

# Habitat complexity explains species-specific occupancy but not species richness in a Western Australian woodland.

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## **Abstract**

Habitat complexity is an important factor governing species richness and habitat selection in birds. The present study examined this relationship in a large Wandoo woodland in Western Australia. Habitat complexity (comprising canopy, shrub, ground vegetation, log and leaf litter cover) and bird species richness was recorded in 48 sites, each approximately three hectares in size. We found no significant correlation of habitat complexity with species richness. We propose the absence of such a relationship results from the resource-poor environment of the woodlands of south-western Australia. The relative scarcity of food resources results in a species richness threshold beyond which there are insufficient niches and resources to support additional species with increasing habitat complexity. Only two species exhibited significant associations with habitat complexity, with the western yellow robin (*Eopsaltria griseogularis*) occupying sites with higher habitat complexity, and the restless flycatcher (*Myiagra inquieta*) occupying sites with lower habitat complexity. Although some species may respond specifically to habitat complexity, management of avian biodiversity within Australian woodlands should take into account the potentially greater role that productivity and resource availability plays in influencing species richness, rather than habitat complexity *per se*. Furthermore, the individual components comprising habitat complexity may be of equal importance in assessing relationship of species richness to overall habitat complexity.

## **Introduction**

Avian species diversity and richness in terrestrial habitats is closely associated with habitat structure and floristics. Many researchers suggest that habitat structure rather than floristics is the principal factor governing avian species diversity, whereby habitats with greater structural complexity harbour more abundant resources and afford a greater potential for segregation of available microhabitats (e.g. Hulbert 2004; MacArthur and MacArthur 1961; MacArthur *et al.* 1962; Willson 1974). This pattern is not restricted to avian communities, with faunal communities as diverse as those of wasps (Lassau and Hochuli 2005), reef fish (Lingo and Szedlmayer 2006) and kelp forest macrofauna (Hauser *et al.* 2006) increasing in diversity and richness with an increase in habitat complexity. Despite the widespread occurrence of this relationship, the exact mechanism that drives this association is still debated. For example, MacArthur and MacArthur (1961) and Willson (1974) suggest that an increase in foliage height diversity results in an increase in species diversity in response to a greater number of available niches. However, species richness and diversity responses to habitat complexity may be regulated by productivity, such that species richness and diversity responds to the productivity and elevated resources in complex habitats (Hulbert 2004).

Just as habitat structure is an important determinant of species diversity and richness, it is also an important factor contributing to the habitat selection of individual species (e.g., Watson *et al.* 2004). The association of whole avian communities and individual species with specific habitat structural attributes is influenced by many factors including the provision of adequate resources for foraging and breeding, and shelter from weather, predators and parasites (Hildén 1965). In turn, many factors can alter habitat structural attributes, and thus the appropriateness of habitat for avian communities and individual species, including grazing (Ammon and Stacey 1997; Ludwig *et al.* 2000; Williams 1990), fire (Coops and Catling 2000) and logging (Willett 2001). An understanding of the habitat complexity thresholds of individual species

will provide further insight into the factors influencing avian diversity, the reasons for the decline of some woodland species (Ford *et al.* 2001) and will allow for a more accurate appraisal of the habitat requirements of declining species and the potential effects of continued landuse changes.

The present study was undertaken in the wheatbelt region of Western Australia; an area in which 93% of the original vegetation has been cleared since the Second World War (Saunders *et al.* 1985). Wandoo (*Eucalyptus wandoo*) woodland was preferentially cleared, on account of its association with more productive downslope soils (Coates 1993). As a result of the decline in distribution and abundance of a large number of species associated with Wandoo woodlands in the wheatbelt of Western Australia (Saunders and Curry 1990; Saunders and Ingram 1995), the present study represents an important step to an understanding of the ecological requirements of this community. The aims of the present study were to (i) determine if there was an association between habitat complexity and avian species richness in Wandoo woodland and (ii) to determine whether individual species exhibited habitat complexity thresholds within this woodland.

