	Crown Land	5.38	2.645	67	Sig.
	Freehold Land	11.55	4.528	137	
Riparian Forests or Woodlands	Crown Land	10.16	2.637	55	-
	Freehold Land	-	-	-	
Riparian and/or Swampy Scrubs or Woodlands	Crown Land	8.85	4.672	40	Sig.
	Freehold Land	13.41	2.917	17	
Riverine Grassy Woodlands or Forests	Crown Land	9.24	3.812	101	Sig.
	Freehold Land	7.86	2.975	70	
Rocky Outcrop or Escarpment	Crown Land	5.54	3.693	63	

EVC group (Vegetation community)	Land Tenure	Mean birds / survey	Stand. Dev.	Number of surveys	Diff.
Scrubs	Freehold Land	-	-	-	
Salt-tolerant and/or succulent Shrublands	Crown Land	3.04	1.899	24	Not sig.
	Freehold Land	2.51	2.155	27	
Wetland Freshwater	Crown Land	4.06	2.423	33	Sig
	Freehold Land	7.80	3.510	90	
Wetland Saline	Crown Land	-	-	-	-
	Freehold Land	2.94	2.718	19	

Of the 13 EVC groups which contained sites in both land tenure, nine showed significant differences. From Table **4-4**, sites on freehold land supported significantly higher species richness in six EVC groups, including Herb-rich Woodlands, Mallee and Freshwater wetlands. Sites on crown land supported significantly higher species richness in three EVC groups: Box Ironbark Forests/ Woodlands, Plains Grasslands/ Chenopod Shrublands and Riverine Grassy Woodlands or Forests.

Sites in Box Ironbark Forests/ Woodlands had over double the bird species richness on crown land compared with sites on crown land. Conversely, sites in freshwater wetlands had nearly double the bird species richness on freehold land compared with sites on crown land.

4.3 Patch Size

Bird species richness data can be analysed according to the size of the vegetation patch where the site was located. The results, for all EVC groups combined (but excluding No Native Vegetation; see above), are shown in Table and Figure . Sites where less than four surveys were undertaken are not included in the analysis.

Table 4-5. Bird species richness data (mean birds per survey) for sites in the three patch size classes. Standard deviation, number of surveys completed (n=1339) and number of sites surveyed (n=109) are also shown.

Patch Size	Mean birds per survey	Stand. Dev.	Number of surveys	Number of sites
Large (>100 ha)	7.31	4.753	761	65
Medium (10—100 ha)	8.31	4.230	540	39
Small (<10 ha)	8.21	2.915	38	5

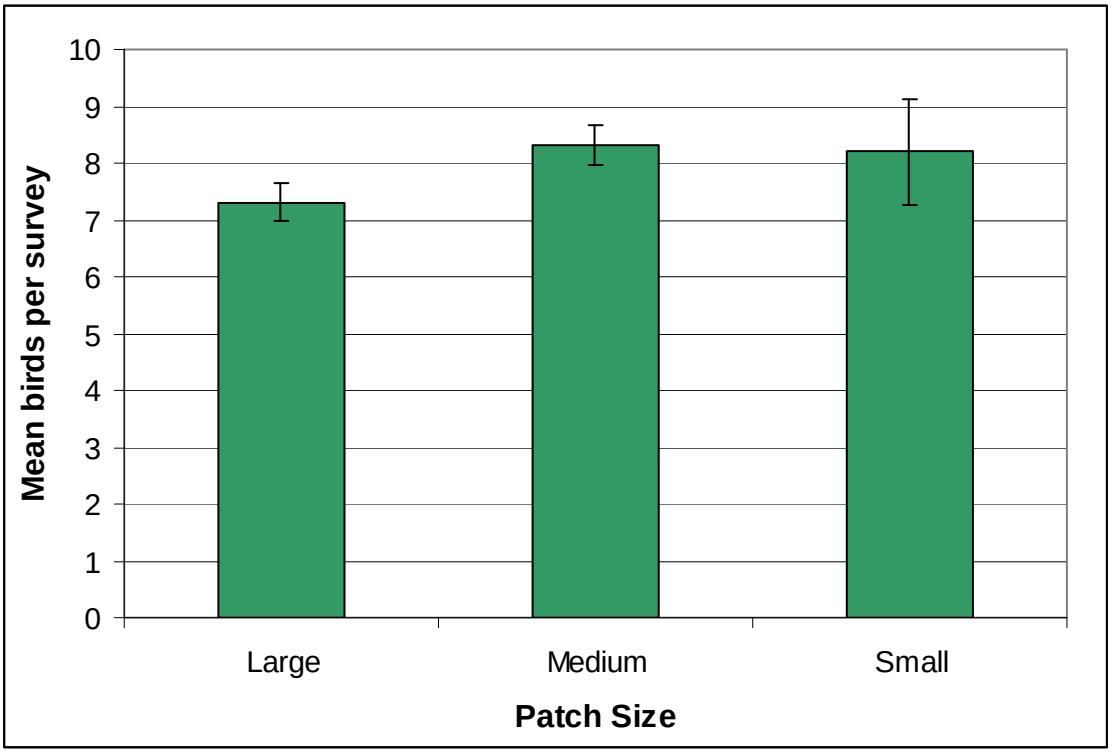

Figure 4-2. Bird species richness data for sites in the three patch size classes. Error bars showing 95% confidence intervals are also shown.

The data in Table and Figure show that sites in medium patch sizes have the highest mean species richness, and sites in large patches the smallest. A standard ANOVA test could not be conducted on patch size results because the variances of the means are not homogeneous. Using the non-parametric Kruskal-Wallis test, the results for the three patch size classes are found to be significantly different ($H=29.429$, $P<0.01$). Sites in large patches are significantly different from sites in small and medium patches; sites in medium and small patches are not significantly different from each other.

The influence of patch size on species richness can be analysed within each EVC group. **Error! Reference source not found.** shows mean species richness by patch size within each of the EVC groups. Not all patch size categories are represented within each EVC group (see Methods). Sites where less than four surveys were undertaken are not included in the analysis.

Table 4-6. Mean species richness for the different Patch Size categories within each EVC Group. Standard deviation, number of surveys (N) and level of significance are also shown.

EVC Group	Patch Size	Mean	Stand. Dev.	N	Significance Level
Box Ironbark Forests or dry/lower fertility Woodlands	Large	8.61	4.807	38	
	Medium				
	Small				
Dry Forests	Large	7.34	3.721	53	z = 0.095, P>0.05 Not significantly different
	Medium				
	Small	7.2	2.588	5	
Heathlands	Large	4.71	3.647	59	
	Medium				
	Small				
Heathy Woodlands	Large	5.29	3.251	84	$F_{2/129}$ = 23.903, P<0.05 Significantly different
	Medium	9.83	3.501	36	
	Small	8.11	3.552	9	
Herb-rich Woodlands	Large	11.8	6.003	66	H=0.03, P=0.862 Not significantly different
	Medium				
	Small	11.33	1.751	6	
Lower Slopes or Hills Woodlands	Large	7.62	3.933	45	z = 1.570 Not significantly different
	Medium	9.03	4.140	37	
	Small				
Lowland Forests	Large	3.33	1.633	6	
	Medium				
	Small				
Mallee	Large	2.76	1.437	17	H=15.091, P<0.01, Significantly different
	Medium	3.71	2.984	7	
	Small	8.0	2.330	8	
Plains Grasslands and Chenopod Shrublands	Large	9.2	6.563	10	H=1.562, P=0.211 Not significantly different
	Medium	6.74	3.120	110	
	Small	-			
Plains Woodlands or Forests	Large	9.32	5.072	134	H=5.613, P=0.06 Not significantly different
	Medium	10.38	4.819	60	
	Small	7.1	2.514	10	
Riparian and/or Swampy Scrubs and Woodlands	Large	6.38	2.959	13	z = 4.6403, P<0.01 Significantly different
	Medium	11.34	4.534	44	
	Small				
Riparian Forests or Woodlands	Large				
	Medium	10.16	2.637	55	
	Small				
Riverine Grassy Woodlands or Forests	Large	8.81	3.442	53	z = 0.299, P>0.05 Not significantly different
	Medium	8.62	4.611	118	
	Small				
Rocky outcrop or Escarpment Scrubs	Large	5.54	3.693	63	
	Medium				
	Small				
Salt-tolerant and/or succulent Shrublands	Large	3.41	2.027	29	z = 0.945, P>0.05 Not significantly different
	Medium	2.91	1.743	22	
	Small				
Wetlands Freshwater	Large	6.59	3.876	91	z = 1.2023, P>0.05 Not significantly different
	Medium	7.38	2.871	32	
	Small				

Three of the 11 EVC groups which had sufficient surveys in more than one patch size category, showed significant differences. In each of these, sites in large patches had significantly lower mean species richness than sites in medium and/or small patches. For the other eight EVC groups, there was no significant differences in mean species richness among the three patch size classes. The results in Table and **Error! Reference source not found.** show that patch size is not a good predictor of bird species richness.

1.

4.4 Isolation

Bird species richness data can be analysed according to the degree of isolation of the vegetation patch where the site was located. The results, for all EVC groups combined, are shown in Table 4-7 and Figure . Sites where less than four surveys were undertaken are not included in the analysis.

Table 4-7. Bird species richness data (mean birds per survey) for the four isolation classes. Standard deviation, number of surveys completed and number of sites surveyed are also shown.

Isolation Category	Mean birds per survey	Stand. Dev.	Number of surveys	Number of sites
Isolated	7.84	4.524	324	26
Semi-isolated	9.05	4.292	367	27
Not Isolated	8.95	4.670	320	27
Continuous	5.00	3.299	328	33

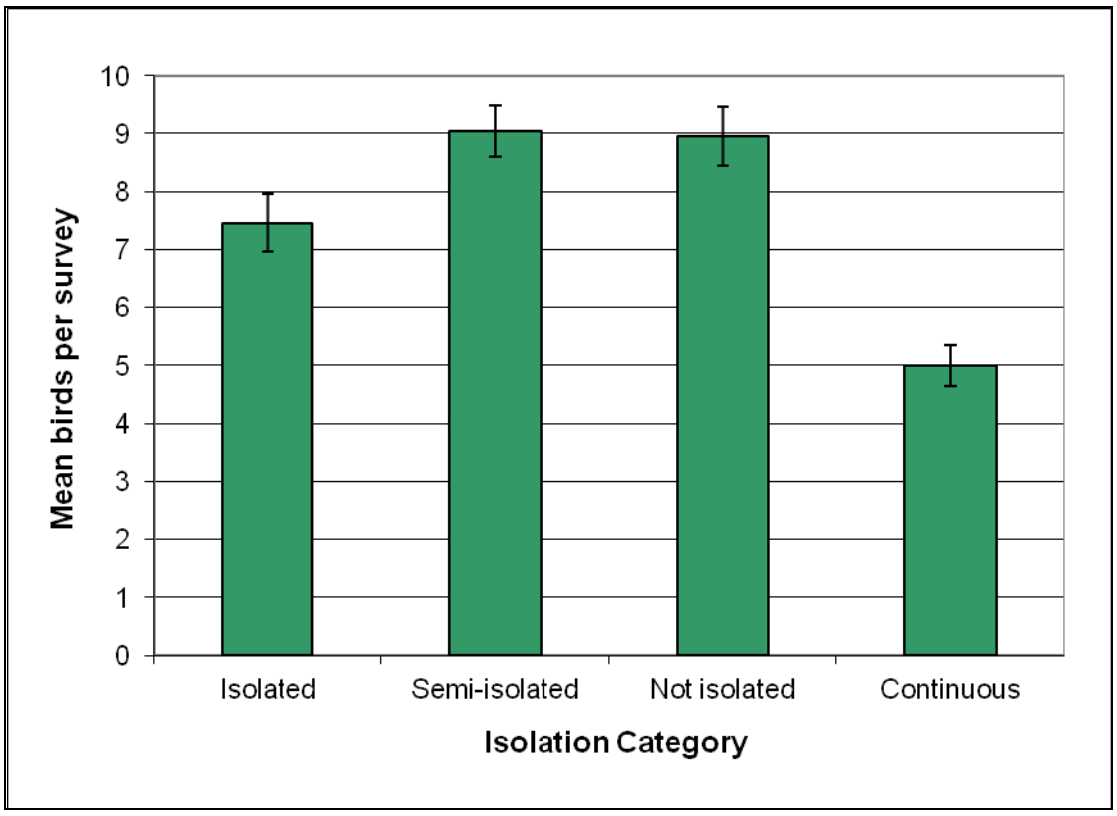

Figure 4-3. Bird species richness data for sites in the four isolation categories. Error bars showing 95% confidence intervals are also shown.

The results in Table 4-7 and Figure show that sites in Semi-isolated or Not Isolated vegetation patches have the highest species richness, whereas sites in isolated and continuous vegetation patches have comparatively lower species richness. A standard ANOVA test could not be performed on Isolation category results because the variances of the means are not homogeneous. Using the non-parametric Kruskal-Wallis test, the results for degree of isolation are found to be significantly different (H=295.16, P<0.01).

