

NEST SITE SELECTION BY THE WESTERN YELLOW ROBIN *Eopsaltria griseogularis* IN WANDOO WOODLAND, WESTERN AUSTRALIA

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Nest site selection by the Western Yellow Robin *Eopsaltria griseogularis* was examined during the 2000 and 2001 breeding seasons in Dryandra Woodland, Western Australia. The average nest height measured 4.1 metres and was found in trees with an average height of 8.2 metres. Nest position generally corresponded to the basal crown height, suggesting an 'intermediate concealment' trade-off represented by concealment by above canopy cover while maintaining some view of the nest surroundings. Nest tree height was not different from that of surrounding trees, although nest trees were generally smaller than all nearest surrounding trees, emphasising the additional concealment and security provided from avian predators by taller surrounding trees. Western Yellow Robins have previously been shown to exhibit strong selection for foraging microhabitat at the same 10 metre x 10 metre scale examined in the present study. The absence of any microhabitat selection at nest sites in the present study indicates that foraging opportunity does not appear to influence selection of nest sites, instead suggesting that detectability of predators may drive selection by affording a view of nest surroundings.

INTRODUCTION

The Western Yellow Robin *Eopsaltria griseogularis* is a ground-foraging insectivore that inhabits forest, woodland and mallee vegetation of south-west Western Australia, and the Eyre Peninsula of South Australia (Higgins and Peter 2002). Although the species inhabits a relatively large area of southern Australia, there is limited information published on the ecology of the species apart from recent papers examining territory-scale habitat selection (Cousin 2004a) and foraging-site selection (Cousin 2004b). A large part of the distribution of the Western Yellow Robin corresponds with the highly fragmented and degraded wheatbelt woodlands of Western Australia (Saunders and Curry 1990). As a result, the Western Yellow Robin has shown widespread decline in distribution and abundance throughout this region (Masters and Milhinch 1974; Saunders and Curry 1990), with suggestions that the species continues to disappear from even some of the largest of remaining remnants (Saunders and Ingram 1995). Understanding reasons for the continued decline of the species requires an understanding of all aspects of the ecology of the species.

To date, there have been no published examinations of nest site selection of the species, apart from a few records of casual observations as part of larger review papers (e.g. Whitlock 1911; Ford 1971) and from the Nest Record Scheme (Higgins and Peter 2002). The aim of the present study was to provide the first quantitative description of the nest site selection of the Western Yellow Robin.

STUDY AREA

The study was undertaken in Dryandra Woodland (32°47'S, 116°58'E), 140 kilometres south-east of Perth, Western Australia. Although Dryandra Woodland is represented by 17

blocks of native vegetation spread over a 50 kilometre north-south distance (Friend *et al.* 1995), the present study was undertaken in the largest (12 283 ha) of the northern blocks. Open Wandoo *Eucalyptus wandoo* woodland is the predominant vegetation type on lower slopes and low-lying areas, while Powderbark Wandoo *E. accedens* woodland occurs on upper slopes and laterite ridges (Fig. 1). Mixed associations of these species with Marri *Corymbia calophylla*, Jarrah *E. marginata*, Sheoak *Allocasuarina huegeliana* and Jam Wattle *Acacia acuminata* also occur, as do large plantation stands (accounting for 30% of the area) of the locally indigenous Mallet *E. astringens* (Coates 1993; Friend *et al.* 1995). Understorey vegetation in the woodland habitats is dominated by interspersed and occasional aggregations of *Gastrolobium*, *Acacia* and *Hakea* shrubs, while ground vegetation is represented by plants such as *Astroloma* and *Hibbertia*, and aggregations of forbs and grasses. A thin layer of leaf litter dominates the ground, with large interspersed areas of bare ground and relatively large volumes of coarse woody debris (Recher and Davis 1998).

METHODS

Nest searching

Nest site selection by the Western Yellow Robin was examined opportunistically as part of a larger study into their foraging ecology and habitat selection during the breeding seasons of 2000 and 2001 (Cousin 2003). Nests were located by following birds exhibiting breeding behaviours, including carrying of nesting material or food as well as diversion behaviours such as persistent contact calls, or 'broken-wing' displays. An assessment of breeding success associated with nest site selection was not undertaken, as it was beyond the scope of the study. All measures of nest and microhabitat attributes surrounding nests were undertaken once the nestling/s



Figure 1. Representative nesting habitat in Wandoo/Powderbark Wandoo woodland.

Photo: J. Cousin

had fledged, to reduce the impact of my presence on nesting adults and nestlings (see Kilgo *et al.* 1996 for a discussion on effect of human visitation on nest success) and to reduce the potential for attracting avian nest predators such as the Common Brushtail Possum *Trichosurus vulpecula* and Grey Shrike-thrush *Colluricincla harmonica* (Fulton 2006a, b).