## **Materials and methods**

### *Study area*

The study was undertaken 180 km south-east of Perth Western Australia in Dryandra Woodland (32°47'S, 116°58'E). This 22,000 ha reserve is represented by 10 blocks of remnant woodland, the largest of which is over 12,000 ha in size (Department of Conservation and Land Management 1995). Dryandra Woodland is characterised by woodland vegetation regimes dominated by Wandoo on the mid to lower slopes and low lying areas, and Powderbark Wandoo (*E. accedens*) on the gentle to steep upper slopes and along lateritic ridges. Mixed species associations with Marri (*Corymbia calophylla*), Jarrah (*E.*

*marginata*) and Rock Sheoak (*Allocasuarina huegeliana*) also occur, as do kwongan shrublands dominated by Proteaceae and Mrytaceae species.

### *Study sites*

We examined the relationship between habitat complexity and avian species richness in 48 sites of *E. wandoo* and *E. accedens* woodland throughout Dryandra Woodland. We undertook fieldwork between July and November 2001, a time corresponding with the breeding season of many of the resident species (pers. obs.). We selected sites with an array of habitat structural complexities, although sites were avoided if they were on the ecotone between woodland and other vegetation communities. This approach avoids complicating the interpretation of avian species presence through a grossly heterogeneous vegetation structure within sites.

### *Habitat complexity*

At each site, we measured habitat complexity in a three hectare area using a modified form of the method developed by Newsome and Catling (1979). The normal method of assigning habitat complexity scores is based on subjective field estimates of percentage cover of various habitat components typically denoting cover as one of five measures of cover (complexity) between one and five (Catling and Burt 1995; Newsome and Catling 1979; Watson *et al.* 2001). However, in this study we assigned component scores following collection and subsequent examination of quantitative field data.

Within each site, we recorded canopy complexity from a measure of canopy cover; the percentage incidence of sapling, (1 m – 5 m), subcanopy (5 m – 10 m) and canopy (> 10 m) trees recorded every 10 m along a 530 m transect traversing the site. We recorded shrub complexity from a measure of the mean shrub density at six equidistant points along the transect, calculated using the point-quarter method (Cottam and Curtis 1956). We measured

ground vegetation (including any herbaceous and grassy vegetation typically < 0.3 m in height) and leaf litter (comprising leaf litter, twigs and bark) complexity from the mean cover within a 0.3 m x 0.3 m quadrat, recorded at 15 equidistant points along the transect. We recorded log complexity from a measure of log density, calculated as the inverse of the mean distance to nearest log from 15 equidistant points along the transect.

To determine the score boundaries for each component, we ordered all data from each component and divided each into five approximately equal sized groups (representing the five score ranks for each component). We then altered the range boundaries to align them for each component score to the nearest major unit (see Table 1). This methodology is a more quantitative method for measuring habitat complexity by eliminating the subjectivity of traditional field-based estimates used in previous studies (e.g., Newsome and Catling 1979; Watson *et al.* 2001).

(Insert Table 1)

For each site, we calculated a habitat complexity score on the basis of five habitat attributes; canopy, shrub, ground vegetation, log and leaf litter cover (Table 1). Each component was rated on a scale of one to five (sparse to abundant), and then totaled to give an overall site habitat complexity score (Catling and Burt 1995; Watson *et al.* 2001). As such, site scores could range between five and 25. Overall habitat complexity scores under 10 typically represented sites with a low canopy cover and understory cover of shrubs and ground vegetation, and a sparse amount of leaf litter and logs. Habitat complexity scores over 20 typically represented sites with a high canopy cover and abundant understory and dense leaf litter and logs. While there is no assumption of equivalence in the increase in scores of one habitat complexity component to the next, there is a general assumption of an overall increase in general structural complexity of the habitat with the addition of scores from any or all

individual habitat complexity components. In the examination of individual species responses to habitat complexity, those components contributing to overall habitat complexity were examined to assist in the interpretation of the overall habitat complexity response.

