Avifauna of the Mulga–Eucalypt Line in Western Australia

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The Mulga–Eucalypt Line has long been recognised as a vegetational transition from *Acacia* spp. domination in the northeast to *Eucalyptus* spp. domination in the southwest. The avifauna of this transition zone was sampled over four seasons at four locations representing a north to south geographic gradient of ~170 km. Each location comprised one survey site dominated by acacias and a second dominated by eucalypts. A total of 81 avian species were recorded over the July 2011 to April 2012 sampling period with an average sample richness of 19 species per plot and a mean plot density of 1.05 birds/ha. Most species were classed as sedentary (39%), with the remainder as locally dispersive (21%), nomadic (25%) or migratory (15%). Ordination analysis indicated a latitudinal gradient of bird species from north to south along the first axis associated with gradually increasing rainfall. The second ordination axis revealed avian species differences dependent on the dominant vegetation. The third ordination axis displayed differences in bird species related to season, especially the spring and summer samples. The avifauna assemblage structure of northern locations was strongly influenced by the inclusion of irruptive, arid-zone nomadic species. Site richness comparisons between locations were not different, but eucalypt-dominated sites had more species than acacia-dominated sites. Site richness was greater during spring and summer. Density also was influenced by the influx of arid-zone nomadic species to the northern sites of the transition zone during spring and summer. Species diversity of the samples was influenced by vegetation type, but the measures of evenness and dominance were not affected by the factors of location, vegetation type or season. The Mulga–Eucalypt Line transition zone presently has considerable conservation value, but is under threat from pressures of agricultural and mining intrusions. Continued protection of native vegetation in the conservation reserves should be encouraged.

KEYWORDS: avifauna community, density, gradient analysis, Mulga–Eucalypt Line, seasonal variation, species richness, vegetation.

INTRODUCTION

The Mulga–Eucalypt Line is a zone of vegetation change running inland from the Western Australian coastal town of Geraldton southeastward through Menzies in the Goldfields (Beard 1990). The line separates the Eremaean Botanical Province to the north and the South-West Botanical Province to the south (Figure 1) and also separates the Southwestern and the Central Provinces of the Western Faunal Sub-Region (Kikkawa & Pearse 1969).

The predominant tree species of the arid regions to the northeast is mulga (*Acacia aneura*), associated with a number of other acacias (e.g. *A. pruinocarpa, A. linophylla, A. coriacea* and *A. acuminata*). The predominant tree species of the more mesic areas to the southwest are eucalypts (e.g. *Eucalyptus salmonophloia, E. loxophleba, E. salubris* and *E. transcontinentalis*) (Boland *et al.* 1984). The vegetation transition from acacia to eucalypt domination has been variously attributed to climatic variables (Beard 1990), predominately rainfall (Patrick 2001), although edaphic parameters play a role within the transition zone (Beard 1990). The Mulga–Eucalypt Line roughly lies between the 250–350 mm rainfall isohyets and separates the arid zone of the northeast with limited rainfall occurring in both summer and winter, from the more mesic Mediterranean climate of the southwest with wet winters and dry summers. Within the transition zone, mulga woodlands with trees 3–4 m in height occur on shallow, red-loam soils overlying hardpan (Beard 1990; Patrick 2001). Eucalypt woodlands in this region with trees to 10 m occur on deeper loam soils with the depth to the hardpan favouring different eucalypt species.

Birds of arid-zone mulga regions of Western Australia have been surveyed by Cody (1994), Recher & Davis (1997), Burbidge *et al.* (2000, 2010) and Bell *et al.* (2013). Serventy & Whittell (1962) noted that bird populations along the Mulga–Eucalypt Line were an admixture of birds of the more arid woodlands, scrublands and hummock grasslands to the north and east and those of the more mesic woodlands and forests to the south and west. A number of studies of the avifauna of *Eucalyptus*-dominated sites south of the Mulga–Eucalypt Line have been published (Ford 1971; Davies 1977; Arnold & Weeldenburg 1998; Recher & Davis 2002, 2010; Bell *et al.* 2007, 2010). Bell *et al.* (2007) showed that there was a gradient of avian assemblage change from northeast to southwest from surveys of exclusively eucalypt woodlands in the northern part of the South-West Botanical Province. A study specifically designed to determine if the avifauna changes across the Mulga–Eucalypt Line or if birds inhabiting *Acacia*-dominated habitats are different from those of adjacent *Eucalyptus*-dominated habitats in the transition zone has not been attempted. The objectives of this study were to: (i)

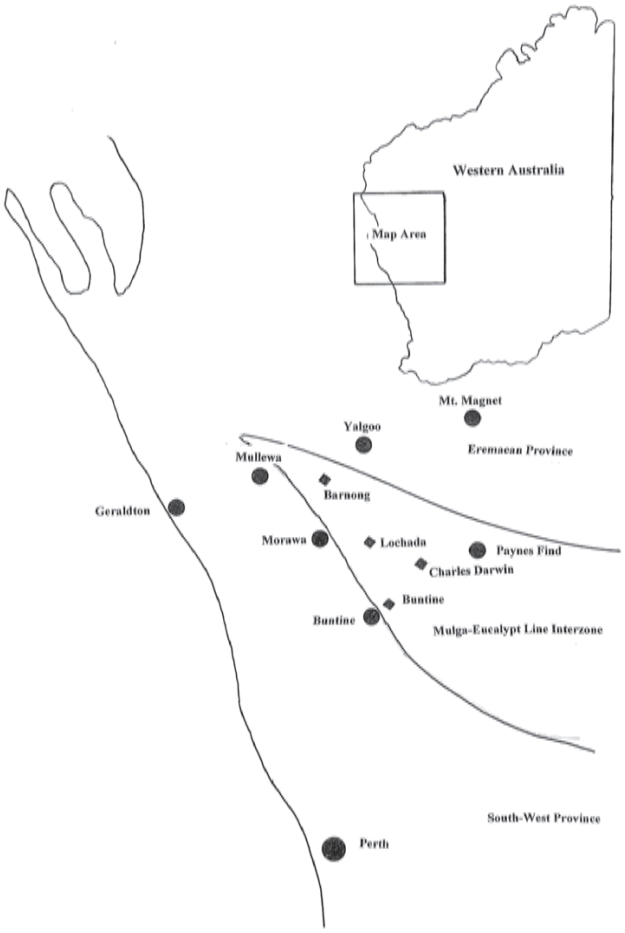

Figure 1 Study area map depicting northwestern region of the Mulga–Eucalypt Line vegetation transition zone between the Eremaean Botanical Province in the northeast and the South-West Botanical Province in the southwest with the local towns in black circles and the study sites in black diamonds.

document the avifauna of this vegetation zone; (ii) determine if a gradient in the avifauna occurs from north to south across this region; (iii) assess whether there are differences in bird assemblages from sites dominated by acacia versus nearby sites dominated by eucalypts; and (iv) determine possible seasonal differences in bird assemblages.

METHODS

Study sites

The avifauna of the Mulga–Eucalypt Line was sampled at four locations (Barnong Nature Reserve, Lochada Nature Reserve, Charles Darwin Reserve and Buntine Nature Reserve) (Figure 1). The four sampling locations also represented a north to south geographic gradient of ~170 km. Details of the geographic location of each study site and the dominant plant species are presented in Table 1. All sites are in native vegetation regions managed for conservation and have been unburned for many years. The Lochada sites are in the Karara and Lochada Important Bird Area (IBA) and the Charles Darwin sites are in the Mt Gibson and Charles Darwin IBA (Dutson *et al*. 2009). Mean annual rainfalls for the nearest Bureau of Meteorological Stations (www.bom.gov.au/climate) for each site were 261 mm for Barnong (Yalgoo), 291 mm for Lochada (Morawa), 282 mm for Charles Darwin (Paynes Find) and 342 mm for Buntine (Buntine).