Isolation category data can also be analysed for each of the EVC groups. Table 4-8 shows the mean species richness by Isolation category for each EVC group.

Table 4-8. Mean species richness for the different Patch Size categories within each EVC Group. Standard deviation, number of surveys (N) and level of significance are also shown.

EVC Group	Isolation Category	Mean	Stand. Dev.	N	Significance Level
Box Ironbark Forests or dry/lower fertility Woodlands	Isolated				
	Semi-isolated				
	Not Isolated	8.61	4.807	38	
	Continuous				
Dry Forests	Isolated	7.20	2.588	5	H=5.559, P=0.062, Not significantly different
	Semi-isolated	9.63	2.066	8	
	Not Isolated				
	Continuous	6.91	3.831	45	
Heathlands	Isolated				H=3.527, P=0.06, Not Significantly different
	Semi-isolated				
	Not Isolated	2.40	1.350	10	
	Continuous	5.18	3.909	49	
Heathy Woodlands	Isolated	8.11	3.551	9	H=55.507, P<0.01, Significantly different
	Semi-isolated	9.83	3.501	36	
	Not Isolated	9.13	4.086	15	
	Continuous	4.45	2.342	69	
Herb-rich Woodland	Isolated	11.33	1.751	6	H=52.515, P<0.01, Significantly different
	Semi-isolated	19.11	4.189	19	
	Not Isolated	11.04	2.821	27	
	Continuous	5.90	2.222	20	
Lower Slopes or Hills Woodlands	Isolated				H=5.595, P=0.06, Not Significantly different
	Semi-isolated	7.56	2.950	50	
	Not Isolated	10.32	5.490	25	
	Continuous	5.86	1.676	7	
Lowland Forests	Isolated				
	Semi-isolated				
	Not Isolated				
	Continuous	3.33	1.633	6	
Mallee	Isolated	6.0	3.381	15	H=8.26, P=0.016, Significantly different
	Semi-isolated				
	Not Isolated	3.0	1.852	8	
	Continuous	2.56	1.014	9	
Plains Grasslands and Chenopod Shrublands	Isolated	6.25	3.163	77	H=21.461, P<0.01, Significantly different
	Semi-isolated	8.82	3.486	39	
	Not Isolated	2.0	1.826	4	
	Continuous				

EVC Group	Isolation Category	Mean	Stand. Dev.	N	Significance Level
Plains Woodlands or Forests	Isolated	12.1	4.649	30	H=42.546, P<0.001, Significantly different
	Semi-isolated	8.98	3.902	54	
	Not Isolated	10.14	4.935	103	
	Continuous	3.0	1.969	17	
Riparian Forests or Woodlands	Isolated	10.51	2.873	37	H=1.474, P=0.225, Not Significantly different
	Semi-isolated	9.44	1.947	18	
	Not Isolated				
	Continuous				
Riparian and/or Swampy Scrubs and Woodlands	Isolated	10.39	4.541	28	H=15.137, P<0.01, Significantly different
	Semi-isolated	13.0	4.147	16	
	Not Isolated				
	Continuous	6.38	2.959	13	
Riverine Grassy Woodlands or Forests	Isolated	8.55	4.145	76	H=1.478, P=0.478, Not Significantly different
	Semi-isolated	8.57	2.937	65	
	Not Isolated	9.23	3.226	30	
	Continuous				
Rocky outcrop or Escarpment Scrubs	Isolated				
	Semi-isolated				
	Not Isolated				
	Continuous	5.54	3.693	63	
Salt-tolerant and/or succulent Shrublands	Isolated	1.91	1.743	22	H=7.875, P=0.019, Significantly different
	Semi-isolated	3.71	1.899	14	
	Not Isolated				
	Continuous	3.13	2.167	15	
Wetland Freshwater	Isolated				H=26.604, P<0.01, Significantly different
	Semi-isolated	6.96	6.958	48	
	Not Isolated	7.77	3.698	60	
	Continuous	2.40	1.920	15	
Wetland Saline	Isolated	2.95	2.718	19	
	Semi-isolated				
	Not Isolated				
	Continuous				

Eight of the 13 EVC groups which had sufficient surveys in more than one isolation category, showed significant differences in mean species richness. Of these, seven showed significantly lower species richness for sites in Continuous vegetation. The other EVC group had no sites in Continuous vegetation but showed significantly lower mean species richness for sites in Not Isolated vegetation.

Mean species richness was highest at sites in Semi-isolated and Not Isolated vegetation (Table 4-7 and 4-3) Seven EVC groups had sites represented in both these isolation categories. Species richness was not significantly different between Semi-isolated and Not Isolated sites in five of the seven EVC groups, and significantly different in two EVC groups; in both cases, semi-isolated sites were significantly larger (Table 4-8). Although there are significant differences between the four different Isolation categories, the degree of isolation of a vegetation patch is a weak predictor of bird species richness, and exerts less influence on species richness than EVC group.

4.5 Bioregions

Bird species richness data can be analysed according to the bioregions in which the sites are located. The results, for all EVC groups combined, are shown in Table and Figure 4-4. Sites where less than four surveys were undertaken are not included in the analysis.

Table 4-9. Bird species richness data (mean birds per survey) for the different bioregions in the Wimmera. Standard deviation, number of surveys completed and number of sites surveyed are also shown.

Bioregion	Mean birds per survey	Stand. Dev.	Number of surveys	Number of sites
Central Victorian Uplands	7.97	3.687	33	5
Dundas Tablelands	9.44	2.861	62	3
Goldfields	9.30	5.568	152	16
Greater Grampians	6.30	3.741	149	11
Lowan Mallee	2.92	2.172	66	8
Murray Mallee	5.90	3.720	159	14
Wimmera	7.37	4.725	864	64

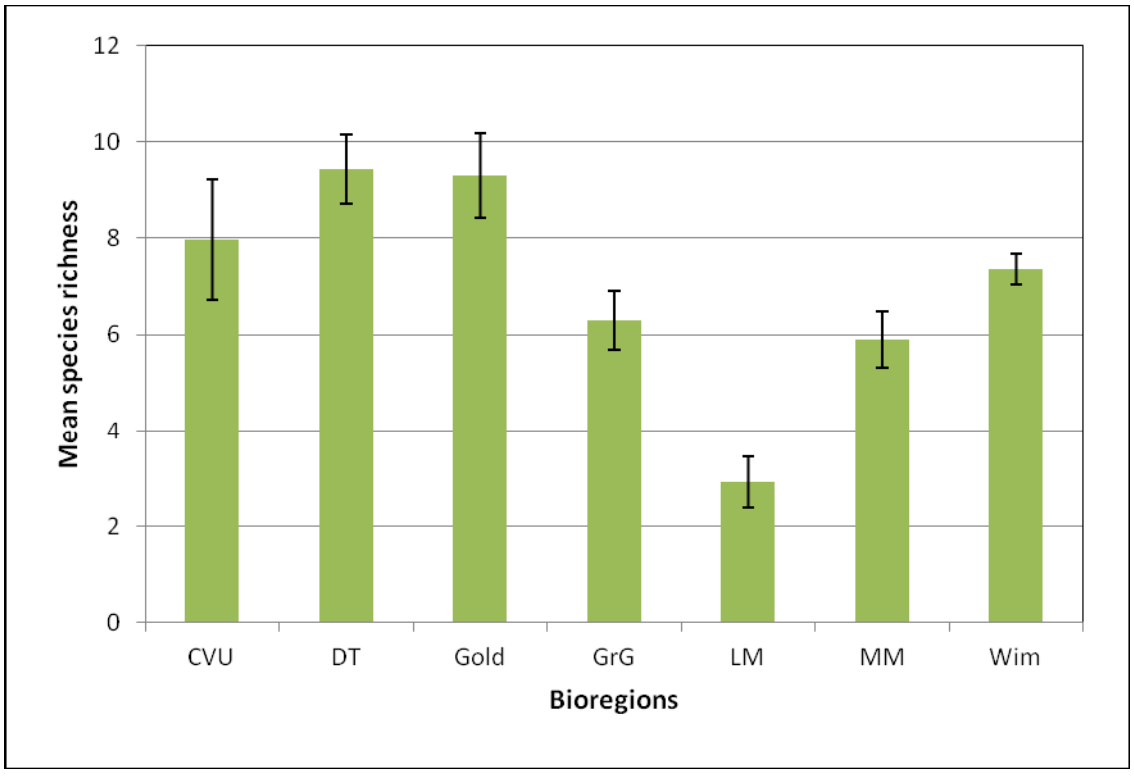

Figure 4-4. Bird species richness data for sites in the different bioregions. Error bars showing 95% confidence intervals are also shown.

CVU = Central Victorian Uplands, DT = Dundas Tablelands, Gold = Goldfields, GrG = Greater Grampians, LM = Lowan Mallee, MM = Murray Mallee, Wim = Wimmera.

The results in Table and Figure 4-4 show marked differences in bird species richness between the different bioregions. The Dundas Tablelands and Goldfields bioregions support the highest bird species richness. The Lowan Mallee bioregion, which includes the Little Desert, supported the lowest bird species richness.
A standard ANOVA test could not be performed on the bioregion results because the variances of the means are not homogeneous. Using the non-parametric Kruskal-Wallis test, the results were found to be significantly different ($H=130.319$, $P<0.01$). Examination of the 95% confidence intervals in shown in Figure 4-4 show some overlap between the different bioregions. Lowan Mallee has significantly lower mean species richness than all other bioregions. Greater Grampians and Murray Mallee support similar levels of species richness and show no overlap with any other bioregion. Dundas Tablelands and Goldfields support similar bird species richness, and overlap with Central Victorian Uplands, but are significantly different from all other bioregions.

Bioregions data can also be analysed by EVC group to determine whether differences in vegetation community can explain the results. Table 4-10 shows bird species richness for each EVC group with the seven bioregions.

Table 4-10. Bird species richness data for each EVC group within the seven bioregions. Mean birds per survey, standard deviation, number of surveys and number of sites are shown.

Bioregion	EVC Group	Mean	Standard Deviation	Number of surveys	Number of sites
Central Victorian Uplands	Dry Forests	7.3	3.840	20	3
	Herb-rich Woodlands	10.33	2.875	6	1
	Rocky outcrop or Escarpment Scrubs	7.86	3.436	7	1
Dundas Tablelands	Heathlands	8.57	2.839	21	1
	Herb-rich Woodlands	11.24	2.844	21	1
	Plains Woodlands or Forests	8.45	1.959	20	1
Goldfields	Box Ironbark Forests or dry/lower fertility Woodlands	10.48	4.753	25	2
	Dry Forests	9.4	3.085	20	3
	Heathy Woodlands	8.11	3.551	9	1
	Herb-rich Woodlands	17.24	5.028	25	2
	Lower Slopes or Hills Woodlands	9.0	6.424	21	2
	No Native Vegetation	4.84	2.135	25	2
	Plains Woodlands or Forests	6.96	2.849	26	3
	Wetlands Freshwater	5.0	2.00	10	1
Greater Grampians	Dry Forests	5.0	2.521	18	1
	Heathy Woodlands	8.51	3.916	49	3
	Herb-rich Woodlands	5.9	2.222	20	1
	Lowland Forests	3.33	1.633	6	1
	Rocky outcrop or Escarpment Scrubs	5.25	3.649	56	4
Lowan Mallee	Heathlands	2.58	2.126	38	4
	Mallee	3.04	1.989	24	3
	Plains Woodlands or Forests	5.5	2.380	4	1
Murray Mallee	No Native Vegetation	1.54	1.561	13	3
	Plains Grasslands and Chenopod Shrublands	4.26	2.116	23	2
	Riverine Grassy Woodlands or Forests	7.92	3.218	93	7
	Salt-tolerant and/or succulent Shrublands	3.13	2.167	15	1
	Wetland Freshwater	2.4	1.920	15	1

Bioregion	EVC Group	Mean	Standard Deviation	Number of surveys	Number of sites
Wimmera	Box Ironbark Forests or dry/lower fertility Woodlands	5.0	2.160	13	1
	Heathy Woodlands	5.37	3.390	71	5
	Lower Slopes or Hills Woodlands	8.13	3.563	70	6
	Mallee	8.0	2.330	8	1
	No Native Vegetation	1.80	1.927	108	7
	Plains Grasslands and Chenopod Shrublands	7.58	3.538	97	8
	Plains Woodlands or Forests	10.2	5.323	154	11
	Riparian Forests or Woodlands	10.16	2.637	55	3
	Riparian and/or Swampy Scrubs and Woodlands	10.21	4.697	57	4
	Riverine Grassy Woodlands or Forests	9.58	3.737	78	6
	Salt-tolerant and/or succulent Shrublands	2.61	1.990	36	4
	Wetland Freshwater	7.65	3.429	98	7
	Wetland Saline	2.95	2.718	19	1

Table 4-10 shows that, not unexpectedly, the EVC groups are not evenly distributed across each bioregion. At this level of breakdown, many EVC groups are represented by only one site. However, the influence of bioregions on bird species richness can be examined by looking the same EVC group across bioregions. Two examples are shown in Figure 4-5 and Figure 4-6, which show bird species richness data for two EVC groups across different bioregions.