#### *Avian surveys*

Collection of quantitative field data took between 60 and 90 minutes to collect from each site. During this time, one author (JAC) recorded habitat data and simultaneously opportunistically recorded avian species presence while the other author (RDP) independently recorded avian species throughout the three hectare site. We recorded avian species by sight as well as by sound, but only if they were within the three hectare area. Species flying over sites were not included. Surveying was undertaken throughout the day except between 1100 and 1400, or if it was too windy, or raining. We only surveyed each site once for avian species. As the vegetation of the study sites was open woodland, we were confident that a single search by each author of at least 60 minutes would account for all present species (see Nix and Brooker 1978). The only vegetation strata presenting any potential hindrance to detectability was the canopy and shrub layers. However, in open eucalypt woodland, when canopy complexity increases, it is not through the formation of additional horizontal layers (as in rainforest), thus, there is no hindrance in detectability of canopy-dwelling species. Furthermore, almost all species inhabiting shrubs in the study area are exceptionally vocal (e.g., white-browed scrubwren (*Rhipidura albiscapa*), blue-breasted fairy-wren (*Malurus pulcherrimus*), inland thornbill (*Acanthiza apicalis*)). Given the long survey time in relatively open habitat, without any impenetrable vegetation to hinder detectability, we were confident that two independent observers were able to detect all species utilising the site. Ideally, repeat surveys would have been conducted at each site to reduce the chance of imperfect detection (see MacKenzie 2005; MacKenzie and Royle 2005 for discussion), however, we opted to maximize the number of sites surveyed rather undertaking repeat surveys.

## *Analysis*

As the data for habitat complexity were ordinal, we calculated Spearman rank correlation coefficients to test for a relationship between the overall habitat complexity score and avian species richness in the 48 sites. We also calculated Spearman rank correlation coefficients to test for relationships between the five individual habitat complexity components and avian species richness in the 48 sites.

To assess the importance of habitat complexity on individual species, we undertook binomial logistic regression analysis on account of the binomial nature of the dependent variable (species either present or absent). We then used these regression models to produce probability of occurrence values and graphs for those species showing a significant association with habitat complexity scores. All regression analysis was undertaken using the Minitab statistics package (Minitab Inc, 2000). There is much conjecture in the literature regarding the appropriateness of significance levels following multiple statistical tests. In the present study, we chose to retain the p-value at the 5% level of significance (see Rice 1989 for discussion).

## **Results**

Fifty-eight species of bird (Appendix 1) were recorded in the 48 sites. Avian species richness at each site ranged between five and 20 species ( $11.02 \pm 0.49$ ; mean  $\pm$  S.E.), while habitat complexity scores ranged between nine and 22 ( $14.96 \pm 0.38$ ).

### *Habitat complexity vs' avian species richness*

There was no significant correlation ( $r_s = 0.204$ ,  $df = 46$ ;  $p = 0.134$ ) between habitat complexity score and avian species richness in the 48 sites (Fig. 1). However, examining each of the habitat complexity components separately indicated a significant positive correlation of

species richness with log complexity ( $r_s = 0.350$ ,  $df = 46$ ;  $p = 0.011$ ) and ground vegetation complexity ( $r_s = 0.295$ ,  $df = 46$ ;  $p = 0.028$ ). There was no significant correlation between species richness and canopy complexity ( $r_s = 0.107$ ,  $df = 46$ ;  $p = 0.726$ ), shrub complexity ( $r_s = -0.001$ ,  $df = 46$ ;  $p = 0.803$ ), or leaf litter complexity ( $r_s = -0.257$ ,  $df = 46$ ;  $p = 0.147$ ).

(Insert Figure 1)

#### *Relationship of habitat complexity with individual species*

For the logistic regression analysis, we eliminated 25 species of bird from the analysis that were recorded in fewer than five sites (see Vittinghoff and McCulloch 2007 for discussion on presence power)(see Appendix 1). Logistic regression models for three of the species showed significant lack of fit according to at least one of Pearson's chi-square, deviance or Hosmer-Lemeshow goodness-of-fit tests (Appendix 1). Of the remaining 30 species, the presence of only two species was significantly related to habitat complexity at the 5% level of significance. The restless flycatcher (*Myiagra inquieta*) occupied significantly less structurally complex habitats (Table 2), while the western yellow robin (*Eopsaltria griseogularis*) occupied significantly more structurally complex habitats (Table 3). For purely exploratory means, if a less stringent estimate of level of significance is examined ( $p < 0.1$ ), the elegant parrot (*Neophema elegans*), rufous treecreeper (*Climacteris rufa*) and yellow-plumed honeyeater (*Lichenostomus ornatus*) occupied structurally less complex habitats (Table 2), while the red-capped robin (*Petroica goodenovii*), striated pardalote (*Pardalotus striatus*) and white-naped honeyeater (*Melithreptus lunatus*) occupied more structurally complex habitats (Table 3).