Sampling procedures

Each of the four sampling locations included two avian survey sites, one in *Acacia*-dominated vegetation and a second in *Eucalyptus*-dominated vegetation. The survey site vegetation, however, was not completely exclusive, since the understory of the *Eucalyptus*-dominated sites had a number of shrubby acacias and the *Acacia*-dominated sampling locations had sporadic eucalypt trees. Each permanently marked survey site was a plot of 500 m radius (78.54 ha) centred in a region of representative vegetation and divided into four quadrants (0-90^{o}, 90-180^{o}, 180-270^{o} and 270-360^{o}). The first two authors shared the field observation and recording of data. Each quadrant was traversed during a half-hour period and all birds heard or sighted were identified, tallied and recorded. Two periods of sampling, one in the early morning and one in the late afternoon, were made for each quadrant in each vegetation type for each season. All four quadrants for a single site were surveyed consecutively. Sampling took place in mid-winter (3–14 July 2011), mid-spring (10–22 September 2011), mid-summer (30 December 2011 to 7 January 2012) and mid-autumn (10–18 April 2012). No samples were taken during rainy or excessively windy conditions. There were no major eucalypt-flowering episodes at any of the

Table 1 Mulga–Eucalypt Line sampling site information.

Location	Latitude	Longitude	Major species
Barnong acacia	28°25.65'S	116°07.86'E	*Acacia linophylla, Melaleuca uncinata*
Barnong eucalypt	28°25.40'S	116°08.52'E	*Eucalyptus loxophleba, E. oleosa*
Lochada acacia	29°12.04'S	116°30.89'E	*A. aneura, A. linophylla*
Lochada eucalypt	29°12.14'S	116°31.53'E	*E. salmonophloia, E. loxophleba*
Darwin acacia	29°35.14'S	116°57.57'E	*A. aneura, Callitris spp., Melaleuca spp.*
Darwin eucalypt	29°36.62'S	116°55.13'E	*E. salmonopholia, E. loxophleba*
Buntine acacia	29°58.02'S	116°35.29'E	*A. acuminata, Casuarina spp.*
Buntine eucalypt	29°58.80'S	116°34.74'E	*E. loxophleba*

sampling sites or seasons. All sites in a single location were sampled at one time, but the order of the locations was randomised in each season's surveys. Sampling was also randomised for vegetation type and then the particular sampling quadrant.

Avian nomenclature followed Christidis & Boles (2008). Movement status designations were determined from the works of Saunders & Ingham (1995), Johnstone & Storr (1998, 2004), Morcombe (2000), Simpson & Day (2004), Recher & Davis (2002, 2010) and Bell *et al*. (2007, 2010).

Statistical analyses

Relative density of each species in each sample was calculated by dividing the number of observations of that species by the total number of birds observed in the sample. In order to reveal patterns of overall avian community structure and patterns of individual bird species distributions, the matrix of relative density data was analysed by Detrended Correspondence Analysis (DCA) (Jongman *et al*. 1995). The matrix included only bird species that occurred in at least two samples.

Characteristics of the avian population of each site were also described in terms of site richness, density and species population heterogenity. Avifauna richness was determined as the total number of bird species recorded at each site during the 4 hours of sampling for each season. Site avifauna density (birds/ha) was the total number of observations of all birds for the two surveys (am and pm) divided by two and then by 78.54 (sample area site). Due to the major irruption of the population of budgerigars in the spring, counts continued only up to a maximum of 100 individuals within any one quadrant. As a result, bird densities during spring could have been underestimated. Three measures of site species heterogeneity were determined: Shannon indices of diversity ($H' = \Sigma p_i \log_{10} p_i$), evenness ($J' = H'/H'_{max}$) and the Simpson index of dominance ($D = \Sigma p_i^2$), where p_i equals the proportion for the ith species. These indices combine both species richness and the evenness of distribution of individuals within the sample (Peet 1974). The Shannon indices are biased toward species richness, while the Simpson index of dominance is biased toward the density of the most common species (Magurran 1988).

Relationships between geographic location, vegetation type and seasonal variation and the DCA site axis scores were explored by correlation analysis and where significant associations found, differences were tested by unpaired t-tests (Zar 1996). A two-way repeated measures ANOVA was used to test aspects of the avian assemblage structure, richness, density, species diversity, evenness and dominance (dependent variables) against independent variables geographic location, vegetation type and seasonal variation (Zar 1996). Where the ANOVA indicated significance Holm-Sidak post-hoc multiple comparison calculations were made to compare differences between groups. No significant interactions were found between the main factors in any ANOVA. While the original data were found to be not normally distributed, even after square-root transformation, all data met the equal-variance test. The results reported are based on square-root transformed data. All statistical testing was carried out using Sigma Stat® 3.5 (Systat Software Inc. 2006).

RESULTS

General avian community

A total of 81 species were recorded in the 2011–2012 samples of birds of the Mulga–Eucalypt Line region, including 30 non-passerines and 51 passerines (Appendices 1, 2). Species richness values for the individual sample locations were similar, ranging between site totals of 47 and 54 species. Species totals separated by vegetation type were also similar with 68 species recorded in *Acacia*-dominated sites and 66 species in *Eucalyptus*-dominated sites (Table 2). Of the species recorded, 39% were classed as sedentary, 21% as locally dispersive, 25% as nomadic and 15% as migratory. Red-capped robin and chestnut-rumped thornbill were the most frequently observed species, each occurring in 31 of the 32 separate samples. Other sedentary and/or locally-dispersive species occurring in more than 75% of samples included the Australian raven, Australian ringneck, grey shrike-thrush and inland thornbill.

Nomadic and/or migratory species appeared in the records of particular seasons. Among these highly mobile species, which were observed only in winter and spring, were the black-eared, pallid and Horsfield's bronze cuckoos, regent parrot and white-winged triller. Black and pied honeyeaters and the rufous songlark were only recorded in the spring samples. Species restricted to only the spring and summer samples included budgerigar, cockatiel, red-backed kingfisher, black-faced cuckoo-shrike and white-fronted honeyeater. Rainbow bee-eater, brown songlark and crimson chat were recorded only in the summer and zebra finch was recorded only in summer and autumn.

Table 2 Species richness and movement type percentages of the avifauna of the Mulga–Eucalypt Line including all samples, samples of acacia sites alone and eucalypt sites alone and the separate seasons alone.

	All	Acacia	Eucalypt	Winter	Spring	Summer	Autumn
Richness	81	68	66	49	57	53	38
Movement Type							
Sedentary	39%	38%	39%	49%	37%	43%	47%
Locally Dispersive	21%	22%	21%	20%	18%	27%	26%
Nomadic	26%	25%	24%	17%	28%	21%	16%
Migratory	14%	15%	15%	14%	17%	9%	11%

Avian assemblage patterns

The DCA ordination procedure utilised a matrix of 62 avian species and 32 samples, after singletons were removed from the complete set of relative densities. The first DCA axis explained 48% of the sample variance and separated the samples on a geographic gradient (Figure 2). The highest first axis sample scores were from Barnong. Lochada samples tended to be grouped in the central section of the first axis and Darwin and Buntine samples were located on the low-score end of the first axis. Correlation analysis revealed a significant (r_{30} = 0.61, p ≤0.05) relationship between sample latitude and the DCA first axis score.

The second DCA axis, which explained another 22% of the sample variance, separated samples from the acacia sites at the higher score end of DCA axis 2 from the eucalypt site scores at the lower end (Figures 2, 3). An unpaired t-test of the second axis DCA sample scores between the acacia sites and the eucalypt sites indicated that the bird assemblages were significantly different (t_{30} = 4.59, p ≤0.001) between vegetation types.

The third DCA axis explained a further 15% of the sample variance and separated the spring samples at the upper end of axis 3 from the summer samples at the lower end of axis 3 (Figure 3). One-way analysis of variance for axis 3 sample scores indicated that season also had a significant ($F_{3,28}$ = 3.95, p ≤0.05) effect on the bird assemblages of the region.

Particularly diagnostic species (those with very high or very low DCA species scores) influenced the position of the samples along the geographic gradient of the first DCA axis (Appendices 1, 2). Northern species included black and pied honeyeaters, budgerigar, cockatiel, zebra finch and little button-quail. All these arid-zone birds were classed as nomadic or migratory birds. Species with low DCA axis 1 values were in the more southerly and mesic end of the geographic gradient and included the black-faced cuckoo-shrike, black-faced woodswallow, grey fantail, yellow-rumped thornbill and red wattlebird.

Avian species strongly influencing the second DCA sample axis and related to vegetation differences included the singing honeyeater, black-faced cuckoo-shrike, rufous songlark, crested pigeon and mulga parrot which had higher scores and were associated with acacia sites. Species with lower scores that were associated primarily with samples from eucalypt sites included the rufous treecreeper, red-backed kingfisher, weebill, regent parrot, striated pardalote and Major Mitchell's cockatoo.

Budgerigar, cockatiel, western corella and crimson chat, species recorded in greatest numbers in spring, influenced the samples on upper end of DCA sample axis 3. Species with low DCA species axis 3 scores were rainbow bee-eater, Nankeen kestrel and Australian magpie, which were recorded only in summer.