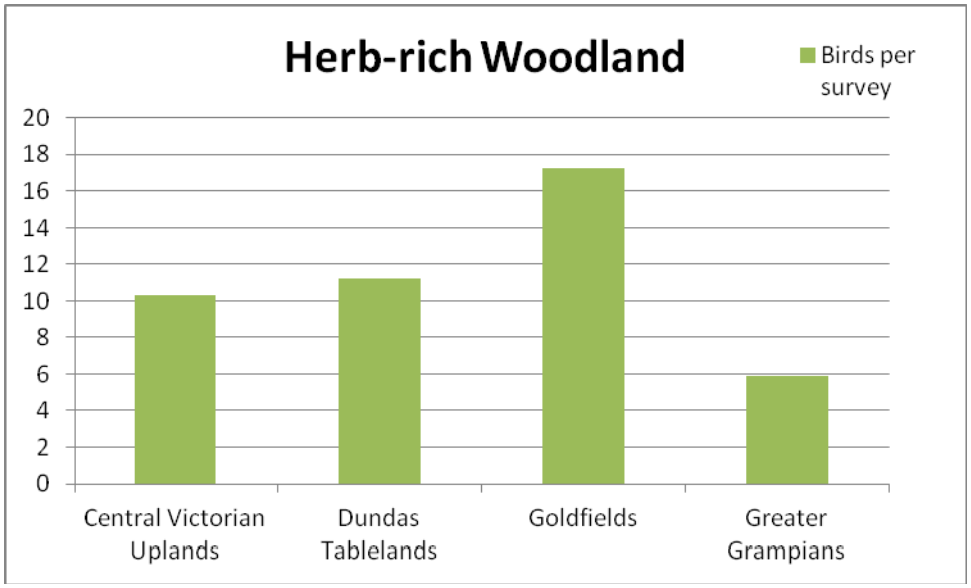

Figure 4-5. Average birds per survey across four bioregions for Herb-rich Woodlands EVC group.

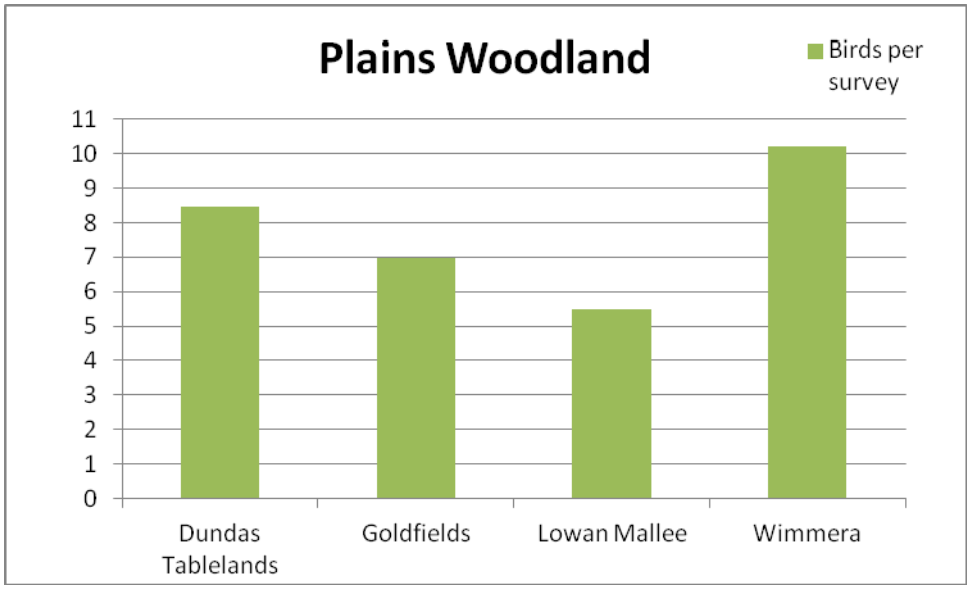

Figure 4-6. Average birds per survey across four bioregions for the Plains Woodlands or Forests EVC group.

The results in Figure 4-5 and Figure 4-6 show great variation in bird species richness within EVC groups across bioregions. This most likely reflects differences in vegetation composition and condition in different parts of the catchment. The Lowan Mallee Bioregion encompasses mostly the infertile sandy soils of Little Desert and southern Big Desert, whereas the Wimmera Bioregion encompasses the more fertile plains and higher rainfall regions in the south (see DSE website).

4.6 Geographic distribution by local government districts

Bird species richness data can be analysed according to the local government district in which sites are located. The results, for all EVC groups combined, are shown in Table 4-1 and Figure 4-7. Sites where less than four surveys were undertaken are not included in the analysis.

Table 4-11. Bird species richness data (mean birds per survey) for the different local government districts in the Wimmera. Standard deviation, number of surveys completed and number of sites surveyed are also shown.

Local Government district	Mean birds per survey	Stand. Dev.	Number of surveys	Number of sites
Ararat Shire	6.06	2.567	50	6
Buloke Shire	3.40	2.945	20	3
Hindmarsh Shire	7.30	4.039	207	17
Horsham Regional City	8.34	4.955	424	28
Northern Grampians Shire	7.97	5.419	272	23
Pyrenees Shire	10.24	5.377	34	5
West Wimmera Shire	4.92	3.286	289	23
Yarriambiack Shire	7.1-	3.947	189	16

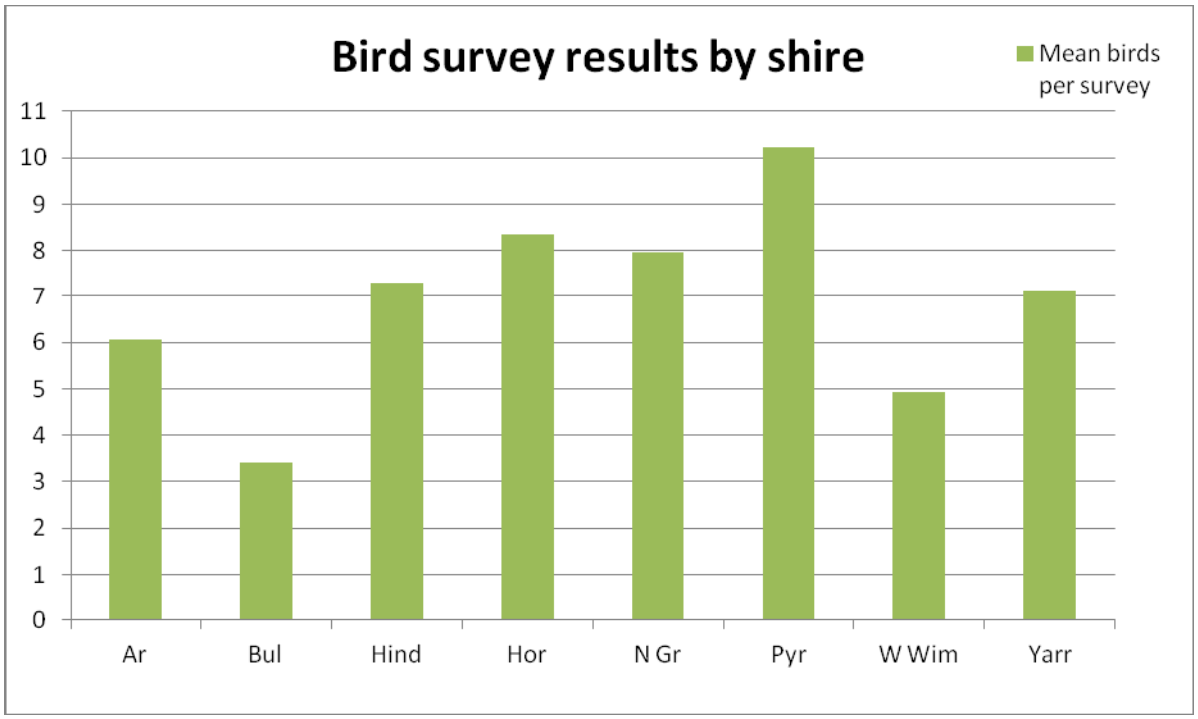

Figure 4-7. Bird species richness data for sites in the eight local government districts in the Wimmera.

Ar = Ararat Shire, Bul = Buloke Shire, Hind = Hindmarsh Shire, Hor = Horsham Regional City, N Gr = Northern Grampians, Pyr = Pyrenees Shire, W Wim = West Wimmera Shire, Yarr = Yarriambiack Shire

Table 4-11 and Figure 4-7 show great variation in bird species richness across the different local government districts, with the Pyrenees Shire supporting the highest species richness, and Buloke Shire the lowest. In the Buloke Shire, only three sites were represented, and one of these was a site of No Native Vegetation, so the EVC grouips within each shire will have a strong bearing on overall species richness by shire. Table 4-12 shows the breakdown of species richness per EVC group within each local government district.

Table 4-12. Bird species richness data for each EVC group within the eight different local government boundaries. Mean birds per survey, standard deviation, number of surveys and number of sites are shown.

Local government district	EVC Group	Mean	Stand. Dev.	Number surveys	Number of sites
Ararat	Dry Forests	6.63	2.712	19	3
	Lower Slopes or Hills Woodlands	4.33	1.633	6	1
	No Native Vegetation	5.33	1.715	18	1
	Rocky outcrop or Escarpment Scrubs	7.86	3.436	7	1
Buloke	No Native Vegetation	0.5	0.756	8	2
	Plains Grasslands and Chenopod Shrublands	5.33	2.103	12	1
Hindmarsh	Heathlands	1.64	1.502	11	1
	Lower Slopes or Hills Woodlands	8.83	2.483	6	1
	No Native Vegetation	3.20	0.837	5	1
	Plains Grasslands and Chenopod Shrublands	8.71	3.197	17	2
	Plains Woodlands or Forests	11.0	2.602	14	1
	Riverine Grassy Woodlands or Forests	8.56	3.183	70	5
	Salt-tolerant and/or succulent Shrublands	3.13	2.167	15	1
	Wetland Freshwater	6.91	4.252	69	5
Horsham	Heathlands	8.57	2.839	21	1
	Heathy Woodlands	7.02	4.364	63	4
	Herb-rich Woodlands	11.24	2.844	21	1
	No Native Vegetation	0.87	0.730	30	2
	Plains Woodlands or Forests	11.19	4.287	90	6
	Riparian Forests or Woodlands	10.26	2.468	38	2
	Riparian and/or Swampy Scrubs and Woodlands	11.28	4.559	46	3
	Riverine Grassy Woodlands or Forests	10.24	4.499	37	3
	Rocky Outcrop or Escarpment Scrubs	4.19	2.095	27	2
	Salt-tolerant and/or succulent Shrublands	2.23	1.960	30	3
	Wetlands Freshwater	8.43	2.856	21	1
Northern Grampians	Box Ironbark Forests or dry/lower fertility Woodlands	6.77	2.956	30	2
	Dry Forests	6.42	3.202	26	2
	Heathy Woodlands	6.18	3.290	22	2
	Herb-rich Woodland	12.07	7.024	45	3
	Lower Slopes or Hills Woodlands	13.67	5.989	6	1
	Lowland Forests	3.33	1.633	6	1
	No Native Vegetation	4.53	2.615	15	1
	Plains Woodlands or Forests	8.84	6.414	55	5
	Riparian Forests or Woodlands	9.94	3.051	17	1
	Riparian and/or Swampy Scrubs and Woodlands	5.73	1.618	11	1
	Rocky outcrop or	6.24	4.469	29	3

Local government district	EVC Group	Mean	Stand. Dev.	Number surveys	Number of sites
	Escarpment Scrubs				
	Wetland Freshwater	5.0	2.00	10	1
Pyrenees	Box Ironbark Forests or dry/lower fertility Woodlands	15.5	4.140	8	1
	Dry Forests	10.08	4.425	13	2
	Herb-rich Woodlands	11.33	1.751	6	1
	No Native Vegetation	3.57	2.699	7	1
West Wimmera	Heathlands	2.96	2.244	27	3
	Heathy Woodlands	6.66	3.497	44	3
	Lower Slopes or Hills Woodlands	7.87	2.877	38	2
	Mallee	3.04	1.989	24	3
	No Native Vegetation	1.61	1.346	38	2
	Plains Grasslands and Chenopod Shrublands	4.83	2.427	40	3
	Plains Woodlands or Forests	6.93	3.016	30	3
	Salt-tolerant and/or succulent Shrublands	4.50	0.548	6	1
	Wetland Freshwater	5.74	1.888	23	2
	Wetland Saline	2.95	2.718	19	1
Yarriambiack	Lower Slopes or Hills Woodlands	8.34	4.613	26	3
	Mallee	8.0	2.330	8	1
	No Native Vegetation	1.56	1.805	25	2
	Plains Grasslands and Chenopod Shrublands	8.39	3.721	51	4
	Plains Woodlands or Forests	5.87	1.685	15	1
	Riverine Grassy Woodlands or Forests	7.91	3.048	64	5

The results in Table 4-12 show that there is great variation in bird species richness within each local government district, and that this variation is driven by the different EVC groups. The influence of geographic variation (local government districts) on bird species richness can examined by graphing EVC groups across different districts. Figure 4-8 and Figure 4-9 show bird species richness data for two EVC groups across different local government districts.