(Insert Tables 2 and 3)

We calculated cumulative probability values for all species with a significance value of  $p < 0.1$  at three habitat complexity scores from the binary logistic regression analysis (Table 4). At an intermediate habitat complexity score of 15, the mean probability of occurrence of the high habitat complexity selective species (from Table 4) was 36.5%, compared to 35.8% for the low habitat complexity selective species.

(Insert Table 4)

Cumulative probability graphs (Fig. 2) for the restless flycatcher and western yellow robin showing relationship with habitat complexity scores (from Tables 2 and 3) indicated that to have a 50% probability of a restless flycatcher occupying a site required sites with a maximum habitat complexity score of 9.5, while having a 50% probability of a western yellow robin occupying a site required sites with a minimum habitat complexity score of 16.2.

(Insert Figure 2)

## **Discussion**

### *Species richness and habitat complexity*

We found no significant correlation between habitat complexity and species richness. A large body of literature suggests that with an increase in structural complexity of the habitat comes an increase in avian species diversity and richness (Hulbert 2004; MacArthur and MacArthur 1961; MacArthur *et al.* 1962; Willson 1974). This pattern is normally attributed to an assumption of greater availability of microhabitats and resources in vegetation with greater structural complexity.

Comparison with other studies of the effect of habitat complexity on avian communities, suggests that the scale of investigation is an important determinant of the relationship between

species richness and structural complexity. Some studies suggest structural complexity is a good determinant of species richness at the landscape scale (Arnold 1988; Mac Nally 1990; Rotenberry 1985; Wiens and Rotenberry 1981) rather than the territory scale of the present study. Similarly, early studies examining the relationship of habitat structure with avian species diversity focused on comparisons between disparate ecosystem types (e.g., comparing grasslands to savannah to rainforest) and revealed that structurally more complex ecosystems were more diverse. As such, the likelihood of detecting a relationship of species richness and habitat complexity in the present study was reduced, given the comparatively subtle variations in structural complexity within the open woodland ecosystem sampled in the present study.

Alternatively, we postulate that the absence of a species richness relationship with habitat complexity may stem from the resource-limited environment characteristic of the woodland ecosystems in south-western Australia. Studies examining the relationship of habitat complexity with species richness in Australia have primarily been undertaken in more productive forests of the southeast of Australia (e.g. Nix and Brooker 1978; Watson *et al.* 2003). Braithwaite *et al.* (1989) found that avian species richness was higher in those southeast forests with a greater tree basal area (an index of total biomass akin to structural complexity) and foliar magnesium. As a result of lower foliar nutrients (Majer *et al.* 1992) and invertebrate biomass (Majer *et al.* 1999; Majer *et al.* 1990) associated with Western Australian *Eucalyptus* trees compared to eastern Australian trees, an increase in structural complexity of the vegetation may not necessarily reflect additional microhabitats and resources for more species. Thus, the higher species richness response present in southeast Australian forests may be influenced by the increased productivity in more structurally complex habitats, rather than structural complexity *per se*. It may suggest that in the present study area, there is a species richness threshold beyond which there are insufficient resources for additional species. While greater habitat complexity intuitively implies a larger number of

foraging niches, an absence of a relationship between habitat complexity and species richness may indicate that species broaden their foraging niches. For example, Recher and Davis (1998) indicated that birds in wandoo woodland broadened their foraging over a wider range of substrates than their eastern Australian counterparts.