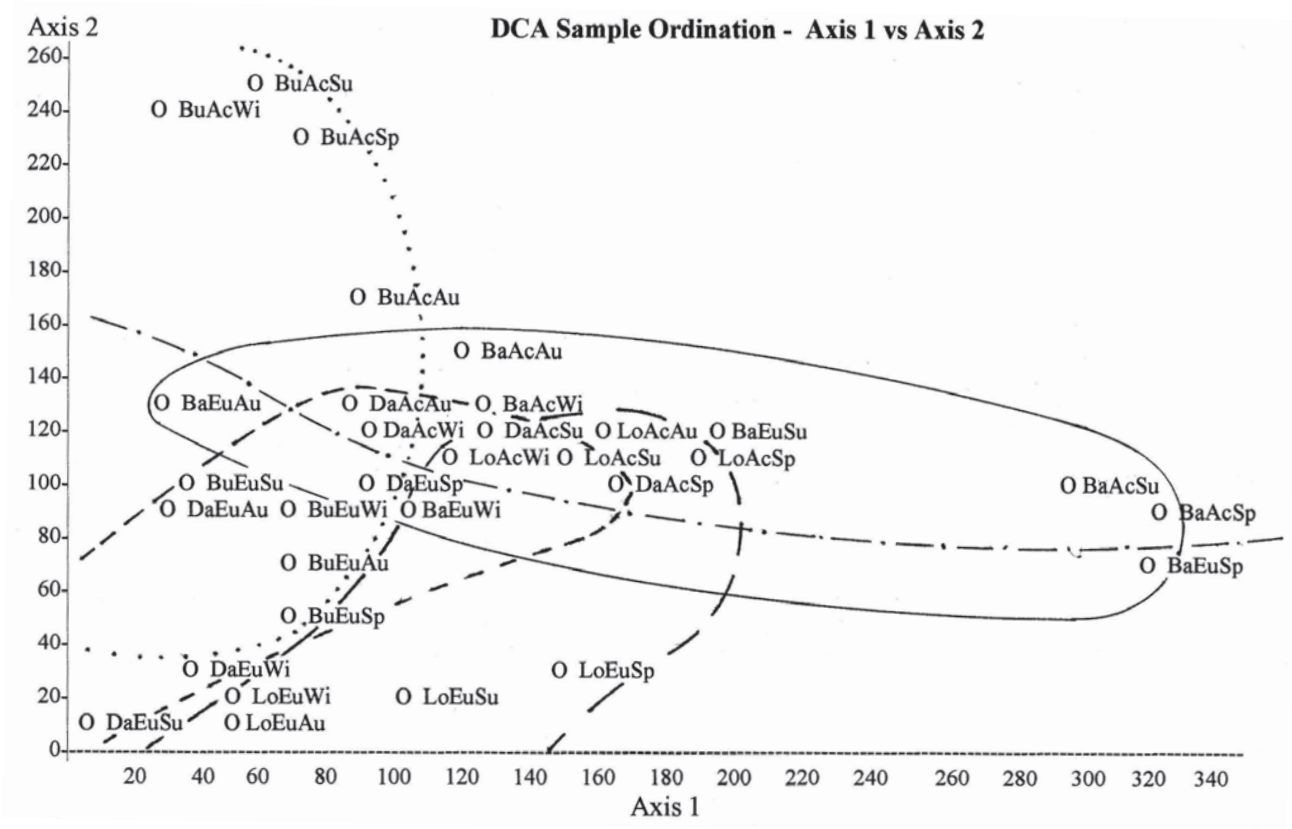

Figure 2 Detrended Correspondence Analysis sample plot for axis 1 values against axis 2 values. The first two letters of the name of the site, the vegetation type and the sampling season designate each sample. On axis 1, values related to the samples from the same location are enclosed by lines of different types: Barnong ————; Lochada — — —; Charles Darwin – – –; Buntine ····. On axis 2, values related to the two vegetation types are separated by the dash-dot-dash line.

Avian community characteristics

Overall, sample richness averaged 19.5±0.8 species per sample (Table 3). However, there was considerable variation between samples. The lowest number of species in a single sample was 14 recorded during winter at the Barnong acacia site. The highest number of species recorded was 28 at the Barnong eucalypt site during summer. Although there were no statistical differences in sample richness between the four locations, the mean number of bird species in eucalypt sites was significantly greater than in acacia sites ($F_{1,3}$ = 30.75, p ≤0.01). The repeated measures ANOVA showed richness of samples in spring and summer to be significantly greater than the samples of winter and autumn ($F_{3,9}$ = 6.90, p ≤0.01).

Bird density in the Mulga–Eucalypt Line during 2011–2012 was generally low at a mean of 1.05 birds/ha, but

Table 3 Richness (no. of species), density (birds/ha), species diversity (H'), evenness (J') and dominance (D) of samples of the Mulga–Eucalypt Line. Values with same superscript within the same factor are not different at p ≤0.05.

	Richness	Density	Diversity	Evenness	Dominance
Overall	19.47 ± 0.76	1.05 ± 0.19	1.03 ± 0.02	0.80 ± 0.02	0.15 ± 0.02
Location					
Barnong	18.88 ± 2.00 [a]	1.79 ± 0.69 [a]	0.89 ± 0.10 [a]	0.71 ± 0.08 [a]	0.23 ± 0.09 [a]
Lochada	20.50 ± 1.57 [a]	0.97 ± 0.08 [a]	1.08 ± 0.04 [a]	0.83 ± 0.02 [a]	0.11 ± 0.01 [a]
Darwin	19.50 ± 1.50 [a]	0.87 ± 0.19 [a]	1.04 ± 0.03 [a]	0.81 ± 0.02 [a]	0.11 ± 0.02 [a]
Buntine	19.00 ± 1.18 [a]	0.58 ± 0.06 [a]	1.10 ± 0.07 [a]	0.87 ± 0.04 [a]	0.16 ± 0.04 [a]
Vegetation					
Acacia	17.56 ± 1.09 [a]	0.82 ± 0.20 [a]	0.99 ± 0.04 [a]	0.80 ± 0.03 [a]	0.15 ± 0.03 [a]
Eucalyptus	21.38 ± 1.07 [b]	1.29 ± 0.30 [b]	1.07 ± 0.06 [b]	0.81 ± 0.04 [a]	0.16 ± 0.04 [a]
Season					
Winter	16.88 ± 1.03 [ac]	0.61 ± 0.09 [a]	1.00 ± 0.03 [a]	0.82 ± 0.01 [a]	0.15 ± 0.01 [a]
Spring	22.50 ± 1.29 [b]	1.91 ± 0.70 [a]	1.00 ± 0.13 [a]	0.74 ± 0.08 [a]	0.28 ± 0.09 [a]
Summer	21.88 ± 1.42 [bc]	0.93 ± 0.09 [a]	1.11 ± 0.04 [a]	0.83 ± 0.02 [a]	0.11 ± 0.02 [a]
Autumn	16.63 ± 1.31 [a]	0.77 ± 0.17 [a]	1.00 ± 0.04 [a]	0.82 ± 0.02 [a]	0.07 ± 0.01 [a]