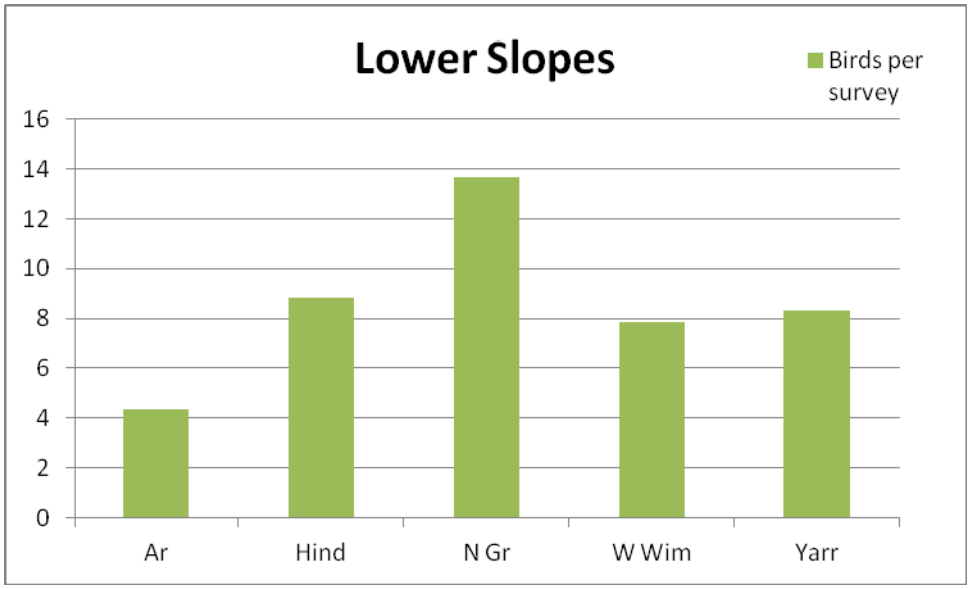

Figure 4-8. Average birds per survey across five local government districts for the Lower Slopes or Hills Woodlands EVC group.

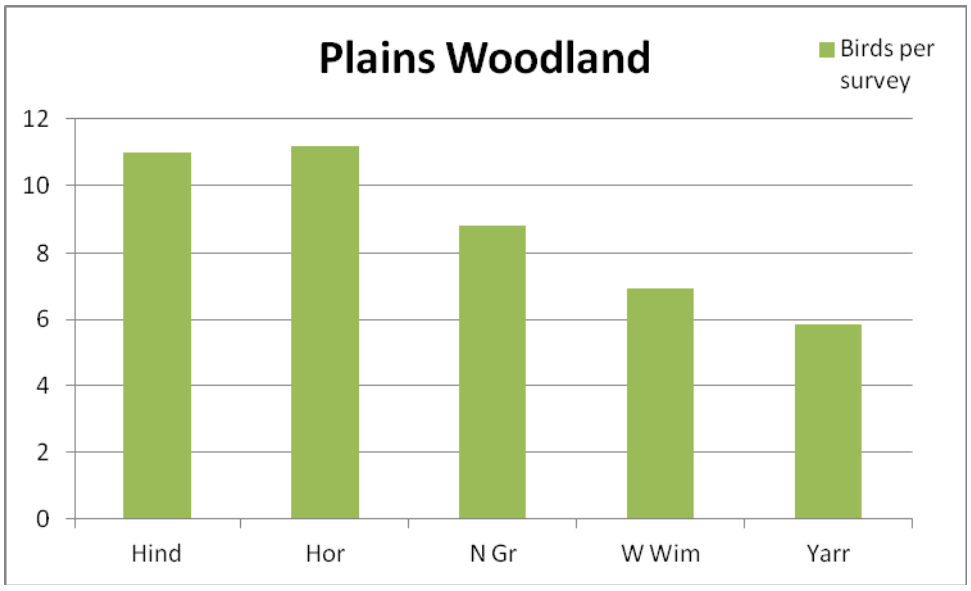

Figure 4-9. Average birds per survey across five local government districts for the Plains Woodlands or Forests EVC group.

The results in Figure 4-8 and Figure 4-9 show great variation in bird species richness within EVC groups across local government districts. This most likely reflects differences in vegetation composition and condition in different parts of the catchment.

4.7 Species composition

The most widespread and most abundant species recorded during the bird monitoring project are shown in Table and Table . The analysis of results for the five different site parameters all indicate that it is vegetation community (EVC group) which accounts for the greatest variability of species richness across the catchment. The species composition of the different EVC groups can be examined to determine whether species composition varies across different EVC groups and which bird species might drive any observed differences.

Table 4-3 ranked the EVC groups according to mean species richness. The top six EVC groups can be divided into two groups - those associated with watercourses and floodplain habitats (Riparian and/or Swampy Scrubs or Woodland, Riparian Forests or Woodlands and Riverine Grassy Woodlands or Forests), and those which generally occur on hilly, undulating or plains country away from watercourses and floodplains (Herb-rich Woodlands, Plains Woodland or Forest Plains Woodland, and Box Ironbark Forests or dry/lower fertility Woodlands).

The species composition of these two groups can be analysed to determine the similarities or differences in their bird species composition. An analysis of similarity (ANOSIM) was performed on the bird monitoring data. The results can be displayed graphically as an MDS (multi Dimensional Scaling) plot, where sites with similar bird species composition are plotted close together, and sites with less similarity are plotted further apart (Figure 4-10).

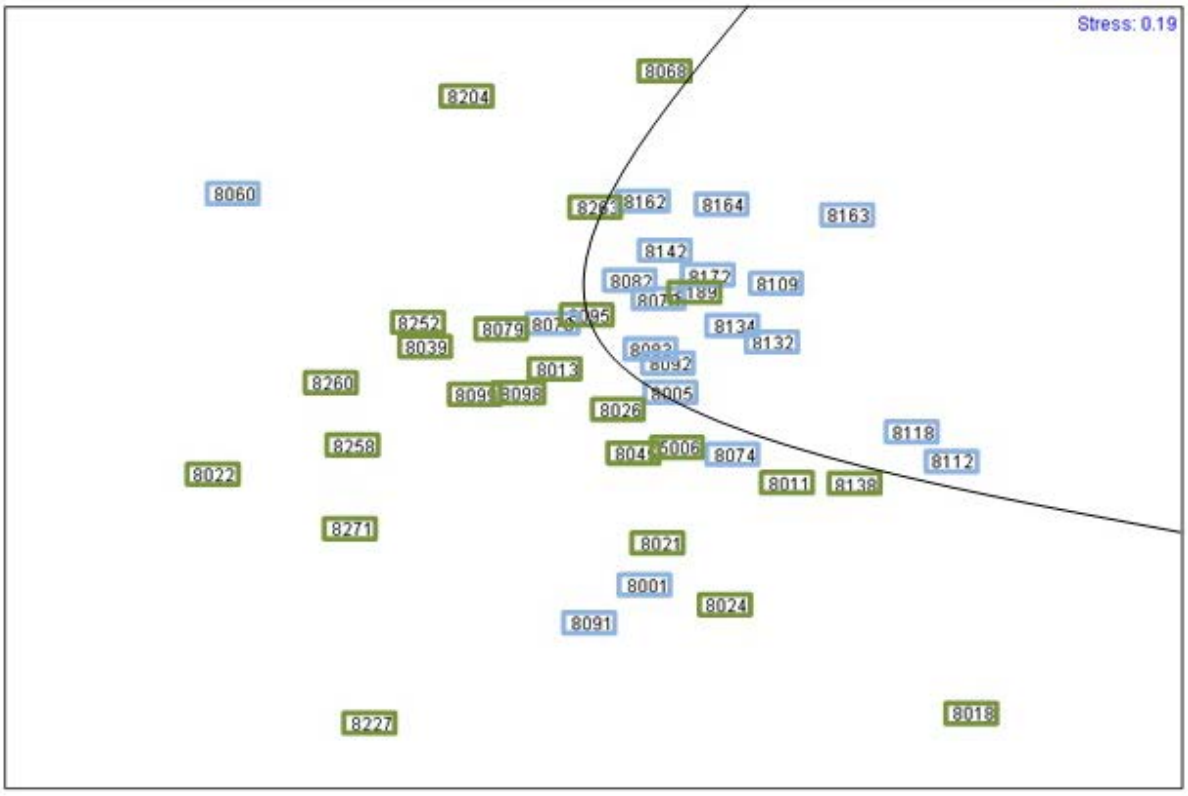

Figure 4-10. MDS plot of sites in riparian/ riverine habitats (blue) and sites in the three main woodland habitats (green). The black curved line delineates visually the cluster of riparian/ riverine sites in the upper right portion of the plot.

The MDS plot in Figure 4-10 shows a distinct cluster of sites in riparian/ riverine habitats, indicating a similarity in the species composition of these sites. Analysis of the data showed that bird species composition differed significantly

between sites in riparian/ riverine habitats and sites in hills/plains woodland habitats (ANOSIM, R = 0.161, *P* = 0.001).

For sites in riparian/ riverine habitats, a SIMPER analysis showed that 12 species contributed approximately 70% of the similarity of their bird compositions. Those species contributing most include Galah (11.1%), Red-rumped Parrot (9.0%), Australian Magpie (8.52%), Brown Treecreeper (6.69%), Willie Wagtail (6.26%) and White-plumed Honeyeater (5.3%).

For sites in the main hills/plains woodland habitat group, a SIMPER analysis showed that 16 species contributed approximately 70% of the similarity of their bird assemblages, including Australian Magpie (8.27%), Red Wattlebird (7.22%), Galah (6.31%), White-plumed Honeyeater (5.78%) and Sulphur-crested Cockatoo (5.47%).

Between the two habitat groupings, a SIMPER analysis showed that the species which contributed most to the differences in species composition were Red-rumped Parrot (3.36%), Brown Treecreeper (2.75%), White-plumed Honeyeater (6.89%), Sulphur-crested Cockatoo (2.73%) and Superb Fairy-wren (2.57%). Red-rumped Parrots were over three times more abundant at sites in riparian/ riverine habitats. Similarly, Brown Treecreepers were nearly twice as abundant at sites in riparian/ riverine habitats. In contrast, Superb Fairy-wren and Sulphur-crested Cockatoo were more abundant in the hills/plains woodland habitat sites. Australian Magpie was found to have similar abundance in both habitat groups and therefore contributed little to the observed differences between them.

4.8 Species as Indicators of biodiversity

Species which are relatively common and well known but sensitive to disturbance can be used as indicators of environmental change. The presence (or absence) of such species at a site can be used to indicate the relative health of the environment at that site (see Birds Australia 2003).

The analysis of the WBMP species composition data revealed that certain species make large contributions to the similarity of bird populations within vegetation communities, and large contributions to the differences between vegetation communities. The presence or absence of these species can therefore be indicative of the relative biodiversity values of sites and of vegetation communities. An example of this is the Brown Treecreeper, a sedentary woodland bird that is both widespread and relatively abundant across the Wimmera (see Table 4-1 and Table), and differed in its contribution to species composition across EVC groups (see *Species Composition*, above). Brown Treecreepers are listed as Vulnerable in NSW where it is considered sensitive to habitat change, particularly the loss of suitable hollow-bearing trees, fallen timber, overgrazing and loss of ground litter (NSW Environment & Heritage website). In Victoria, Brown Treecreeper is listed as Near Threatened on the DSE Advisory List of Threatened Vertebrate Fauna, 2007.

Brown Treecreeper, an example of an indicator species

The WBMP database contains 490 records of Brown Treecreeper from 70 sites surveyed four or more times, at an overall reporting rate of 33%.

Table **4-12** shows reporting rates of Brown Treecreeper recorded within each EVC group across the Wimmera.

Table 4-12. Reporting rates of Brown Treecreepers recorded in each EVC group. The total number of surveys undertaken and total number of sites surveyed is also shown.

Vegetation community (EVC group)	Reporting Rate (%)	Number of surveys	Number of sites
Riparian Forests or Woodlands	69.09	55	3
Riverine Grassy Woodlands or Forests	64.33	171	13
Riparian and/or Swampy Scrubs or Woodland	54.39	57	4
Plains Grasslands and Chenopod Shrublands	52.50	120	10
Box Ironbark Forests or dry/lower fertility Woodlands	47.37	38	3
Lower Slopes or Hills Woodlands	46.34	82	8
Plains Woodland or Forest Plains Woodland	38.73	204	16
Dry Forests	32.76	58	7
Herb-rich Woodlands	30.56	72	5
Heathy Woodlands	25.58	129	9
Wetland Freshwater	23.58	123	9
Mallee	12.50	33	4
Wetland Saline	5.26	19	1
Rocky outcrop or Escarpment Scrubs	4.76	63	6
Heathlands	1.69	59	5
No Native Vegetation	0.68	146	12
Lowland Forests	0	6	1
Salt-tolerant and/or succulent Shrublands	0	51	5

The results in

Table **4-12** show that Brown Treecreepers were most abundant in the three riparian/ riverine EVC groups (see Table 4-3). Brown Treecreepers also showed high relative abundance in the Plains Grassland and Chenopod Shrublands EVC group, the Box Ironbark Forests or dry/lower fertility Woodlands EVC group and the Lower Slopes or Hills Woodlands EVC group. In contrast, Brown Treecreepers were rarely recorded in Mallee or Heathlands EVC groups.