#### *Species richness and individual habitat complexity components*

The presence of a significant positive correlation between avian species richness and log density and ground vegetation cover supports results from other studies. Laven and MacNally (1998) found that the abundance and species richness of birds was significantly higher in sites with a higher abundance of logs. Logs provide abundant invertebrate prey habitat that large numbers of avian species such as the robins and treecreepers utilise as a foraging resource (Cousin 2004b; Laven and Mac Nally 1998; Recher 1991). Similarly, the significant positive correlation of avian species richness with ground vegetation can be explained by the elevated diversity of invertebrate communities in a structurally diverse and complex ground vegetation (Bromham *et al.* 1999). The absence of a relationship between species richness and canopy complexity stems from the fact that an increase in canopy complexity in the open woodland of the present study area does not necessarily reflect formation of additional horizontal layers and thus an increase in available microhabitats.

#### *Individual species response to habitat complexity*

Although there was no relationship between species richness and habitat complexity, a number of individual species did exhibit clear associations with habitat complexity. The present study is the first to demonstrate a specific habitat complexity response by the western yellow robin. Occupation of sites with a high habitat complexity by western yellow robins reflects the selection by this species for habitat with high understorey complexity, particularly comprising a rich litter layer and dense coarse woody debris (Higgins and Peter 2002), and

selection for habitat with a dense canopy cover (Cousin 2004a). These factors relate to the selection of sites with abundant understorey invertebrate prey habitat, an important foraging resource of the ground foraging western yellow robin (Cousin 2004b). Occupation by the restless flycatcher of sites with lower habitat complexity reflects the selection by this species for open woodland sites (Boles 1988). Although classed as an arboreal forager (Boles 1988), in southwestern Australia the restless flycatcher is primarily an aerial forager (Recher and Davis 1998). Occupation of sites with a low understorey complexity assists in the foraging behaviour of this species, which often hovers and scans for prey above open ground. Interestingly, in a study by Watson *et al.* (2001), the restless flycatcher exhibited a habitat complexity response by occupying more complex sites, although their results reflected a combination of remnant size and habitat complexity and the primarily arboreal foraging behaviour of this species in eastern Australia.

### *Conclusion*

Although some species may respond predictably to habitat with specific structural properties, the results of the present study suggest that conservation management plans should not focus too heavily on the accepted doctrine of 'greater habitat complexity will result in greater species richness'. Indeed, only one species in the present study, the Western Yellow Robin, responded favourably to greater overall habitat complexity. Instead, management of avian biodiversity within Australian woodlands should take into account the potentially greater role that productivity and resource availability plays in influencing species richness. Furthermore, the results of the present study also suggest the importance of examining the role of individual structural components comprising habitat complexity, as these may be of equal importance in assessing the relationship of species richness with habitat complexity.

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**Table 1: The individual components of the habitat complexity score and their rating boundaries.**

Canopy refers to percentage incidence of sapling, subcanopy and canopy trees. Shrubs refers to shrubs per hectare. Ground vegetation refers to percentage cover of herbaceous and grassy vegetation on the ground. Logs refer to mean distance from sampling points to logs. Leaf litter refers to percentage cover of leaf litter, twigs and bark on the ground.

<i>Components</i>	Habitat complexity score				
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
Canopy	< 20%	20 – 30%	30 – 40%	40 – 50%	> 50%
Shrubs	< 500	500 - 1000	1000 - 2000	2000 - 5000	> 5000
Ground vegetation	< 5%	5 – 10%	10 – 20%	20 – 30%	> 30%
Logs	> 7 m	6 – 7 m	5 – 6 m	4 – 5 m	< 4 m
Leaf litter	< 50%	50 – 60%	60 – 70%	70 – 80%	> 80%

**Table 2: Negative relationships between bird-species presence and habitat complexity according to binomial logistic regression analysis.**

Analysis includes all species found in at least five sites. ' $\beta$ ' refers to regression co-efficient, 'n' refers to number of sites (out of 48) in which the species was recorded. 95% CI refers to the lower and upper bounds of the 95% confidence interval of the odds ratio. \* significant at  $p < 0.05$ .