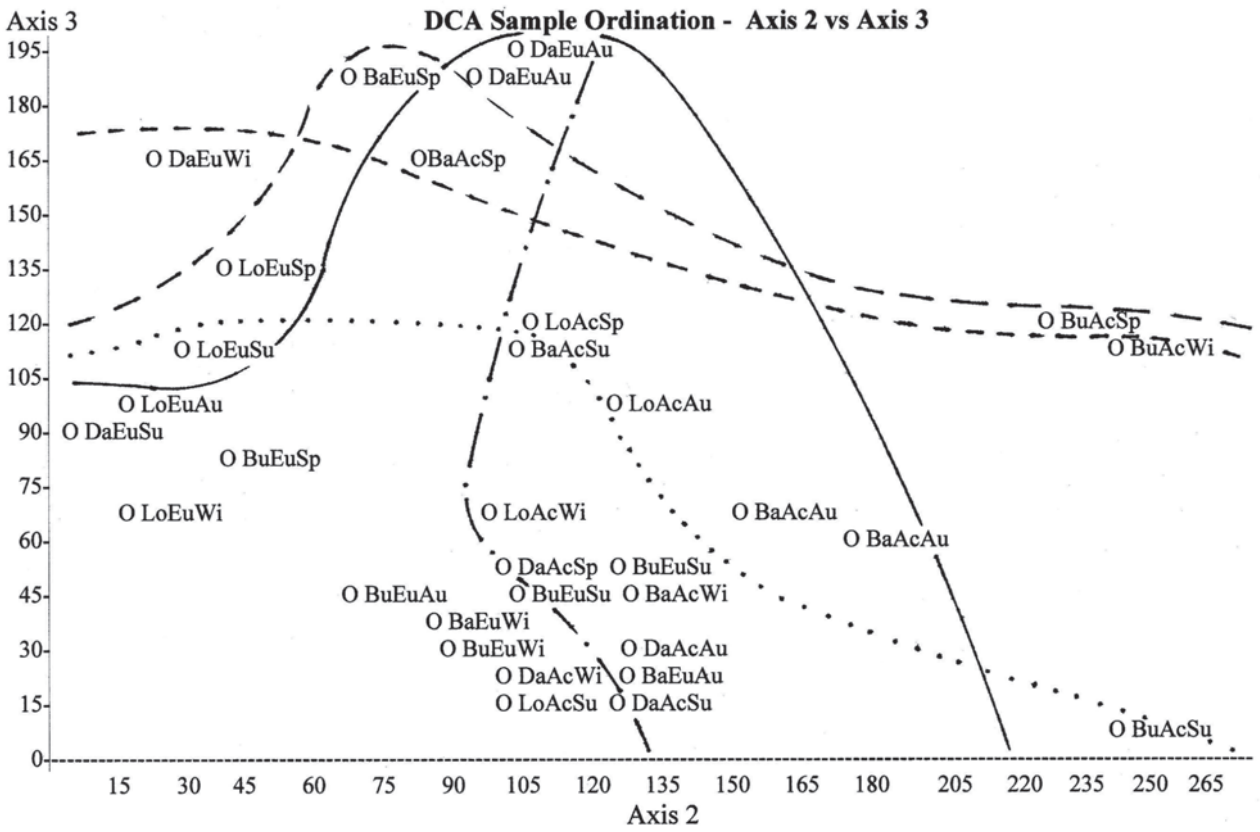

Figure 3 Detrended Correspondence Analysis sample plot for axis 2 values against axis 3 values. The first two letters of the name of the site, the vegetation type and the sampling season designate each sample. On axis 2, values related to the two vegetation types are separated by dash-dot-dash line as in Figure 2. On axis 3, values related to the samples from the same seasonal samples are enclosed by lines of different types: Autumn ————; Spring — — —; Winter– – –; Summer ·····.

highly variable (Table 3). Only vegetation type had a significant ($F_{1,3}$ = 16.06, p ≤0.05) influence on the mean density of birds in the study samples, with eucalypt sites having greater density compared to acacia sites.

The Shannon measure of species diversity (H′) averaged 1.03±0.02 overall (Table 3). As with the measures of bird density, only samples varying by vegetation type were significantly ($F_{1,3}$ = 10.34, p ≤0.05) different with eucalypt-dominated sites being more diverse than acacia-dominated sites. The statistical comparisons of the evenness (J′) and dominance (D) showed no difference due to location, vegetation type or season of samples. Although there were no statistical differences in sample richness between the four locations, the repeated measures ANOVA (square-root transferred) showed the mean number of bird species in eucalypt sites was significantly greater than in acacia sites ($F_{1,3}$ = 30.75, p ≤0.01); furthermore, the richness of samples in spring and summer to be significantly greater than the samples of winter and autumn ($F_{3,9}$ = 6.90, p ≤0.01).

DISCUSSION

During the sampling period of July 2011 to April 2012, the avifauna of the Mulga–Eucalypt Line varied in relation to a north to south geographic gradient mainly in the pool of available sedentary and locally dispersive species, but also as a result of the presence of a number of nomadic and migratory birds in northern sites. There was a secondary influence of vegetation type, with some birds associated with *Acacia*-dominated sites and others associated with *Eucalyptus*-dominated sites. Seasonal variation in the avifauna of sites appeared small, as the majority of species were either sedentary or locally dispersive species. Minor seasonal differences were due to the influx of nomadic and migratory species during spring and summer.

Geographic pattern

The geographic variation in avian assemblage noted in the Mulga–Eucalypt Line has been recorded for other Western Australian regions. A biogeographic gradient in avian population structure associated primarily with rainfall was documented along the northern portion of the South-West Botanical Province in vegetation dominated by eucalypt species (Bell *et al.* 2007). Also, a gradual, broad-scale change in avian community structure due to climatic factors was the primary influence in a study of biogeographic patterns in birds of the Carnarvon Basin, well to the north of the present study region (Burbidge *et al*. 2000). Birds in the southern sites of the study area were primarily sedentary and locally dispersive species, while the more northern sites included a number of arid-zone nomadic species.

Influence of vegetation type

The samples of the bird assemblages of the Mulga–Eucalypt Line also showed differences in composition between the *Acacia*-dominated sites and nearby *Eucalyptus*-dominated sites. The singing honeyeater, black-faced cuckoo-shrike, rufous songlark, crested pigeon and mulga parrot were species strongly associated with *Acacia*-dominated sites of the region. All these species have been previously associated predominantly with *Acacia* spp. (although not strictly *Acacia aneura*-dominated vegetation sites) (Cody 1994; Burbidge 2010; Bell *et al.* 2013). Species more likely to be associated with *Eucalyptus*-dominated woodlands included the rufous treecreeper, weebill, red-backed kingfisher, tawny frogmouth, Major Mitchell's cockatoo, red-tailed black cockatoo, regent parrot, brown goshawk and brown falcon. The differential use of particular tree species by birds recorded in our study has been observed in a range of other studies (Hartley 1953; Franzreb 1978; Noske 1979; Ford *et al.* 1986; Holmes & Robinson 1981). A number of reasons have been suggested for the preference of particular tree species by birds. The abundance, biomass and availability of insect resources and the relative abundance of particular tree species in a region may have relevance to insectivorous birds choosing certain tree species (Abbott & Van Heurck 1985). *Acacia* and *Eucalyptus* support entirely different psyllid subfamilies (New 1988), but data from studies from woodlands and forests in Western Australia indicate that there is high overlap among the insects eaten by bird species (Calver & Wooller 1981; Wooller & Calver 1981; Tullis *et al*. 1982; Abbott & Van Heurck 1985; Carver *et al*. 1991; Majer *et al*. 1997). Leaf morphological and nutrient differences in leaves between tree species may also be relevant in facilitating the search for insects among foliage elements (Jackson 1979; Braithwaite *et al*. 1989; Recher *et al*. 1996; Watson 2011). Large trees for nesting and perching may be related to the presence of particular raptors (Storr 1984; Aumann 2001). Nest hollows for some species of parrots could also influence a preference for eucalypt-dominated sites.

Seasonal differences

Minor differences in avifauna assemblage of the Mulga–Eucalypt Line were also found between the four seasonal samples of the July 2011 to March 2012 sampling period. As 70% of the bird species recorded were classed either as sedentary of locally dispersive, seasonal differences might be expected to be small. However, a wide number of arid zone birds in Australia are known to be highly responsive to changes in available food and water resources (Davies 1984; Pavey & Nano 2009). Bell *et al.* (2007) found that the influx of nomadic honeyeaters during episodes of eucalypt flowering strongly influenced the avian associations of eucalypt sites to the south of the Mulga–Eucalypt Line. In the current study, black and pied honeyeaters, two opportunistic nectarivores, occurred in the northern sampling sites during spring, but a general lack of flowering episodes in eucalypt species during the sampling period could have limited any variation in avian assemblage structure due to season. Three species of migratory cuckoos, Horsfield's bronze cuckoo, pallid cuckoo and black-eared cuckoo, were recorded in the Mulga–Eucalypt Line samples, but none were numerous. Other Mulga–Eucalypt Line species listed as migratory, including the striated pardalote, white-winged triller, rufous songlark, tree martin and grey fantail, were also recorded occasionally during the 2011–2012 sampling period, but were never numerous. Nix (1976) characterised a number of Western Australian species as migratory. Keast (1968) also reported information related to the seasonal

migratory movements of a range species, including a number of honeyeaters. It is apparent, however, that further analysis of the movement patterns of arid-zone birds and the classification of the species as either migratory or nomadic is needed. The lack of tagging and recapture studies of terrestrial birds of Australia is a major impediment in the determination of the potential influence of migration on the presence of species in arid-zone samples (Griffioen & Clarke 2002).