In the Wimmera, both the Plains Grassland and Chenopod Shrubland EVC group and Lower Slopes or Hills Woodlands EVC group are dominated by endangered EVCs (DSE website). The presence of Brown Treecreepers in endangered vegetation communities and in vegetation communities of high species richness demonstrates that this species can be used as an indicator of sites important both for high conservation value and sites supporting high biodiversity value.

The indicator species concept can be used effectively as a broad approach across woodland communities but should be used with caution with specialised vegetation communities. As an example, Salt-tolerant and/or succulent Shrublands as an EVC group was found to be relatively poor in bird species diversity (see Table 4-3), yet is floristically complex, contains a number of threatened EVCs within the Wimmera and supports numerous listed threatened species.

4.9 Birds as indicators of environmental change

Changes in bird species richness and relative abundance over time can be used as a measure of changing environmental conditions at a site. An example of this can be seen in a series of three surveys undertaken at a site on the Mackenzie River near Horsham. The first survey was undertaken on 11 October 2005, when the creek was dry. An environmental flow down the river occurred the following week. Follow-up surveys were conducted on 28 October, 5 November and 4 December 2005. The results of the four surveys are shown in Figure 4-11.

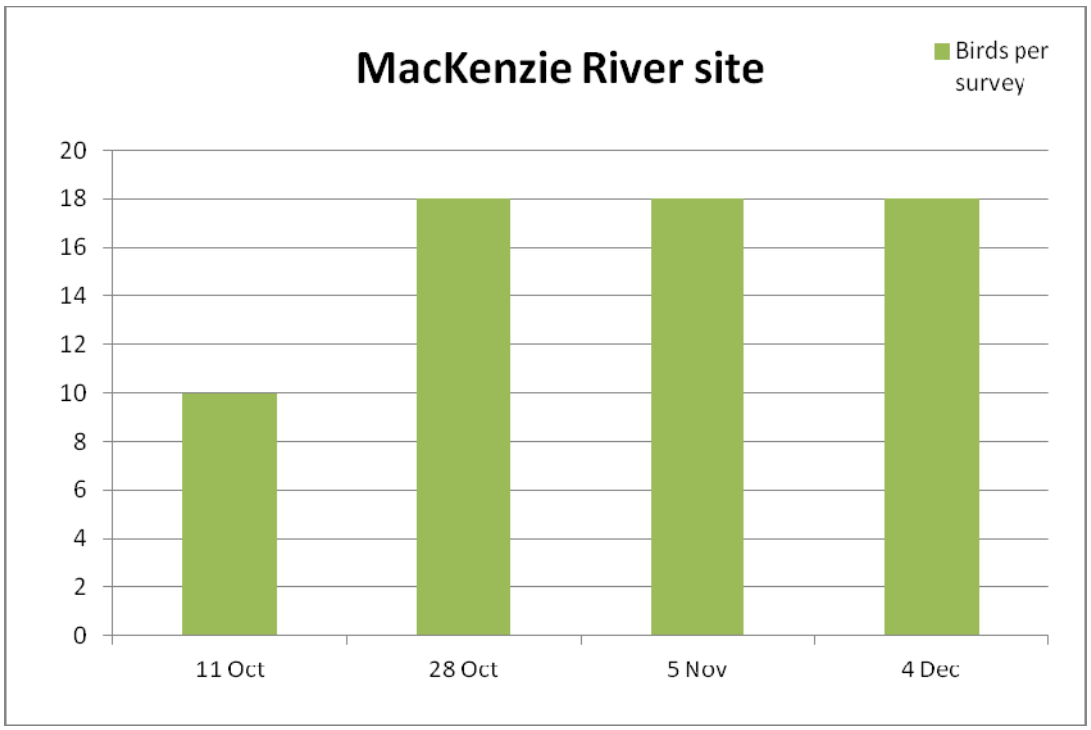

Figure 4-11. Results of four surveys around an environmental flow at Mackenzie River in 2005.

Although limited to only four surveys at a single site, they recorded a dramatic increase in the number of birds surveyed, up from ten birds pre-flow, to 18 birds on all three post-flow surveys. Most of the ten species recorded during the first survey were still present during the subsequent surveys. The increase was due mainly to an influx of insectivorous birds. Waterbirds were recorded at the site on 28 October and 4 December.

5. Discussion

The analysis of results show that the site parameter with the strongest influence on relative biodiversity values (as measured by birds) across the Wimmera catchment is the vegetation community, or EVC group. Bird species richness data for EVC groups showed a greater than four-fold difference between the most diverse vegetation community (Herb-rich Woodlands) and the least diverse (Salt-tolerant and/or succulent Shrublands) (Table 4-3). The characteristics which define EVCs, such as eucalypt-lined watercourses in riparian woodlands, or succulent chenopod shrubs in salt-tolerant shrublands, also explain why bird species richness varies. For example, chenopod shrubs grow in harsh, often highly saline conditions, and are relatively slow growing. They produce little nectar or sap and do not attract a very broad suite of insects. Riparian understorey tends to grow in fertile, well-watered conditions and is floristically very productive (see Costermans 2009). These characteristics will, however, vary in condition across the catchment and be influenced by factors such as geography, stream flow, water quality and land use.

The results showed significant geographic differences within vegetation communities (see Table 4-10 and Table 4-11). Bioregions partly capture these differences, because bioregions reflect grouped landscape-scale natural features and environmental processes. However, the significant variation between EVC groups within bioregions (Table 4-10), and the significant variation within EVC groups between bioregions (Figure 4-4 and Figure 4-5) demonstrate that bioregions only account for some of observed differences in biodiversity values across the catchment.

Another factor explaining geographic variation in bird species richness within EVC groups is water quality and stream flow. This is particularly important for riverine/ riparian vegetation types, which grow along waterways and associated floodplains. The bird monitoring results (Table 4-12) show that bird species richness for riparian/ riverine EVC groups varied geographically (local council districts). During the five year survey period, stream flow down the main waterways in the catchment (Wimmera River and Yarriambiack Creek) was low to non-existent (unpublished WCMA data). The highest bird species richness for riparian/ riverine EVC groups was recorded in the Horsham local council district, where salinity levels were lowest and some stream flow occurred. Moderate levels of bird species richness were recorded in the Hindmarsh local council district, where water was present but salinity levels were higher. The lowest bird species richness for riparian/ riverine EVC groups was recorded in the Yarriambiack local council district, where water was absent.

The effect of stream flow on bird populations can also be demonstrated through observations at the Mackenzie River site (Figure 4-11). The dramatic increase in bird species richness following an environmental release demonstrates not only the importance of stream flow to birds (and by inference, biodiversity) but the ability of bird monitoring as a tool to detect rapid environmental change.

The bird monitoring results also demonstrate that significant differences in biodiversity values linked are to land tenure (
Table **4-4**). The differences in relative biodiversity values observed have implications for the way land is managed across the catchment. For example, Box Ironbark habitats had significantly higher biodiversity values on public land compared to freehold. This suggests that land use practices on private land are degrading the value of these

habitats for biodiversity. Freshwater wetland habitats had significantly higher biodiversity values on freehold land compared with crown land, suggesting that land management practices on freehold land were beneficial to biodiversity. The reasons for these observed differences would only become apparent from a more detailed examination of the attributes of the respective vegetation communities.

Some bird species are more indicative of biodiversity values than others. The results have shown that presence of certain bird species at a site are can be good indicators of relative biodiversity values. Species such as the Brown Treecreeper can be used to indicate high conservation value vegetation. The presence or absence of these species can be used guide management decisions for prioritising on-ground habitat works such as protection, revegetation and connectivity.

6. Management Implications

One of the original aims of the bird monitoring project was to track the condition of WCMA assets as measured by bird communities. The results of the bird monitoring project have shown that biodiversity differences exist across the catchment and that these differences are expressed most strongly through variation in vegetation communities, and to a lesser extent, geography and land tenure. The condition of an environmental asset can be measured across any gradient by assessing relative biodiversity values. Gradients can occur across time, such as the establishment and growth of revegetation areas, the regrowth of native vegetation following fire, or long-term changes in vegetation quality due to climatic variation. Gradients can also be physical, such as salinity differences along waterways, the impacts of environmental water releases or the effectiveness of landscape connectivity. Biodiversity values along these gradients can be measured through analysing the survey data in the bird monitoring database. An example of this can be seen in the results for geographic variation within EVC groups (see Results, section 4.6). The bird monitoring project has demonstrated both the feasibility and effectiveness of tracking WCMA assets by measuring bird communities.

A second aim of the bird monitoring project was to establish a strategy for gauging the success of on-ground management for protecting terrestrial biodiversity. This project has demonstrated that regular bird monitoring at selected sites can be an effective method of measuring biodiversity values across the catchment. The Wimmera CMA has invested huge sums of money into on-ground management activities, including protection and enhancement of native vegetation on private land through tender and incentive funding models, revegetation programs, salinity control, wetland and riparian restoration. Site inspections may reveal reductions in weed levels or pest animal activity, changes in vegetation structure and condition, or growth and survival rates in revegetation plots, but do not reveal much about the ecological function of these sites. Are we just planting trees, or creating additional, ecologically functioning habitat for wildlife? An assessment of the biodiversity value of a site, as measured by birds, can be a powerful way of gauging the success of on-ground management programs.

Understanding catchment-wide biodiversity values will allow the WCMA to make informed decisions for priority planning and decision-making within the framework of its Regional Catchment Strategy.

7. Recommendations

The following broad recommendation can be made from the outcomes of the Wimmera Bird Monitoring Project.

Incorporate the biodiversity values of vegetation communities into on-ground management planning and action.

The WCMA possesses a large dataset showing the relative biodiversity values of different vegetation communities (as measured by EVC groups) across the Wimmera catchment. The WCMA can identify which vegetation communities support the highest biodiversity values and determine where high biodiversity values occur. From a geographic perspective, the WCMA can identify high value areas on a broad scale, such as by regional council boundaries or waterway catchment, or on a local scale, such as local Landcare groups. This can help form the basis of identifying priority areas, or priority zones within a defined area.

From an ecological perspective, high value vegetation communities can be prioritised within identified geographic boundaries, or catchment-wide. Priorities can also be determined for focal species, either directly from existing records, or through extrapolation from known habitat values.

The land tenure of identified high biodiversity priority areas can also help determine the focus of activities, for example, on co-operative management, such as with government agencies if on crown land, landholder agreements if on private land, or with multiple groups if building connectivity between priority areas of different tenure.

An additional recommendation is made for on-going monitoring of key sites across the catchment.

The Wimmera Bird Monitoring Project conducted surveys for five years. Some sites have been monitored continuously since 2005. The Wimmera experienced drought conditions for most of the five year monitoring period. Although this data set reflects biodiversity values as they existed in a dry climate period, only through on-going monitoring will it be possible to reveal how biodiversity values change with, for example, the flooding rains of 2010, and therefore how assets change with changing climate. Bird monitoring has continued since 2009 at approximately 20 sites, driven partly by the efforts of dedicated volunteers, and partly through WCMA projects such as EWR monitoring and Project Hindmarsh. Maintaining a degree of monitoring of key sites will allow the WCMA to continuously track the condition of catchment assets, the effectiveness of on-ground works and environmental response to climate change.

8. References

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9. Appendix 1

List of bird species recorded in the Wimmera, showing their taxonomic relationship of Order and Family, plus their common names and scientific names. The Birds Australia Atlas numbers are also shown. The list has been compiled from information supplied by Horsham BirdLife and from sightings data in the Wimmera Bird Monitoring Project database.