<i>Species</i>	$\beta$	n	<i>p</i>	Odds ratio	95% CI	
					Lower	Upper
Australian ringneck	-0.0236	34	0.847	0.98	0.77	1.24
Brown honeyeater	-0.0487	10	0.724	0.95	0.73	1.25
Dusky woodswallow	-0.2021	12	0.149	0.82	0.62	1.07
Elegant parrot	-0.2854	12	0.056	0.75	0.56	1.01
Restless flycatcher	-0.3835	7	0.038*	0.68	0.47	0.98
Rufous treecreeper	-0.2351	28	0.071	0.79	0.61	1.02
Scarlet robin	-0.0745	9	0.607	0.93	0.70	1.23
Tree martin	-0.0545	13	0.666	0.95	0.74	1.21
Yellow-plumed honeyeater	-0.2318	24	0.072	0.79	0.62	1.02

**Table 3: Positive relationships between bird-species presence and habitat complexity according to binomial logistic regression analysis.**

Analysis includes all species found in at least five sites. ' $\beta$ ' refers to regression co-efficient, 'n' refers to number of sites (out of 48) in which the species was recorded. 95% CI refers to the lower and upper bounds of the 95% confidence interval of the odds ratio. \* significant at  $p < 0.05$ .

<i>Species</i>	$\beta$	n	<i>p</i>	Odds ratio	95% CI	
					Lower	Upper
Australian raven	0.0087	14	0.943	1.01	0.79	1.28
Black-faced cuckoo-shrike	0.0398	5	0.826	1.04	0.73	1.48
Brown-headed honeyeater	0.0319	7	0.839	1.03	0.76	1.40
Fan-tailed cuckoo	0.207	7	0.201	1.23	0.90	1.69
Golden whistler	0.1527	13	0.242	1.16	0.90	1.50
Grey fantail	0.0430	30	0.710	1.04	0.83	1.31
Grey shrike-thrush	0.0363	22	0.745	1.04	0.83	1.29
Inland thornbill	0.1358	13	0.293	1.15	0.89	1.48
Red wattlebird	0.0885	9	0.535	1.09	0.83	1.45
Red-capped parrot	0.0254	11	0.847	1.03	0.79	1.33
Red-capped robin	0.3267	6	0.071	1.39	0.97	1.98
Silvereye	0.2388	9	0.118	1.27	0.94	1.71
Striated pardalote	0.2483	35	0.080	1.28	0.97	1.69
Varied sitella	0.0247	12	0.847	1.02	0.80	1.32
Weebill	0.0298	38	0.828	1.03	0.79	1.35
Western gerygone	0.1728	33	0.182	1.19	0.92	1.53
Western spinebill	0.2159	9	0.151	1.24	0.92	1.67

Western thornbill	0.1031	13	0.417	1.11	0.86	1.42
Western yellow robin	0.4087	19	0.013*	1.50	1.09	2.08
White-browed scrubwren	0.1031	13	0.417	1.11	0.86	1.42
White-naped honeyeater	0.2774	12	0.060	1.32	0.99	1.76

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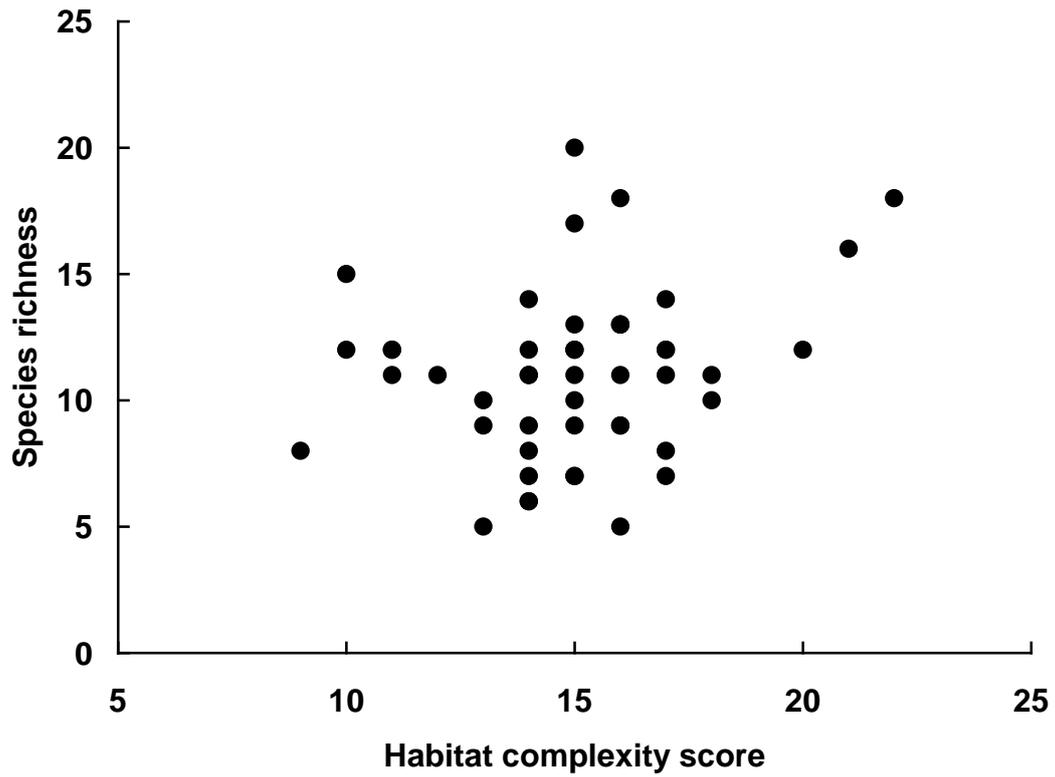
**Table 4: Percent probability of occurrence of various species in sites with differing habitat complexity scores (HCS).**