Bird richness, density and heterogeneity

Mean species richness within the Mulga–Eucalypt Line was not affected by location, although richness of eucalyptus sites was greater than acacia sites and sample richness in spring and summer was enhanced over samples from autumn and winter. Generally, habitats that are more productive, of greater maturity and/or have greater habitat heterogenity are richer in animal assemblages (Ricklefs & Schluter 1993). However, this does not seem the case for Western Australian bird assemblages, as samples from a very wide range of sites all have similar site richness values. The mean richness of samples of the avifauna of the Mulga–Eucalypt Line at 19.5 species was similar to those recorded for avifauna of the Pilbara much further to the north, as measured by Burbidge *et al.* (2010), which averaged 19.1 species. In the Doolgunna and Mooloogool Rangelands of the northeastern Gascoyne, also to the north of the present samples, species richness averaged 21.7 species per sample (Bell *et al.* 2013). Managed eucalypt forest sites, well to the southwest of the Mulga–Eucalypt Line, typically contain 10–33 bird species per site (Williams *et* al. 2001; Abbott *et al*. 2003). *Eucalyptus*-dominated sites in the northern regions of the South-West Botanical Province, also south of the present study, averaged 27.3 species per sample in the study by Bell *et al*. (2007). Cousin & Phillips (2008) hypothesised that scarcity of food resources results in a species richness threshold beyond which there is insufficient resources to support additional species as habitat complexity increases. Low species richness of Western Australian regions relative to other Australian regions has also been associated with reduced numbers of nectar-feeding species and fewer litter-, trunk- and bark-gleaning species (Nichols & Muir 1989; Woinarski *et al.* 1997). The lack of eucalypt flowering episodes during our sampling period might have further influenced possible richness differences due to season by reducing the number of expected nectar-feeding nomadic honeyeaters. Careful documentation of vegetation structural complexity could provide more conclusive evidence to compare species richness values between north to south gradients in Western Australia and to compare the species richness of Western Australia sites to comparably complex habitats of eastern Australia.

Slight changes in the avifauna of spring and summer in the samples of the Mulga–Eucalypt Line were mainly due to the inclusion of a few nomadic and migratory species to the sedentary and locally dispersive species present in all seasons. Reduced impetus for migration due to the general lack of a large seasonal variation in resource availability has previously been highlighted for the restricted richness of Western Australian avifaunal assemblages (Nichols & Muir 1989) and may be an influence affecting the richness of samples in our study.

Bird density of sites of the Mulga–Eucalypt Line averaged 1.05±1.07 birds/ha. However, during spring the sample in the *Eucalyptus*-dominated site of the Barnong Nature Reserve rose to 5.87 birds/ha due primarily to the irruption in populations of budgerigars and cockatiels. The density of birds in sites of the Mulga–Eucalypt Line was generally much lower than in more mesic Australian habitats. Density of birds in tropical eucalypt savanna woodlands of the Northern Territory is quite high at 9.4 birds/ha (Woinarski & Tidemann 1991). Density of birds in southwestern Western Australian jarrah forest is also relatively high at 5.2 birds/ha (Nichols & Muir 1989). In mallee-boombush (*Melaleuca uncinata*) habitats of northeastern Victoria, bird density is ~3.0 birds/ha (Gilmore 1985). Bird density in relation to habitat resource availability obviously requires further research.

Species diversity (H′) in the Mulga–Eucalypt Line averaged 1.03. Evenness (J′) averaged 0.80 and dominance (D) averaged 0.15. Species diversity values of the winter sample *Eucalyptus*-dominated sites of Bell *et al.* (2007) in the more mesic region to the south of the Mulga–Eucalypt Line averaged slightly higher at 1.12, possibly due to the more even distribution of the densities of individuals among the species. The measures of heterogeneity in the Mulga–Eucalypt Line, however, were quite variable, probably due to the influx of a number of irruptive species of the arid interior during spring and summer. Our findings generally concur with those of Keast (1985), who stated that eucalypt communities throughout Australia vary little in total avian species diversity, although the causes are not known.

All sites utilised in this study were within protected conservation reserves, although much of the Mulga–Eucalypt Line region is increasingly being affected by mining, wheat farming and sheep-grazing activities. Continued protection of the reserves by the Western Australia Department of Parks and Wildlife and independent conservation organisations, such as Bush Heritage Australia, is essential for the maintenance and conservation of the avifauna of this important vegetation transition zone between the arid zone of central Australia and the woodlands and forests of the southwest Western Australia.

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Appendix 1 *Acacia* plot species composition, DCA site and species scores, total number of observations, species movement type and percentage of observations for each site, vegetation type and season for all acacia sites during the 2011–2012 survey period.