ORDER, Family, Common Name	**Scientific Name**	**Atlas No.**
CASUARIIFORMES		
Casuariidae		
Emu	*Dromaius novaehollandiae*	1
GALLIFORMES		
Megapodiidae		
Malleefowl	*Leipoa ocellata*	7
Phasianidae		
Stubble Quail	*Coturnix pectoralis*	9
Brown Quail	*Coturnix ypsilophora*	11
ANSERIFORMES		
Anatidae		
Plumed Whistling-Duck	*Dendrocygna eytoni*	205
Musk Duck	*Biziura lobata*	217
Freckled Duck	*Stictonetta naevosa*	214
Cape Barren Goose	*Cereopsis novaehollandiae*	198
Black Swan	*Cygnus atratus*	203
Australian Shelduck	*Tadorna tadornoides*	207
Australian Wood Duck	*Chenonetta jubata*	202
Pink-eared Duck	*Malacorhynchus membranaceus*	213
Australasian Shoveler	*Anas rhynchotis*	212
Grey Teal	*Anas gracilis*	211
Chestnut Teal	*Anas castanea*	210
Pacific Black Duck	*Anas superciliosa*	208
Hardhead	*Aythya australis*	215
Blue-billed Duck	*Oxyura australis*	216
PODICIPEDIFORMES		
Podicipedidae		
Australasian Grebe	*Tachybaptus novaehollandiae*	61
Hoary-headed Grebe	*Poliocephalus poliocephalus*	62
Great Crested Grebe	*Podiceps cristatus*	60
COLUMBIFORMES		
Columbidae		
Rock Dove	*Columba livia*	957
Spotted Turtledove	*Streptopelia chinensis*	989
Common Bronzewing	*Phaps chalcoptera*	34
Brush Bronzewing	*Phaps elegans*	35
Crested Pigeon	*Ocyphaps lophotes*	43
Diamond Dove	*Geopelia cuneata*	31
Peaceful Dove	*Geopelia striata*	30
CAPRIMULGIFORMES		
Podargidae		
Tawny Frogmouth	*Podargus strigoides*	313

ORDER, Family, Common Name	**Scientific Name**	**Atlas No.**
Eurostopodidae		
White-throated Nightjar	*Eurostopodus mystacalis*	330
Spotted Nightjar	*Eurostopodus argus*	331
APODIFORMES		
Aegothelidae		
Australian Owlet-nightjar	*Aegotheles cristatus*	317
Apodidae		
White-throated Needletail	*Hirundapus caudacutus*	334
Fork-tailed Swift	*Apus pacificus*	335
Anhingidae		
Australasian Darter	*Anhinga novaehollandiae*	101
Phalacrocoracidae		
Little Pied Cormorant	*Microcarbo melanoleucos*	100
Great Cormorant	*Phalacrocorax carbo*	96
Little Black Cormorant	*Phalacrocorax sulcirostris*	97
Pied Cormorant	*Phalacrocorax varius*	99
CICONIIFORMES		
Pelecanidae		
Australian Pelican	*Pelecanus conspicillatus*	106
Ardeidae		
Australasian Bittern	*Botaurus poiciloptilus*	197
Australian Little Bittern	*Ixobrychus dubius*	195
White-necked Heron	*Ardea pacifica*	189
Eastern Great Egret	*Ardea modesta*	187
Intermediate Egret	*Ardea intermedia*	186
Cattle Egret	*Ardea ibis*	977
White-faced Heron	*Egretta novaehollandiae*	188
Little Egret	*Egretta garzetta*	185
Nankeen Night-Heron	*Nycticorax caledonicus*	192
Threskiornithidae		
Glossy Ibis	*Plegadis falcinellus*	178
Australian White Ibis	*Threskiornis molucca*	179
Straw-necked Ibis	*Threskiornis spinicollis*	180
Royal Spoonbill	*Platalea regia*	181
Yellow-billed Spoonbill	*Platalea flavipes*	182
ACCIPITRIFORMES		
Accipitridae		
Black-shouldered Kite	*Elanus axillaris*	232
Letter-winged Kite	*Elanus scriptus*	233
Square-tailed Kite	*Lophoictinia isura*	230
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	226
Whistling Kite	*Haliastur sphenurus*	228
Black Kite	*Milvus migrans*	229
Brown Goshawk	*Accipiter fasciatus*	221
Collared Sparrowhawk	*Accipiter cirrocephalus*	222
Spotted Harrier	*Circus assimilis*	218
Swamp Harrier	*Circus approximans*	219
Wedge-tailed Eagle	*Aquila audax*	224
Little Eagle	*Hieraaetus morphnoides*	225
FALCONIFORMES		
Falconidae		

ORDER, Family, Common Name	**Scientific Name**	**Atlas No.**
Nankeen Kestrel	*Falco cenchroides*	240
Brown Falcon	*Falco berigora*	239
Australian Hobby	*Falco longipennis*	235
Black Falcon	*Falco subniger*	238
Peregrine Falcon	*Falco peregrinus*	237
GRUIFORMES		
Gruidae		
Brolga	*Grus rubicunda*	177
Rallidae		
Purple Swamphen	*Porphyrio porphyrio*	58
Buff-banded Rail	*Gallirallus philippensis*	46
Baillon's Crake	*Porzana pusilla*	50
Australian Spotted Crake	*Porzana fluminea*	49
Spotless Crake	*Porzana tabuensis*	51
Black-tailed Native-hen	*Tribonyx ventralis*	55
Dusky Moorhen	*Gallinula tenebrosa*	56
Eurasian Coot	*Fulica atra*	59
Otididae		
Australian Bustard	*Ardeotis australis*	176
CHARADRIIFORMES		
Burhinidae		
Bush Stone-curlew	*Burhinus grallarius*	174
Recurvirostridae		
Black-winged Stilt	*Himantopus himantopus*	146
Red-necked Avocet	*Recurvirostra novaehollandiae*	148
Banded Stilt	*Cladorhynchus leucocephalus*	147
Charadriidae		
Red-capped Plover	*Charadrius ruficapillus*	143
Double-banded Plover	*Charadrius bicinctus*	140
Inland Dotterel	*Charadrius australis*	145
Black-fronted Dotterel	*Elseyornis melanops*	144
Red-kneed Dotterel	*Erythrogonys cinctus*	132
Banded Lapwing	*Vanellus tricolor*	135
Masked Lapwing	*Vanellus miles*	133
Pedionomidae		
Plains-wanderer	*Pedionomus torquatus*	20
Rostratulidae		
Australian Painted Snipe	*Rostratula australis*	170
Scolopacidae		
Latham's Snipe	*Gallinago hardwickii*	168
Common Greenshank	*Tringa nebularia*	158
Marsh Sandpiper	*Tringa stagnatilis*	159
Red-necked Stint	*Calidris ruficollis*	162
Sharp-tailed Sandpiper	*Calidris acuminata*	163
Curlew Sandpiper	*Calidris ferruginea*	161
Turnicidae		
Painted Button-quail	*Turnix varius*	14
Red-chested Button-quail	*Turnix pyrrhothorax*	19
Little Button-quail	*Turnix velox*	18
Glareolidae		
Australian Pratincole	*Stiltia isabella*	173

ORDER, Family, Common Name	**Scientific Name**	**Atlas No.**
Laridae		
Gull-billed Tern	*Gelochelidon nilotica*	111
Whiskered Tern	*Chlidonias hybrida*	110
Silver Gull	*Chroicocephalus novaehollandiae*	125
PSITTACIFORMES		
Cacatuidae		
Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*	264
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	267
Gang-gang Cockatoo	*Callocephalon fimbriatum*	268
Galah	*Eolophus roseicapillus*	273
Long-billed Corella	*Cacatua tenuirostris*	272
Little Corella	*Cacatua sanguinea*	271
Sulphur-crested Cockatoo	*Cacatua galerita*	269
Cockatiel	*Nymphicus hollandicus*	274
Psittacidae		
Rainbow Lorikeet	*Trichoglossus haematodus*	254
Musk Lorikeet	*Glossopsitta concinna*	258
Little Lorikeet	*Glossopsitta pusilla*	260
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*	259
Regent Parrot	*Polytelis anthopeplus*	278
Crimson Rosella	*Platycercus elegans*	282
Eastern Rosella	*Platycercus eximius*	288
Australian Ringneck	*Barnardius zonarius*	294
Blue Bonnet	*Northiella haematogaster*	297
Swift Parrot	*Lathamus discolor*	309
Red-rumped Parrot	*Psephotus haematonotus*	295
Mulga Parrot	*Psephotus varius*	296
Budgerigar	*Melopsittacus undulatus*	310
Blue-winged Parrot	*Neophema chrysostoma*	306
Elegant Parrot	*Neophema elegans*	307
CUCULIFORMES		
Cuculidae		
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	342
Black-eared Cuckoo	*Chalcites osculans*	341
Shining Bronze-Cuckoo	*Chalcites lucidus*	344
Pallid Cuckoo	*Cacomantis pallidus*	337
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	338
STRIGIFORMES		
Strigidae		
Powerful Owl	*Ninox strenua*	248
Barking Owl	*Ninox connivens*	246
Southern Boobook	*Ninox novaeseelandiae*	242
Tytonidae		
Eastern Barn Owl	*Tyto javanica*	249
CORACIIFORMES		
Halcyonidae		
Laughing Kookaburra	*Dacelo novaeguineae*	322
Red-backed Kingfisher	*Todiramphus pyrrhopygius*	325
Sacred Kingfisher	*Todiramphus sanctus*	326
Meropidae		
Rainbow Bee-eater	*Merops ornatus*	329

ORDER, Family, Common Name	**Scientific Name**	**Atlas No.**
Coraciidae		
Dollarbird	*Eurystomus orientalis*	318
PASSERIFORMES		
Climacteridae		
White-throated Treecreeper	*Cormobates leucophaea*	558
White-browed Treecreeper	*Climacteris affinis*	561
Brown Treecreeper	*Climacteris picumnus*	555
Maluridae		
Superb Fairy-wren	*Malurus cyaneus*	529
Splendid Fairy-wren	*Malurus splendens*	532
Variegated Fairy-wren	*Malurus lamberti*	536
Acanthizidae		
White-browed Scrubwren	*Sericornis frontalis*	488
Chestnut-rumped Heathwren	*Calamanthus pyrrhopygia*	498
Shy Heathwren	*Calamanthus cautus*	499
Striated Fieldwren	*Calamanthus fuliginosus*	500
Redthroat	*Pyrrholaemus brunneus*	497
Speckled Warbler	*Chthonicola sagittata*	504
Weebill	*Smicrornis brevirostris*	465
Western Gerygone	*Gerygone fusca*	463
Striated Thornbill	*Acanthiza lineata*	470
Yellow Thornbill	*Acanthiza nana*	471
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	486
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	481
Buff-rumped Thornbill	*Acanthiza reguloides*	484
Slender-billed Thornbill	*Acanthiza iredalei*	482
Inland Thornbill	*Acanthiza apicalis*	476
Brown Thornbill	*Acanthiza pusilla*	475
Southern Whiteface	*Aphelocephala leucopsis*	466
Pardalotidae		
Spotted Pardalote	*Pardalotus punctatus*	565
Striated Pardalote	*Pardalotus striatus*	976
Meliphagidae		
Eastern Spinebill	*Acanthorhynchus tenuirostris*	591
Lewin's Honeyeater	*Meliphaga lewinii*	605
Yellow-faced Honeyeater	*Lichenostomus chrysops*	614
Singing Honeyeater	*Lichenostomus virescens*	608
White-eared Honeyeater	*Lichenostomus leucotis*	617
Yellow-tufted Honeyeater	*Lichenostomus melanops*	619
Yellow-plumed Honeyeater	*Lichenostomus ornatus*	622
Fuscous Honeyeater	*Lichenostomus fuscus*	613
White-plumed Honeyeater	*Lichenostomus penicillatus*	625
White-fronted Honeyeater	*Purnella albifrons*	594
Noisy Miner	*Manorina melanocephala*	634
Yellow-throated Miner	*Manorina flavigula*	635
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	640
Little Wattlebird	*Anthochaera chrysoptera*	712
Red Wattlebird	*Anthochaera carunculata*	638
Black Honeyeater	*Sugomel niger*	589
Tawny-crowned Honeyeater	*Glyciphila melanops*	593
Crescent Honeyeater	*Phylidonyris pyrrhopterus*	630

ORDER, Family, Common Name	**Scientific Name**	**Atlas No.**
New Holland Honeyeater	*Phylidonyris novaehollandiae*	631
Black-chinned Honeyeater	*Melithreptus gularis*	580
Brown-headed Honeyeater	*Melithreptus brevirostris*	583
White-naped Honeyeater	*Melithreptus lunatus*	578
Blue-faced Honeyeater	*Entomyzon cyanotis*	641
Crimson Chat	*Epthianura tricolor*	449
Orange Chat	*Epthianura aurifrons*	450
White-fronted Chat	*Epthianura albifrons*	448
Pomatostomidae		
Grey-crowned Babbler	*Pomatostomus temporalis*	443
White-browed Babbler	*Pomatostomus superciliosus*	445
Neosittidae		
Varied Sittella	*Daphoenositta chrysoptera*	549
Campephagidae		
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	424
White-bellied Cuckoo-shrike	*Coracina papuensis*	425
White-winged Triller	*Lalage sueurii*	430
Pachycephalidae		
Crested Shrike-tit	*Falcunculus frontatus*	416
Olive Whistler	*Pachycephala olivacea*	405
Gilbert's Whistler	*Pachycephala inornata*	403
Golden Whistler	*Pachycephala pectoralis*	398
Rufous Whistler	*Pachycephala rufiventris*	401
Grey Shrike-thrush	*Colluricincla harmonica*	408
Crested Bellbird	*Oreoica gutturalis*	419
Oriolidae		
Olive-backed Oriole	*Oriolus sagittatus*	671
Artamidae		
White-breasted Woodswallow	*Artamus leucorynchus*	543
Masked Woodswallow	*Artamus personatus*	544
White-browed Woodswallow	*Artamus superciliosus*	545
Black-faced Woodswallow	*Artamus cinereus*	546
Dusky Woodswallow	*Artamus cyanopterus*	547
Grey Butcherbird	*Cracticus torquatus*	702
Pied Butcherbird	*Cracticus nigrogularis*	700
Australian Magpie	*Cracticus tibicen*	705
Pied Currawong	*Strepera graculina*	694
Grey Currawong	*Strepera versicolor*	697
Rhipiduridae		
Rufous Fantail	*Rhipidura rufifrons*	362
Grey Fantail	*Rhipidura albiscapa*	361
Willie Wagtail	*Rhipidura leucophrys*	364
Corvidae		
Australian Raven	*Corvus coronoides*	930
Forest Raven	*Corvus tasmanicus*	868
Little Raven	*Corvus mellori*	954
Monarchidae		
Leaden Flycatcher	*Myiagra rubecula*	365
Satin Flycatcher	*Myiagra cyanoleuca*	366
Restless Flycatcher	*Myiagra inquieta*	728
Black-faced Monarch	*Monarcha melanopsis*	373