Species included are those with a binary logistic regression p-value less than 0.1. Species are ordered in ascending p-value scores from Tables 2 and 3.

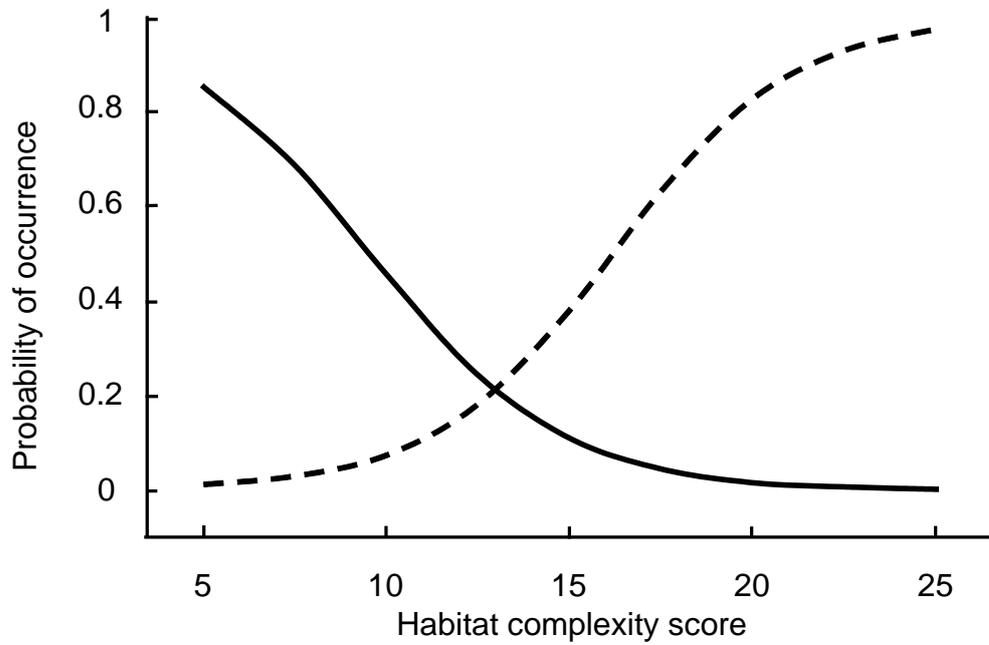
Species	HCS 8	HCS 15	HCS 22
Western yellow robin	3	38	92
Restless flycatcher	64	11	1
Elegant parrot	68	23	4
White-naped honeyeater	4	23	68
Red-capped robin	1	10	53
Rufous treecreeper	88	59	22
Yellow-plumed honeyeater	83	50	16
Striated pardalote	34	75	94

**Figure 1: Relationship of total habitat complexity score to bird species richness in 48 sites.**

Please note that there are only 39 points in the figure, as a result of double-ups in sites with identical habitat complexity scores and species richness.