Site			Barnong	Lochada	Darwin	Buntine	Barnong	Lochada	Darwin	Buntine
Vegetation			Acacia							
Season			Winter				Spring			
DCA Axis 1 Sample Score			114	117	103	24	324	185	160	69
DCA Axis 2 Sample Score			123	97	101	237	85	105	95	227
DCA Axis 3 Sample Score			40	60	26	103	164	119	56	118
Total Number of Observations			69	125	54	61	570	147	107	74
Common name	**Scientific name**	**Movement type**								
Australian hobby	*Falco longipennis*	Loc.Disp.	-	-	-	-	-	-	-	-
Australian magpie	*Cracticus tibicen*	Loc.Disp.	-	-	-	-	-	-	-	-
Australian owlet-nightjar	*Aegotheles cristatus*	Sedentary	-	-	-	-	-	-	-	-
Australian raven	*Corvus coronoides*	Sedentary	1.45%	3.10%	-	1.64%	0.18%	2.70%	-	1.64%
Australian ringneck	*Barnardius zonarius*	Sedentary	-	6.20%	9.26%	3.28%	-	0.68%	1.87%	-
Black honeyeater	*Certhionyx niger*	Nomadic	-	-	-	-	2.98%	-	-	-
Black-eared cuckoo	*Chalcites osculans*	Migratory	-	-	1.85%	-	-	-	-	3.28%
Black-faced cuckoo-shrike	*Coracina novaehollandiae*	Migratory	-	-	-	14.75%	-	-	-	-
Black-faced woodswallow	*Artamus cinereus*	Nomadic	-	-	-	-	-	-	-	-
Black-shouldered kite	*Elanus axillaris*	Loc.Disp.	-	-	-	-	-	-	-	-
Bourke's parrot	*Neopsephotus bourkii*	Nomadic	-	-	-	-	-	-	-	-
Brown falcon	*Falco berigora*	Sedentary	-	-	-	-	-	-	-	-
Brown goshawk	*Accipter fasciatus*	Loc.Disp.	-	-	-	-	-	-	0.93%	-
Brown songlark	*Cincloramphus cruralis*	Nomadic	-	-	-	-	-	3.38%	-	-
Budgerigar	*Melopsittacus undulatus*	Nomadic	-	-	-	-	76.49%	8.78%	-	-
Chestnut-rumped thornbill	*Acanthiza uropygialis*	Loc.Disp.	4.35%	9.30%	24.07%	4.92%	0.18%	6.08%	19.63%	4.92%
Cockatiel	*Nymphicus hollandicus*	Migratory	-	-	-	-	0.18%	-	3.74%	-
Collared sparrowhawk	*Accipiter cirrhocephalus*	Sedentary	-	-	-	-	-	-	-	-
Common bronzewing	*Phaps chalcoptera*	Loc.Disp.	-	-	1.85%	-	-	-	-	-
Crested bellbird	*Oreoica gutturalis*	Sedentary	4.35%	1.55%	-	-	0.70%	0.68%	6.54%	6.56%
Crested pigeon	*Ocyphaps lophotes*	Sedentary	-	-	-	3.28%	-	-	-	3.28%
Crimson chat	*Ephthianura tricolor*	Nomadic	-	-	-	-	-	11.49%	-	-
Diamond dove	*Geopelia cuneata*	Nomadic	-	-	-	-	-	-	-	-
Emu	*Dromaius novaehollandiae*	Loc.Disp.	-	-	-	-	-	-	-	-
Galah	*Eolophus roseicapillus*	Sedentary	-	-	1.85%	42.62%	0.53%	8.11%	-	44.26%
Grey butcherbird	*Cracticus torquatus*	Sedentary	-	-	-	-	-	-	-	-
Grey currawong	*Strepera versicolor*	Sedentary	-	2.33%	-	-	-	-	-	-
Grey fantail	*Rhipidura albiscapa*	Migratory	-	-	1.85%	1.64%	-	-	0.93%	-
Grey shrike-thrush	*Colluricincla harmonica*	Sedentary	2.90%	2.33%	-	3.28%	0.53%	0.68%	1.87%	3.28%
Horsfield's bronze-cuckoo	*Chalcites basalis*	Migratory	-	-	1.85%	-	0.53%	-	0.93%	-
Inland thornbill	*Acanthiza apicalis*	Loc.Disp.	24.64%	9.30%	11.11%	3.28%	0.88%	-	-	-
Little button-quail	*Turnix velox*	Sedentary	-	-	-	-	0.88%	1.35%	-	1.64%
Little crow	*Corvus bennetti*	Sedentary	-	-	-	-	-	6.08%	-	-
Major Mitchell's cockatoo	*Cacatua leadbeateri*	Sedentary	-	-	-	-	-	0.68%	-	-
Malleeflowl	*Leipoa ocellata*	Sedentary	-	-	-	1.64%	-	-	-	-
Mistletoe bird	*Dicaeum hirundinaceum*	Nomadic	-	-	-	-	-	-	0.93%	-
Mulga parrot	*Psephotus varius*	Sedentary	-	3.10%	3.70%	-	-	-	2.80%	-
Nankeen kestrel	*Falco cenchroides*	Sedentary	-	-	-	-	-	-	-	-
Pallid cuckoo	*Cacomantis pallidus*	Migratory	-	-	-	-	-	0.68%	-	-
Pied butcherbird	*Cracticus nigrogularis*	Sedentary	-	1.55%	-	-	-	0.68%	-	-
Pied honeyeater	*Certhionyx variegatus*	Nomadic	-	-	-	-	7.72%	8.11%	3.74%	-
Rainbow bee-eater	*Merops ornatus*	Migratory	-	-	-	-	-	-	-	-
Red-capped robin	*Petroica goodenovii*	Loc.Disp.	20.29%	24.03%	25.93%	1.64%	2.46%	18.24%	14.95%	3.28%
Red-tailed black-cockatoo	*Calyptorhynchus banksii*	Nomadic	-	1.55%	-	-	-	0.68%	1.87%	-
Redthroat	*Pyrrholaemus brunneus*	Sedentary	5.80%	6.98%	9.26%	1.64%	0.88%	1.35%	0.93%	1.64%
Rufous songlark	*Cinclorhamphus mathewsi*	Migratory	-	-	-	-	-	0.68%	-	1.64%
Rufous whistler	*Pachycephala rufiventris*	Loc.Disp.	-	0.78%	-	-	0.53%	0.68%	8.41%	1.64%
Singing honeyeater	*Lichenostomus virescens*	Nomadic	4.35%	1.55%	-	9.84%	1.40%	1.35%	0.93%	16.39%
Southern boobook	*Ninox novaeseelandiae*	Sedentary	-	-	-	1.64%	-	-	-	-
Southern whiteface	*Aphelocelphala leucopsis*	Sedentary	1.45%	3.10%	-	-	-	6.76%	-	3.28%
Spiny-cheeked honeyeater	*Acanthagenys rufogularis*	Nomadic	1.45%	-	-	-	0.53%	4.05%	11.21%	-
Splendid fairy wren	*Malurus splendens*	Loc.Disp.	14.49%	8.53%	5.56%	-	-	3.38%	3.74%	4.92%
Striated pardalote	*Pardalotus striatus*	Migratory	-	6.20%	-	-	-	-	-	-
Variagated fairy-wren	*Malurus lamberti*	Sedentary	-	-	-	-	1.40%	-	-	-
Wedge-tailed eagle	*Aquila audax*	Sedentary	-	-	-	-	-	-	-	-
Weebill	*Smicrornis brevirostris*	Sedentary	-	-	1.85%	-	-	-	-	-
Welcome Swallow	*Hirundo neoxena*	Nomadic	-	-	-	-	-	0.68%	-	-
Western Corella	*Cacatua pastinator*	Nomadic	-	-	-	-	-	-	-	1.64%
Western Yellow Robin	*Eopsaltria griseogularis*	Loc.Disp.	-	-	-	-	-	-	-	-
Whistling Kite	*Haliastur sphenurus*	Nomadic	-	-	-	-	-	-	0.93%	-
White-browed Babbler	*Pomatostomus superciliosus*	Sedentary	7.25%	-	-	4.92%	0.53%	-	-	18.03%
White-eared Honeyeater	*Lichenostomus leucotis*	Loc.Disp.	-	-	-	-	-	-	1.87%	-
White-fronted Honeyeater	*Purnella albifrons*	Nomadic	-	-	-	-	-	-	1.87%	-
White-winged Triller	*Lalage sueurii*	Migratory	-	5.43%	-	-	0.53%	0.68%	9.35%	-
Willie Wagtail	*Rhipidura leucophrys*	Loc.Disp.	1.45%	-	-	-	-	-	-	-
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	Sedentary	-	-	-	-	-	1.35%	-	-
Yellow-throated Miner	*Manorina flavigula*	Loc.Disp.	5.80%	-	-	-	-	-	-	-
Zebra Finch	*Taeniopygia guttata*	Nomadic	-	-	-	-	-	-	-	-

Barnong Acacia Summer	Lochada Acacia Summer	Darwin Acacia Summer	Buntine Acacia Summer	Barnong Acacia Autumn	Lochada Acacia Autumn	Darwin Acacia Autumn	Buntine Acacia Autumn	DCA Species Scores Axis 1	Axis 2	Axis 3
295	**140**	**109**	**61**	**119**	**131**	**87**	**84**			
100	**97**	**118**	**247**	**147**	**118**	**129**	**168**			
114	**10**	**16**	**0**	**66**	**94**	**28**	**60**			
163	**166**	**115**	**100**	**46**	**94**	**96**	**67**			
-	-	-	1.00%	-	-	-	-	-	-	-
-	4.82%	-	-	-	-	-	-	146	60	-346
-	-	0.87%	-	-	-	-	-	-	-	-
-	0.60%	2.61%	1.00%	-	1.06%	1.04%	5.97%	53	58	50
-	11.45%	4.35%	2.00%	-	4.26%	4.17%	5.97%	95	9	127
-	-	-	-	-	-	-	-	367	99	134
-	-	-	-	-	-	-	-	-11	-39	93
-	-	0.87%	1.00%	-	-	-	-	-132	329	-82
-	-	-	1.00%	-	-	-	-	-131	277	-167
-	-	-	1.00%	-	-	-	-	-	-	-
-	-	-	-	4.35%	-	-	-	29	251	172
-	3.01%	-	-	-	-	-	-	21	-26	-176
-	1.20%	-	-	-	-	-	-	37	-52	176
-	-	-	-	-	-	-	-	-	-	-
65.84%	-	-	-	-	-	-	-	352	70	187
1.24%	22.29%	23.48%	8.00%	28.26%	18.09%	35.42%	10.45%	51	100	14
9.32%	-	1.74%	-	-	-	-	-	293	-14	211
-	0.60%	-	-	-	-	-	-	92	-18	-253
-	1.81%	-	-	-	2.13%	-	2.99%	35	82	-63
0.62%	-	10.43%	-	-	-	-	-	176	122	45
-	1.81%	0.87%	-	-	-	-	5.97%	-7	298	46
-	-	-	-	-	-	-	-	286	79	216
0.62%	-	-	-	-	-	-	-	-	-	-
-	-	1.74%	-	-	-	-	-	182	54	86
-	-	-	4.00%	-	12.77%	2.08%	13.43%	55	243	241
-	-	-	-	2.17%	-	2.08%	-	-54	105	-47
-	3.01%	-	-	-	-	-	-	131	40	-117
-	-	-	-	-	-	3.13%	1.49%	-94	39	-155
1.86%	0.60%	0.87%	5.00%	-	-	1.04%	2.99%	151	166	131
-	-	-	-	-	-	-	-	264	47	-58
3.11%	2.41%	6.09%	4.00%	-	3.19%	-	4.48%	70	68	-8
4.97%	-	-	2.00%	-	-	-	-	304	234	17
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	27	-108	-36
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	21.00%	-	-	8.33%	5.97%	38	293	-88
-	1.20%	0.87%	-	-	-	-	-	45	31	-183
-	-	-	-	-	-	-	-	253	-56	230
-	-	-	-	-	4.26%	-	-	81	-55	222
-	-	-	-	-	-	-	-	328	114	153
-	-	8.70%	2.00%	-	-	-	-	-9	230	-270
1.24%	5.42%	11.30%	3.00%	4.35%	6.38%	7.29%	7.46%	138	85	41
-	-	-	-	-	-	-	-	154	-59	231
9.32%	2.41%	4.35%	3.00%	4.35%	-	2.08%	7.46%	220	171	-20
-	-	-	-	-	-	-	-	182	320	214
1.86%	2.41%	5.22%	-	-	-	2.08%	2.99%	208	98	-4
1.24%	-	-	30.00%	-	-	1.04%	1.49%	23	367	16
-	-	-	-	-	-	-	-	-	-	-
-	-	7.85%	-	19.57%	13.83%	8.33%	-	131	111	138
6.83%	0.60%	-	1.00%	-	10.64%	3.13%	-	238	54	51
11.18%	12.65%	7.85%	4.00%	21.74%	15.96%	14.58%	8.96%	188	199	90
-	-	-	-	-	-	-	-	-74	16	198
-	-	-	-	-	-	-	-	-	-	-
0.62%	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-20	-66	131
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	76	202	264
-	-	-	-	-	-	-	1.49%	-	-	-
-	-	-	2.00%	-	-	-	-	47	189	-44
-	-	-	-	6.52%	-	-	7.46%	-4	264	17
-	-	-	1.00%	-	-	-	-	4	230	-4
0.62%	-	-	1.00%	-	-	-	-	263	230	-32
-	-	-	-	-	-	-	-	257	7	173
-	-	-	-	2.17%	-	-	2.99%	59	235	182
-	1.81%	-	2.00%	-	-	4.17%	-	-67	52	-118
-	-	-	-	-	1.06%	-	-	122	-78	147
32.92%	18.67%	-	-	6.52%	6.38%	-	-	306	116	48