ORDER, Family, Common Name	**Scientific Name**	**Atlas No.**
Magpie-lark	*Grallina cyanoleuca*	415
Corcoracidae		
White-winged Chough	*Corcorax melanorhamphos*	693
Petroicidae		
Jacky Winter	*Microeca fascinans*	377
Scarlet Robin	*Petroica boodang*	380
Red-capped Robin	*Petroica goodenovii*	381
Flame Robin	*Petroica phoenicea*	382
Rose Robin	*Petroica rosea*	384
Hooded Robin	*Melanodryas cucullata*	385
Eastern Yellow Robin	*Eopsaltria australis*	392
Southern Scrub-robin	*Drymodes brunneopygia*	441
Alaudidae		
Horsfield's Bushlark	*Mirafra javanica*	648
Eurasian Skylark	*Alauda arvensis*	993
Cisticolidae		
Golden-headed Cisticola	*Cisticola exilis*	525
Acrocephalidae		
Australian Reed-Warbler	*Acrocephalus australis*	524
Megaluridae		
Little Grassbird	*Megalurus gramineus*	522
Rufous Songlark	*Cincloramphus mathewsi*	509
Brown Songlark	*Cincloramphus cruralis*	508
Timaliidae		
Silvereye	*Zosterops lateralis*	574
Hirundinidae		
White-backed Swallow	*Cheramoeca leucosterna*	358
Welcome Swallow	*Hirundo neoxena*	357
Fairy Martin	*Petrochelidon ariel*	360
Tree Martin	*Petrochelidon nigricans*	359
Turdidae		
Bassian Thrush	*Zoothera lunulata*	779
Common Blackbird	*Turdus merula*	991
Sturnidae		
Common Starling	*Sturnus vulgaris*	999
Nectariniidae		
Mistletoebird	*Dicaeum hirundinaceum*	564
Estrildidae		
Zebra Finch	*Taeniopygia guttata*	653
Red-browed Finch	*Neochmia temporalis*	662
Diamond Firetail	*Stagonopleura guttata*	652
Passeridae		
House Sparrow	*Passer domesticus*	995
Motacillidae		
Australasian Pipit	*Anthus novaeseelandiae*	647
Fringillidae		
European Goldfinch	*Carduelis carduelis*	996
Common Greenfinch	*Chloris chloris*	997

10. Appendix 2

Table of all sites surveyed, showing the five site parameters, plus local government region, number of surveys undertaken, mean species richness and the total number of bird species recorded at the site.

Site no.	Bioregion	EVC group name	Land Tenure	Patch Size	Isolation category	Local Government district	N surveys	Mean birds / survey	Total Species
8000	Wimmera	No Native Vegetation	Freehold	-	-	Northern Grampians	15	4.53	17
8001	Wimmera	Riparian and/ or Swampy Scrubs or Woodland	Crown Land	M	Isolated	Northern Grampians	11	5.72	17
8004	Greater Grampians	Heathy Woodlands	Crown Land	L	Continuous	Northern Grampians	13	4.85	23
8005	Wimmera	Riparian Forests or Woodlands	Crown Land	M	Isolated	Northern Grampians	17	9.94	30
8007	Goldfields	Dry Forests	Crown Land	L	Continuous	Pyrenees	7	10.71	31
8009	Wimmera	Plains Woodland or Forest Plains Woodland	Freehold	L	Semi-isolated	Northern Grampians	3	12.33	19
8011	Goldfields	Plains Woodland or Forest Plains Woodland	Freehold	S	Isolated	Northern Grampians	10	7.1	24
8013	Wimmera	Plains Woodland or Forest Plains Woodland	Freehold	L	Not Isolated	Northern Grampians	16	17.25	44
8015	Greater Grampians	Rocky outcrop or escarpment Scrubs	Crown Land	L	Continuous	Northern Grampians	16	9.44	38
8016	Wimmera	No Native Vegetation	Freehold	-	-	Yarriambiack	4	1	2
8018	Wimmera	Plains Woodland or Forest Plains Woodland	Crown Land	L	Continuous	Northern Grampians	13	2.23	9
8019	Goldfields	No Native Vegetation	Freehold	-	-	Pyrenees	7	3.57	12
8021	Goldfields	Plains Woodland or Forest Plains Woodland	Crown Land	L	Not Isolated	Northern Grampians	10	5.3	20
8022	Greater Grampians	Herb-rich Woodlands	Crown Land	L	Continuous	Northern Grampians	20	5.9	30
8024	Wimmera	Box Ironbark Forests/ Woodlands	Freehold	L	Not Isolated	Northern Grampians	13	5	23
8025	Goldfields	No Native Vegetation	Freehold	-	-	Ararat	18	5.33	29
8026	Goldfields	Box Ironbark Forests/ Woodlands	Crown Land	L	Not Isolated	Northern Grampians	17	8.12	33

Site no.	Bioregion	EVC group name	Land Tenure	Patch Size	Isolation category	Local Government district	N surveys	Mean birds / survey	Total Species
8029	Goldfields	Heathy Woodlands	Crown Land	S	Isolated	Northern Grampians	9	8.11	33
8031	Goldfields	Wetland Freshwater	Crown Land	L	Not Isolated	Northern Grampians	10	5	13
8035	Goldfields	Lower Slopes or Hills Woodlands	Freehold	L	Not Isolated	Northern Grampians	6	13.67	41
8036	Greater Grampians	Dry Forests	Crown Land	L	Continuous	Northern Grampians	18	5	28
8038	Central Victorian Uplands	Dry Forests	Freehold	L	Continuous	Pyrenees	6	9.33	29
8039	Goldfields	Herb-rich Woodlands	Freehold	L	Semi-isolated	Northern Grampians	19	19.11	76
8041	Greater Grampians	Lowland Forests	Crown Land	L	Continuous	Northern Grampians	6	3.33	12
8043	Goldfields	Dry Forests	Freehold	L	Semi-isolated	Northern Grampians	8	9.625	33
8045	Goldfields	Herb-rich Woodlands	Freehold	S	Isolated	Pyrenees	6	11.33	23
8049	Central Victorian Uplands	Dry Forests	Crown Land	L	Continuous	Ararat	7	4.86	13
8050	Greater Grampians	Rocky outcrop or escarpment Scrubs	Crown Land	L	Continuous	Northern Grampians	5	2	8
8054	Greater Grampians	Montane	Crown Land	L	Continuous	Northern Grampians	2	3	5
8055	Central Victorian Uplands	Rocky outcrop or escarpment Scrubs	Crown Land	L	Continuous	Ararat	7	7.86	24
8056	Central Victorian Uplands	Dry Forests	Crown Land	L	Continuous	Ararat	7	7.86	26
8057	Greater Grampians	Heathy Woodlands	Crown Land	L	Continuous	Ararat	2	7	9
8058	Goldfields	Dry Forests	Freehold	S	Isolated	Ararat	5	7.2	20
8059	Wimmera	No Native Vegetation	Freehold	-	-	Horsham	13	0.923	7
8060	Wimmera	Riparian and/ or Swampy Scrubs or Woodland	Crown Land	L	Continuous	Horsham	13	6.38	35
8061	Lowan Mallee	Plains Woodland or Forest Plains Woodland	Crown Land	L	Continuous	Horsham	3	10.33	25
8062	Wimmera	No Native Vegetation	Freehold	-	-	Horsham	17	0.82	6
8063	Wimmera	No Native Vegetation	Freehold	-	-	Horsham	3	3.67	8
8068	Wimmera	Plains Woodland or Forest Plains Woodland	Crown Land	L	Not Isolated	Horsham	6	7.83	26
8069	Wimmera	Salt-tolerant and/ or succulent Shrublands	Crown Land	M	Isolated	Horsham	10	2.7	18

Site no.	Bioregion	EVC group name	Land Tenure	Patch Size	Isolation category	Local Government district	N surveys	Mean birds / survey	Total Species
8070	Wimmera	Riverine Grassy Woodlands or Forests	Crown Land	M	Isolated	Horsham	13	15.08	38
8071	Wimmera	Mallee	Freehold	S	Isolated	Horsham	2	9.5	16
8072	Wimmera	Riverine Grassy Woodlands or Forests	Freehold	M	Isolated	Horsham		5	
8073	Wimmera	Salt-tolerant and/ or succulent Shrublands	Crown Land	L	Semi-isolated	Horsham	8	3.125	14
8074	Wimmera	Riverine Grassy Woodlands or Forests	Crown Land	M	Isolated	Horsham	13	6.08	22
8075	Wimmera	Salt-tolerant and/ or succulent Shrublands	Freehold	M	Isolated	Horsham	12	1.75	11
8076	Wimmera	Riparian and/ or Swampy Scrubs or Woodland	Crown Land	M	Semi-isolated	Horsham	16	13	52
8078	Greater Grampians	Rocky outcrop or escarpment Scrubs	Crown Land	L	Continuous	Horsham	7	5.14	19
8079	Wimmera	Plains Woodland or Forest Plains Woodland	Freehold	M	Semi-isolated	Horsham	15	10.2	47
8080	Wimmera	Plains Woodland or Forest Plains Woodland	Crown Land	S	Isolated	Horsham	2	9	14
8082	Wimmera	Riparian Forests or Woodlands	Crown Land	M	Semi-isolated	Horsham	18	9.44	30
8083	Wimmera	Riparian Forests or Woodlands	Crown Land	M	Isolated	Horsham	20	11	47
8085	Wimmera	Mallee	Freehold	S	Semi-isolated	Horsham	2	10	15
8087	Wimmera	Wetland Saline	Crown Land	M	Semi-isolated	Horsham	2	2.5	5
8088	Wimmera	No Native Vegetation	Freehold	-	-	Horsham	1	2	2
8089	Wimmera	Salt-tolerant and/ or succulent Shrublands	Crown Land	M	Isolated	Horsham	2	2	4
8090	Wimmera	Heathy Woodlands	Crown Land	L	Continuous	Horsham	20	3	28
8091	Wimmera	Riverine Grassy Woodlands or Forests	Crown Land	M	Semi-isolated	Horsham	11	9.45	22
8092	Wimmera	Riparian and/ or Swampy Scrubs or Woodland	Freehold	M	Isolated	Horsham	17	13.41	40
8094	Wimmera	Heathy Woodlands	Crown Land	L	Continuous	Horsham	7	4	14
8095	Wimmera	Plains Woodland or Forest Plains Woodland	Freehold	M	Isolated	Horsham	20	14.6	56

Site no.	Bioregion	EVC group name	Land Tenure	Patch Size	Isolation category	Local Government district	N surveys	Mean birds / survey	Total Species
8096	Wimmera	Wetland Freshwater	Freehold	M	Semi-isolated	Horsham	21	8.43	32
8097	Greater Grampians	Heathy Woodlands	Freehold	M	Semi-isolated	Horsham	17	8.59	34
8098	Dundas Tablelands	Herb-rich Woodlands	Crown Land	L	Not Isolated	Horsham	21	11.24	49
8099	Wimmera	Plains Woodland or Forest Plains Woodland	Crown Land	L	Not Isolated	Horsham	14	7.57	36
8100	Greater Grampians	Heathy Woodlands	Freehold	M	Semi-isolated	Horsham	19	10.95	42
8103	Greater Grampians	Rocky outcrop or escarpment Scrubs	Crown Land	L	Continuous	Horsham	20	3.85	30
8105	Dundas Tablelands	Heathlands	Crown Land	L	Continuous	Horsham	21	8.57	53
8107	Murray Mallee	No Native Vegetation	Freehold	-	-	Buloke	4	0.25	1
8109	Murray Mallee	Riverine Grassy Woodlands or Forests	Freehold	M	Isolated	Yarriambiack	7	9.43	25
8111	Murray Mallee	Plains Grasslands/ Chenopod Shrubland	Freehold	M	Semi-isolated	Buloke	12	5.33	17
8112	Murray Mallee	Riverine Grassy Woodlands or Forests	Freehold	M	Isolated	Yarriambiack	7	5.14	11
8114	Murray Mallee	Plains Grasslands/ Chenopod Shrubland	Freehold	M	Isolated	Yarriambiack	11	3.09	12
8117	Wimmera	Plains Grasslands/ Chenopod Shrubland	Freehold	M	Isolated	Yarriambiack	1	6	6
8118	Murray Mallee	Riverine Grassy Woodlands or Forests	Freehold	M	Isolated	Yarriambiack	15	5.33	23
8120	Wimmera	Plains Grasslands/ Chenopod Shrubland	Freehold	M	Isolated	Yarriambiack	2	11.5	15
8121	Wimmera	Mallee	Freehold	M	Isolated	Yarriambiack	2	7.5	11
8122	Wimmera	Mallee	Freehold	S	Isolated	Yarriambiack	8	8	22
8125	Wimmera	Plains Grasslands/ Chenopod Shrubland	Freehold	M	Isolated	Yarriambiack	2	9.5	13
8127	Murray Mallee	Plains Grasslands/ Chenopod Shrubland	Freehold	S	Isolated	Buloke	1	6	6
8128	Wimmera	Riverine Grassy Woodlands or Forests	Crown Land	M	Isolated	Yarriambiack	2	8.5	13
8129	Wimmera	Plains Grasslands/ Chenopod Shrubland	Freehold	M	Isolated	Yarriambiack	13	8.77	28
8130	Wimmera	Lower Slopes or Hills Woodlands	Crown Land	L	Not Isolated	Yarriambiack	13	6.31	27