**Figure 2: Cumulative probability graph for the restless flycatcher (bold line) and the western yellow robin (dashed line) as a function of habitat complexity score.**



## Appendix 1: Alphabetical list of common and scientific names of birds observed during the study.

\* species recorded at less than five sites

† species eliminated as a result of significant lack of fit of logistic regression model

Australian magpie *	<i>Gymnorhina tibicen</i>	Restless flycatcher	<i>Myiagra inquieta</i>
Australian raven	<i>Corvus coronoides</i>	Rufous treecreeper	<i>Climacteris rufa</i>
Australian ringneck	<i>Barnardius zonarius</i>	Rufous whistler *	<i>Pachycephala rufiventris</i>
Australian shelduck *	<i>Tadorna tadornoides</i>	Scarlet robin	<i>Petroica boodang</i>
Black-faced cuckoo-shrike	<i>Coracina novaehollandiae</i>	Shining bronze-cuckoo *	<i>Chalcites lucidus</i>
Blue-breasted fairy-wren †	<i>Malurus pulcherrimus</i>	Silvereye	<i>Zosterops lateralis</i>
Brown goshawk *	<i>Accipiter fasciatus</i>	Singing honeyeater *	<i>Lichenostomus virescens</i>
Brown honeyeater	<i>Lichmera indistincta</i>	Striated pardalote	<i>Pardalotus striatus</i>
Brown-headed honeyeater	<i>Melithreptus brevirostris</i>	Tawny-crowned honeyeater *	<i>Phylidonyris melanops</i>
Carnaby's cockatoo *	<i>Calyptorhynchus latirostris</i>	Tree martin	<i>Petrochelidon nigricans</i>
Common bronzewing †	<i>Phaps chalcoptera</i>	Varied sitella	<i>Daphoenositta chrysoptera</i>
Dusky woodswallow	<i>Artamus cyanopterus</i>	Weebill	<i>Smicromis brevirostris</i>
Elegant parrot	<i>Neophema elegans</i>	Welcome swallow *	<i>Hirundo neoxena</i>
Fan-tailed cuckoo	<i>Cacomantis flabelliformis</i>	Western gerygone	<i>Gerygone fusca</i>
Golden whistler	<i>Pachycephala pectoralis</i>	Western rosella *	<i>Platycercus icterotis</i>
Grey currawong †	<i>Strepera versicolor</i>	Western shrike-tit *	<i>Falcunculus leucogaster</i>
Grey fantail	<i>Rhipidura albiscapa</i>	Western spinebill	<i>Acanthorhynchus superciliosus</i>
Grey shrike-thrush	<i>Colluricincla harmonica</i>	Western thornbill	<i>Acanthiza inornata</i>
Hooded robin *	<i>Melanodryas cucullata</i>	Western wattlebird *	<i>Anthochaera lunulata</i>
Horsefield's bronze-cuckoo *	<i>Chalcites basalis</i>	Western yellow robin	<i>Eopsaltria griseogularis</i>
Inland thornbill	<i>Acanthiza apicalis</i>	Whistling kite *	<i>Haliastur sphenurus</i>
Laughing kookaburra *	<i>Dacelo novaeguineae</i>	White-browed babbler *	<i>Pomatostomus superciliosus</i>
New Holland honeyeater *	<i>Phylidonyris novaehollandiae</i>	White-browed scrubwren	<i>Sericornis frontalis</i>
Painted button-quail *	<i>Turnix varia</i>	White-eared honeyeater *	<i>Lichenostomus leucotis</i>
Purple-crowned lorikeet *	<i>Glossopsitta porphyrocephala</i>	White-naped honeyeater	<i>Melithreptus lunatus</i>
Rainbow bee-eater *	<i>Merops ornatus</i>	White-winged triller *	<i>Lalage tricolor</i>
Red wattlebird	<i>Anthochaera carunculata</i>	Willie wagtail *	<i>Rhipidura leucophrys</i>
Red-capped parrot	<i>Purpureicephalus spurius</i>	Yellow-plumed honeyeater	<i>Lichenostomus ornatus</i>
Red-capped robin	<i>Petroica goodenovii</i>	Yellow-rumped thornbill *	<i>Acanthiza chrysorrhoa</i>