Appendix 2 *Eucalyptus* plot species composition, DCA site and species scores, total number of observations, species movement type and percentage of observations for each site, vegetation type and season for all eucalypt sites during the 2011–2012 survey period.

Site			**Barnong**	**Lochada**	**Darwin**	**Buntine**	**Barnong**	**Lochada**	**Darwin**	**Buntine**
Vegetation			**Eucalyptus**							
Season			**Winter**				**Spring**			
DCA Axis 1 Sample Score			**72**	**49**	**37**	**44**	**319**	**148**	**83**	**64**
DCA Axis 2 Sample Score			**83**	**19**	**22**	**82**	**66**	**32**	**99**	**42**
DCA Axis 3 Sample Score			**35**	**63**	**160**	**29**	**179**	**133**	**203**	**85**
Total Number of Observations			**150**	**131**	**88**	**81**	**922**	**218**	**247**	**112**
Common name	**Scientific name**	**Movement type**								
Australian magpie	*Cracticus tibicen*	Loc.Disp.	-	-	-	-	-	-	-	-
Australian raven	*Corvus coronoides*	Sedentary	3.95%	-	3.41%	2.47%	0.33%	2.78%	0.81%	9.09%
Australian ringneck	*Barnardius zonarius*	Sedentary	1.32%	9.92%	1.14%	-	-	11.11%	4.05%	4.55%
Black honeyeater	*Certhionyx niger*	Nomadic	-	-	-	-	1.19%	-	-	-
Black-eared cuckoo	*Chalcites osculans*	Migratory	1.32%	-	-	-	-	-	1.21%	13.64%
Black-faced cuckoo-shrike	*Coracina novaehollandiae*	Migratory	-	-	-	-	0.33%	-	-	-
Black-faced woodswallow	*Artamus cinereus*	Nomadic	-	-	-	-	0.33%	-	-	-
Bourke's parrot	*Neopsephotus bourkii*	Nomadic	-	-	-	-	-	-	-	-
Brown falcon	*Falco berigora*	Sedentary	-	0.76%	-	1.23%	-	-	-	-
Brown goshawk	*Accipter fasciatus*	Loc.Disp.	-	-	-	-	-	0.46%	0.81%	-
Brown songlark	*Cincloramphus cruralis*	Nomadic	-	-	-	-	-	-	-	-
Budgerigar	*Melopsittacus undulatus*	Nomadic	-	-	-	-	80.80%	12.96%	7.69%	-
Chestnut-rumped thornbill	*Acanthiza uropygialis*	Loc.Disp.	20.39%	14.50%	-	22.22%	0.98%	9.26%	0.81%	12.12%
Cockatiel	*Nymphicus hollandicus*	Migratory	-	-	-	-	3.58%	6.48%	2.02%	-
Collared sparrowhawk	*Accipiter cirrhocephalus*	Sedentary	-	0.76%	-	-	-	-	-	-
Common bronzewing	*Phaps chalcoptera*	Loc.Disp.	-	-	-	-	-	-	-	-
Crested bellbird	*Oreoica gutturalis*	Sedentary	1.32%	4.58%	-	-	0.11%	2.31%	-	-
Crested pigeon	*Ocyphaps lophotes*	Sedentary	-	-	-	-	0.33%	-	-	-
Crimson chat	*Epthianura tricolor*	Nomadic	-	-	-	-	-	-	-	-
Emu	*Dromaius novaehollandiae*	Loc.Disp.	-	-	-	-	-	0.93%	0.40%	-
Galah	*Eolophus roseicapillus*	Sedentary	1.32%	1.53%	18.18%	1.23%	1.74%	2.78%	32.39%	13.64%
Grey butcherbird	*Cracticus torquatus*	Sedentary	1.97%	-	-	-	0.11%	-	-	-
Grey currawong	*Strepera versicolor*	Sedentary	-	-	-	-	-	-	0.40%	-
Grey fantail	*Rhipidura albiscapa*	Migratory	4.61%	4.58%	1.14%	2.47%	-	-	-	-
Grey shrike-thrush	*Colluricincla harmonica*	Sedentary	1.97%	2.29%	2.27%	1.23%	0.22%	0.93%	2.43%	6.06%
Horsfield's bronze-cuckoo	*Chalcites basalis*	Migratory	-	-	1.14%	1.23%	-	0.46%	0.40%	-
Inland thornbill	*Acanthiza apicalis*	Loc.Disp.	13.82%	3.82%	5.68%	19.75%	0.11%	3.24%	5.26%	12.12%
Jacky winter	*Microeca fascinans*	Loc.Disp.	0.66%	-	1.14%	1.23%	-	-	-	1.52%
Little button-quail	*Turnix velox*	Sedentary	-	-	-	-	-	-	-	1.52%
Little eagle	*Hieraaetus morphnoides*	Sedentary	-	-	-	-	-	-	-	-
Major Mitchell's cockatoo	*Lophochroa leadbeateri*	Sedentary	-	4.58%	-	-	-	-	0.40%	-
Mulga parrot	*Psephotus varius*	Sedentary	1.32%	-	-	-	0.98%	-	0.81%	1.52%
Nankeen kestrel	*Falco cenchroides*	Sedentary	-	-	-	-	-	-	-	-
Pallid cuckoo	*Cacomantis pallidus*	Migratory	-	-	1.14%	-	0.11%	2.78%	-	-
Pied butcherbird	*Cracticus nigrogularis*	Sedentary	-	-	3.41%	-	-	2.31%	0.40%	-
Rainbow bee-eater	*Merops ornatus*	Migratory	-	-	-	-	-	-	-	-
Red wattlebird	*Anthochaera carunculata*	Nomadic	-	-	1.14%	-	-	-	1.21%	-
Red-backed kingfisher	*Todiramphus pyrrhopygius*	Nomadic	-	-	-	-	0.33%	0.93%	-	-
Red-capped robin	*Petroica goodenovii*	Loc.Disp.	17.76%	12.21%	5.68%	9.88%	2.17%	7.41%	2.43%	4.55%
Red-tailed black-cockatoo	*Calyptorhynchus banksii*	Nomadic	-	-	9.09%	-	-	5.09%	-	-
Redthroat	*Pyrrholaemus brunneus*	Sedentary	-	-	-	-	-	-	-	4.55%
Regent parrot	*Polytelis anthopeplus*	Nomadic	-	-	4.55%	-	-	-	5.26%	-
Rufous tree-creeper	*Climacteris rufa*	Sedentary	-	-	4.55%	-	-	-	2.02%	-
Rufous whistler	*Pachycephala rufiventris*	Loc.Disp.	0.66%	2.29%	-	-	0.22%	-	0.81%	1.52%
Singing honeyeater	*Lichenostomus virescens*	Nomadic	-	-	-	2.47%	-	-	-	-
Southern whiteface	*Aphelocelphala leucopsis*	Sedentary	12.50%	2.29%	-	-	-	6.02%	-	-
Spiny-cheeked honeyeater	*Acanthagenys rufogularis*	Nomadic	-	-	-	2.47%	0.43%	2.31%	-	16.67%
Splendid fairy wren	*Malurus splendens*	Loc.Disp.	1.32%	-	-	-	-	-	-	-
Striated pardalote	*Pardalotus striatus*	Migratory	-	1.53%	2.27%	-	-	0.46%	-	-
Tawny frogmouth	*Podargus strigoides*	Sedentary	-	-	2.27%	-	-	-	0.40%	4.55%
Tree martin	*Petrochelidon nigricans*	Migratory	-	-	2.27%	-	-	-	11.74%	-
Varied sittella	*Daphoenositta chrysoptera*	Sedentary	2.63%	-	-	-	-	-	-	-
Weebill	*Smicrornis brevirostris*	Sedentary	2.63%	29.01%	29.55%	16.05%	1.74%	12.50%	8.10%	45.45%
Western corella	*Cacatua pastinator*	Nomadic	-	-	-	2.47%	-	-	2.83%	-
Western gerygone	*Gerygone fusca*	Sedentary	-	-	-	-	-	-	-	-
Whistling kite	*Haliastur sphenurus*	Nomadic	-	-	-	-	-	-	-	1.52%
White-browed babbler	*Pomatostomus superciliosus*	Sedentary	1.97%	-	-	8.64%	-	-	-	3.03%
White-browed treecreeper	*Climacteris affinis*	Sedentary	-	1.53%	-	-	-	-	-	-
White-eared honeyeater	*Lichenostomus leucotis*	Loc.Disp.	-	-	-	1.23%	-	-	-	-
White-fronted honeyeater	*Purnella albifrons*	Nomadic	-	-	-	-	-	-	-	-
White-winged triller	*Lalage sueurii*	Migratory	-	0.76%	-	-	1.84%	4.17%	2.43%	6.06%
Willie wagtail	*Rhipidura leucophrys*	Loc.Disp.	-	-	-	-	-	-	-	-
Yellow-plumed honeyeater	*Lichenostomus ornatus*	Loc.Disp.	-	-	-	-	-	-	-	-
Yellow-rumped thornbill	*Acanthiza chrysorrhoa*	Sedentary	1.97%	-	-	3.70%	-	0.46%	-	3.03%
Yellow-throated miner	*Manorina flavigula*	Loc.Disp.	3.29%	3.05%	-	-	2.06%	1.85%	2.43%	3.03%
Zebra finch	*Taeniopygia guttata*	Nomadic	-	-	-	-	-	-	-	-