Site no.	Bioregion	EVC group name	Land Tenure	Patch Size	Isolation category	Local Government district	N surveys	Mean birds / survey	Total Species
8131	Wimmera	Plains Grasslands/ Chenopod Shrubland	Freehold	L	Semi-isolated	Yarriambiack	6	14	25
8132	Wimmera	Riverine Grassy Woodlands or Forests	Freehold	M	Semi-isolated	Yarriambiack	14	9.36	30
8133	Wimmera	No Native Vegetation	Freehold	-	-	Yarriambiack	21	1.667	18
8134	Wimmera	Riverine Grassy Woodlands or Forests	Freehold	M	Isolated	Yarriambiack	21	9.19	41
8135	Wimmera	Plains Grasslands/ Chenopod Shrubland	Crown Land	M	Semi-isolated	Yarriambiack	21	9.33	35
8136	Wimmera	Lower Slopes or Hills Woodlands	Freehold	M	Not Isolated	Yarriambiack	6	15.67	37
8137	Wimmera	Lower Slopes or Hills Woodlands	Crown Land	L	Continuous	Yarriambiack	7	5.86	18
8138	Wimmera	Plains Woodland or Forest Plains Woodland	Crown Land	L	Not Isolated	Yarriambiack	15	5.87	16
8142	Murray Mallee	Riverine Grassy Woodlands or Forests	Crown Land	L	Not Isolated	Hindmarsh	14	10.36	40
8143	Murray Mallee	Salt-tolerant and/ or succulent Shrublands	Freehold	L	Continuous	Hindmarsh	15	3.13	19
8145	Murray Mallee	Wetland Freshwater	Crown Land	L	Continuous	Hindmarsh	15	2.4	13
8148	Murray Mallee	Riverine Grassy Woodlands or Forests	Crown Land	M	Semi-isolated	Hindmarsh	3	3.67	7
8149	Murray Mallee	Riverine Grassy Woodlands or Forests	Crown Land	L	Not Isolated	Hindmarsh	3	5.33	13
8150	Murray Mallee	No Native Vegetation	Freehold	-	-	Hindmarsh	5	3.2	9
8152	Lowan Mallee	Mallee	Freehold	L	Continuous	Hindmarsh	2	6.5	13
8154	Wimmera	Plains Grasslands/ Chenopod Shrubland	Freehold	M	Isolated	Hindmarsh	5	12.8	29
8157	Wimmera	Plains Grasslands/ Chenopod Shrubland	Freehold	M	Isolated	Hindmarsh	12	7	24
8161	Wimmera	Wetland Freshwater	Crown Land	L	Semi-isolated	Hindmarsh	8	6	14
8162	Murray Mallee	Riverine Grassy Woodlands or Forests	Streamside Reserve	L	Semi-isolated	Hindmarsh	17	8.59	48
8163	Wimmera	Riverine Grassy Woodlands or Forests	Freehold	L	Semi-isolated	Hindmarsh	6	7.33	17
8164	Murray Mallee	Riverine Grassy Woodlands or Forests	Crown Land	M	Semi-isolated	Hindmarsh	17	7.76	35

Site no.	Bioregion	EVC group name	Land Tenure	Patch Size	Isolation category	Local Government district	N surveys	Mean birds / survey	Total Species
8165	Wimmera	Wetland Freshwater	Freehold	L	Not Isolated	Hindmarsh	18	11.39	30
8166	Wimmera	Lower Slopes or Hills Woodlands	Crown Land	M	Semi-isolated	Hindmarsh	6	8.83	24
8167	Wimmera	Wetland Freshwater	Freehold	L	Semi-isolated	Hindmarsh	19	5.74	25
8170	Wimmera	Wetland Freshwater	Freehold	L	Not Isolated	Hindmarsh	9	8.78	30
8171	Lowan Mallee	Mallee	Crown Land	L	Continuous	Hindmarsh	2	2.5	3
8172	Murray Mallee	Riverine Grassy Woodlands or Forests	Streamside Reserve	L	Not Isolated	Hindmarsh	16	8.25	44
8173	Wimmera	Mallee	Freehold	M	Isolated	Hindmarsh	2	7.5	14
8174	Lowan Mallee	Mallee	Freehold	M	Not Isolated	Hindmarsh	1	3	3
8175	Lowan Mallee	No Native Vegetation	Freehold	-	-	Hindmarsh	1	4	4
8176	Lowan Mallee	Heathlands	Crown Land	L	Continuous	Hindmarsh	11	1.64	11
8177	Lowan Mallee	Heathlands	Crown Land	L	Continuous	Hindmarsh	1	1	1
8178	Lowan Mallee	No Native Vegetation	Freehold	-	-	Hindmarsh	2	3	5
8179	Lowan Mallee	Mallee	Freehold	L	Not Isolated	West Wimmera		5	
8180	Wimmera	No Native Vegetation	Freehold	-	-	West Wimmera	19	2.11	17
8181	Wimmera	No Native Vegetation	Freehold	-	-	West Wimmera	19	1.11	6
8182	Lowan Mallee	Heathlands	Freehold	L	Not Isolated	West Wimmera	10	2.4	17
8183	Lowan Mallee	Mallee	Crown Land	L	Not Isolated	West Wimmera	8	3	13
8185	Lowan Mallee	Mallee	Freehold	M	Isolated	West Wimmera	7	3.71	19
8187	Wimmera	Plains Grasslands/ Chenopod Shrubland	Crown Land	L	Not Isolated	West Wimmera	4	2	6
8189	Wimmera	Plains Woodland or Forest Plains Woodland	Freehold	M	Semi-isolated	West Wimmera	20	8.05	43
8190	Wimmera	Lower Slopes or Hills Woodlands	Freehold	L	Semi-isolated	West Wimmera	19	7.26	43
8192	Wimmera	Plains Grasslands/ Chenopod Shrubland	Freehold	M	Isolated	West Wimmera	19	5.89	24
8194	Wimmera	Plains Grasslands/ Chenopod Shrubland	Freehold	M	Isolated	West Wimmera	17	4.29	16
8196	Wimmera	Lower Slopes or Hills Woodlands	Freehold	M	Semi-isolated	West Wimmera	19	8	34

Site no.	Bioregion	EVC group name	Land Tenure	Patch Size	Isolation category	Local Government district	N surveys	Mean birds / survey	Total Species
8204	Lowan Mallee	Plains Woodland or Forest Plains Woodland	Crown Land	L	Continuous	West Wimmera	4	5.5	16
8205	Lowan Mallee	Heathlands	Crown Land	L	Continuous	West Wimmera	13	3.15	27
8206	Lowan Mallee	Heathlands	Crown Land	L	Continuous	West Wimmera	4	3.75	10
8210	Wimmera	Wetland Freshwater	Freehold	M	Semi-isolated	West Wimmera	2	3.5	6
8212	Wimmera	Wetland Freshwater	Freehold	L	Not Isolated	West Wimmera	12	6.08	20
8214	Wimmera	Wetland Freshwater	Freehold	M	Semi-isolated	West Wimmera	1	7	7
8215	Wimmera	Wetland Freshwater	Freehold	M	Isolated	West Wimmera	2	9.5	14
8216	Wimmera	Plains Woodland or Forest Plains Woodland	Crown Land	L	Continuous	West Wimmera	1	3	3
8217	Wimmera	Wetland Freshwater	Freehold	M	Not Isolated	West Wimmera	11	5.36	22
8221	Wimmera	Wetland Freshwater	Freehold	L	Not Isolated	West Wimmera	1	11	11
8222	Wimmera	Heathy Woodlands	Crown Land	L	Continuous	West Wimmera	11	6.64	36
8223	Wimmera	Heathy Woodlands	Freehold	L	Not Isolated	West Wimmera	15	9.13	40
8224	Wimmera	Plains Woodland or Forest Plains Woodland	Freehold	S	Isolated	West Wimmera	1	8	8
8226	Wimmera	Heathy Woodlands	Freehold	L	Not Isolated	West Wimmera	1	8	8
8227	Wimmera	Plains Woodland or Forest Plains Woodland	Crown Land	M	Semi-isolated	West Wimmera	6	4.167	15
8231	Wimmera	Wetland Saline	Freehold	M	Isolated	West Wimmera	19	2.947	24
8233	Wimmera	Salt-tolerant and/ or succulent Shrublands	Crown Land	L	Semi-isolated	West Wimmera	6	4.5	13
8235	Wimmera	No Native Vegetation	Freehold	-	-	West Wimmera	1	3	3
8237	Wimmera	Heathy Woodlands	Crown Land	L	Continuous	West Wimmera	18	4.61	26
8246	Lowan Mallee	Mallee	Crown Land	L	Continuous	West Wimmera	9	2.67	8
8247	Greater Grampians	Rocky outcrop or Escarpment Scrubs	Crown Land	L	Continuous	Northern Grampians	8	2.5	15
8252	Goldfields	Box Ironbark Forests/ Woodlands	Crown Land	L	Not Isolated	Pyrenees	8	15.5	41
8256	Wimmera	Lower Slopes or Hills Woodlands	Freehold	M	Semi-isolated	Hindmarsh	3	7	14
8258	Dundas Tablelands	Plains Woodland or Forest Plains Woodland	Freehold	L	Not Isolated	Horsham	20	8.4	34

Site no.	Bioregion	EVC group name	Land Tenure	Patch Size	Isolation category	Local Government district	N surveys	Mean birds / survey	Total Species
8260	Wimmera	Plains Woodland or Forest Plains Woodland	Freehold	L	Not Isolated	Horsham	17	15.12	46
8261	Wimmera	Non-indigenous	Freehold	S	Semi-isolated	Horsham	9	13	36
8263	Wimmera	Plains Woodland or Forest Plains Woodland	Freehold	L	Semi-isolated	Hindmarsh	14	11.0	44
8264	Murray Mallee	No Native Vegetation	Freehold	-	-	Buloke	4	0.75	2
8265	Wimmera	Lower Slopes or Hills Woodlands	Freehold	M	Isolated	Hindmarsh	14	2.57	13
8266	Wimmera	Plains Woodland or Forest Plains Woodland	Freehold	L	Semi-isolated	Hindmarsh	13	5.15	34
8269	Goldfields	Plains Woodland or Forest Plains Woodland	Freehold	M	Semi-isolated	Northern Grampians	2	3	6
8270	Goldfields	Plains Woodland or Forest Plains Woodland	Freehold	S	Isolated	Northern Grampians	1	11	11
8271	Central Victorian Uplands	Herb-rich Woodlands	Freehold	L	Not Isolated	North Grampians	6	10.33	38
8272	Wimmera	Riverine Grassy Woodlands or Forests	Crown Land	M	Semi-isolated	Horsham	2	9	15
8274	Wimmera	Plains Woodland or Forest Plains Woodland	Freehold	M	Isolated	West Wimmera	1	5	4
8275	Goldfields	Plains Woodland or Forest Plains Woodland	Crown Land	S	Isolated	Northern Grampians	1	9	9
8277	Wimmera	Lower Slopes or Hills Woodlands	Crown Land	L	Not Isolated	Hindmarsh	1	5	5
8278	Lowan Mallee	Mallee	Freehold	M	Not Isolated	Hindmarsh	1	5	5
2543	Goldfields	Lower Slopes or Hills Woodlands	Freehold	M	Semi-isolated	Ararat	6	4.67	15
2544	Goldfields	Lower Slopes or Hills Woodlands	Freehold	M	Semi-isolated	Ararat	6	4.33	10
5006	Goldfields	Plains Woodland or Forest Plains Woodland	Freehold	L	Not Isolated	Northern Grampians	6	9.5	30
5008	Goldfields	Non-indigenous	Freehold	S	Isolated	Northern Grampians	6	10.17	30