Barnong	Lochada	Darwin	Buntine	Barnong	Lochada	Darwin	Buntine			
Eucalyptus										
Summer				Autumn						
165	**109**	**0**	**28**	**41**	**55**	**36**	**37**			
101	**24**	**0**	**100**	**130**	**8**	**86**	**72**			
55	**117**	**88**	**44**	**21**	**90**	**193**	**40**	**DCA Species Scores**		
205	**169**	**98**	**146**	**126**	**163**	**290**	**84**	**Axis 1**	**Axis 2**	**Axis 3**
1.46%	2.05%	-	2.74%	-	-	-	-	146	60	-346
0.98%	1.37%	2.04%	2.05%	1.59%	1.84%	0.34%	1.19%	53	58	50
1.46%	15.07%	4.08%	3.42%	1.59%	9.20%	2.76%	1.19%	95	9	127
-	-	-	-	-	-	-	-	367	99	134
-	0.68%	-	-	-	-	-	-	-11	-39	93
1.46%	-	4.08%	4.11%	-	-	-	-	-132	329	-82
-	-	-	1.37%	6.35%	-	-	-	-131	277	-167
-	-	-	-	1.59%	-	-	-	29	251	172
-	-	2.04%	-	-	0.61%	-	-	21	-26	-176
-	0.68%	4.08%	-	-	-	-	-	37	-52	176
-	0.68%	-	-	-	-	-	-	-	-	-
2.44%	-	-	-	-	-	-	-	352	70	187
10.24%	8.22%	9.18%	7.53%	33.33%	17.18%	10.00%	19.05%	51	100	14
5.85%	16.44%	-	-	-	-	2.41%	-	293	-14	211
-	-	-	-	-	-	-	-	92	-18	-253
-	3.42%	-	2.05%	1.59%	0.61%	-	-	35	82	-63
1.95%	2.74%	-	0.68%	-	-	-	1.19%	176	122	45
0.49%	0.68%	-	-	-	-	-	-	-7	298	46
-	0.93%	-	-	-	-	-	-	286	79	216
-	0.00%	-	-	-	-	-	-	182	54	86
-	4.79%	-	6.16%	3.97%	0.61%	24.83%	5.95%	55	243	241
-	-	-	-	1.59%	1.23%	-	1.19%	-54	105	-47
-	-	-	-	-	0.61%	0.34%	-	131	40	-117
-	-	-	-	-	-	0.34%	11.90%	-94	39	-155
0.98%	1.37%	2.04%	2.05%	-	-	1.72%	1.19%	151	166	131
-	-	-	-	-	-	-	-	264	47	-58
6.83%	2.74%	1.02%	7.53%	2.38%	1.84%	0.69%	7.14%	70	68	-8
-	-	-	-	-	-	-	-	-82	-64	-61
0.98%	-	-	1.37%	-	-	-	-	304	234	17
-	-	-	2.05%	-	-	-	-	-	-	-
-	-	-	-	-	1.23%	-	-	27	-108	-36
3.41%	-	-	-	10.32%	-	-	4.76%	38	293	-88
-	-	1.02%	-	-	-	-	-	45	31	-183
-	-	-	-	-	-	-	-	253	-56	230
-	8.22%	4.08%	-	0.79%	1.84%	2.41%	-	81	-55	222
-	1.37%	-	3.42%	-	-	-	-	328	114	153
-	-	1.02%	0.68%	-	-	-	-	-9	230	-270
-	0.68%	-	-	-	-	-	-	230	-114	219
4.88%	0.00%	1.02%	1.37%	11.90%	4.91%	3.79%	7.14%	138	85	41
-	1.37%	-	-	-	-	1.38%	-	154	-59	231
2.44%	-	3.06%	-	-	1.23%	-	2.38%	220	171	-20
-	-	-	-	-	-	-	-	83	-58	295
-	-	10.20%	-	-	-	3.45%	-	182	320	214
1.95%	-	1.02%	1.37%	-	0.61%	-	1.19%	208	98	-4
1.46%	-	-	6.85%	-	1.84%	2.41%	-	23	367	16
5.85%	-	-	-	3.17%	5.52%	-	-	131	111	138
15.12%	-	-	3.42%	-	-	0.34%	-	238	54	51
4.88%	6.85%	-	-	2.38%	-	-	3.57%	188	199	90
-	-	1.02%	3.42%	-	-	3.10%	-	-74	16	198
-	-	-	-	-	-	-	-	-61	-127	101
-	-	-	-	-	-	21.03%	-	19	32	346
-	-	-	-	-	-	-	-	-	-	-
4.88%	19.86%	36.73%	24.66%	7.14%	30.67%	15.17%	22.62%	-20	-66	131
-	-	-	-	-	-	-	-	76	202	264
0.49%	-	-	-	-	-	-	-	-	-	-
-	0.68%	-	-	-	-	-	-	47	189	-44
1.46%	-	-	6.16%	3.97%	-	-	3.57%	-4	264	17
-	-	-	-	-	1.23%	-	-	-117	-148	-46
-	-	-	2.05%	-	-	1.03%	-	4	230	-4
2.93%	-	-	-	-	-	-	-	263	230	-32
-	-	-	-	-	-	-	-	257	7	173
1.95%	-	-	-	2.38%	-	0.69%	-	59	235	182
-	3.42%	-	-	-	-	-	-	-	-	-
0.49%	-	9.18%	2.05%	3.97%	-	1.38%	-	-67	52	-118
1.46%	9.59%	3.06%	1.37%	-	17.18%	0.34%	4.76%	122	-78	147
10.73%	2.74%	-	-	-	-	-	-	306	116	48