Microhabitat attributes

Nest site selection was examined by recording habitat attributes at nest sites and random points within four study sites in Dryandra Woodland. Three additional nests opportunistically found in three sites outside the study areas were also used in analysis, although as no random point habitat attributes were recorded at these sites (only nest height and nest tree attributes were recorded), these nests were not included in analyses of microhabitat attributes associated with nest site selection. At each of the four study sites, microhabitat attributes at all nests were recorded within a 10 metre x 10 metre plot centered directly beneath the nest. This plot was subdivided into four 5 metre x 5 metre plots and the percentage cover of live shrubs, dead shrubs, herbs and grasses was estimated within each of these plots and then averaged to give a value for the 10 metre x 10 metre plot. As the categories were not necessarily mutually exclusive, the total cover could exceed 100 per cent, as live shrubs and herbs could each cover 80 per cent of the area. Leaf litter density was also estimated in the 5 metre x 5 metre plots, according to one of nine indices of leaf litter abundance between sparse and dense, and averaged for the 10 metre x 10 metre plot. Counts were also made of sapling (1–5 m), subcanopy (5–10 m) and canopy (>10 m) trees within the 10 metre x 10 metre plot. To determine selection of nesting sites with specific microhabitat attributes, the same attributes were recorded at random points throughout the site to compare to nest sites (see Martin and Roper 1988; Sieg and Becker 1990

for comparable methodology). Within each study site, 20 random points were located equidistantly along a 530-metre rectangular transect (see Cousin 2004a). All random point data and all nest site data from the four study sites were pooled to give an overall analysis of nest site selection; resulting in a comparison of microhabitat attributes at 16 nests to 80 random points.

Analysis

No analysis was undertaken on nest height and the height of the nesting tree, although a Pearson correlation coefficient was calculated between the proportional height of nests in nesting trees and the height of the nesting tree. A paired-sample t-test was undertaken to compare the height of nesting trees with the average height of the four nearest surrounding trees for each of the nests.

Analysis of differences in microhabitat attributes between nest sites and random points was undertaken separately for each microhabitat variable. As some of the variables were correlated, they were reduced by combining pairs of similar attributes, eliminating collinearity. Dead shrub and live shrub were combined, herbs and grasses were combined and sapling and subcanopy counts were combined. These new variables were combined by summation of their component values (as both components of the new variable were mutually exclusive), resulting in new variables denoted 'shrub', 'ground vegetation' and 'sapsub' respectively. The final remaining five variables (shrub, ground vegetation, leaf litter, sapsub and canopy) were not able to be transformed to normality, so all analyses were undertaken using non-parametric Mann-Whitney tests for tied ranks (Zar 1999). As there were more than 40 values for one of the samples (80 in the case of random points), the normal approximation to the Mann-Whitney test was used instead of

the usual U critical value table. In this method, Z-scores are calculated from the U distribution mean and standard error. As a result of the presence of tied ranks, the usual standard error formula is altered to take into account an adjusted 'quantity' measure as calculated by a summation formula of the number of ties in the dataset. The resultant Z-score is then compared to the t-distribution critical value for $\alpha = 0.05$ with infinite degrees of freedom (see Zar 1999, pp 150–153).

RESULTS

Nest site and nesting tree characteristics

The average nest height measured 4.13 ± 0.87 metres (mean \pm SE, $n = 19$, range: 0.55–12 m) while the average nesting tree height measured 8.16 ± 1.24 metres (mean \pm SE, range: 1.95–20 m). Nest position within nest trees averaged 44.1 ± 0.5 per cent of the height of the tree, corresponding with the basal crown height (the height of the lowest branches). There was a significant positive correlation between the nest position and height of the nesting tree ($r = 0.5140$, $df = 18$, $p = 0.0244$), although the nest was in a proportionately higher position in canopy trees (> 10 m) compared to nests in sapling (1–5 m) and subcanopy trees (5–10 m), where there was considerable variation (Fig. 2). The position of the nests in all trees still corresponds to the basal crown height, with its general lower position in sapling (1–5 m) trees and higher position in canopy trees (> 10 m) reflecting the greater extent of crown depth in the former. Subcanopy trees, with their varied and open crown depth (pers. obs.) harboured nests at more varied positions (Fig.

2). Of the 19 nest trees, 15 (79%) were Wandoo, with two nests (10.5%) each in Powderbark Wandoo and Marri. No chi-square analysis could be undertaken on account of low expected frequencies for species other than Wandoo. Of all the four closest trees to nesting trees (4×19 nests = 76 surrounding trees), 61 (80.3%) were Wandoo trees (similar to the percentage Wandoo trees as nests; 79%), eleven (14.5%) were Powderbark trees and four (5.3%) were Marri.

Height of nesting tree versus nearest tree

The height of nesting trees was not significantly different to the average height of the four closest trees (paired- $t = 1.058$, $df = 18$, $p = 0.3042$), although at eight of 19 nests (42.1%), the nesting trees were smaller than all of the four closest trees. This compares to only three nests (15.8%) where the nesting tree was the tallest of the four closest trees.

Microhabitat attributes surrounding nests

Microhabitat surrounding nests was characterised by denser trees, a lower percentage cover of shrubs and ground vegetation and a greater index of leaf litter cover compared to random points (Table 1). However, only the percentage cover of ground vegetation was significantly different ($U = 438.5$, $p = 0.0481$) between nest sites and random points. If the Bonferroni correction for multiple tests is taken into account however (reducing level of significance to 1%), then none of the habitat variables differ significantly between nest sites and random points.

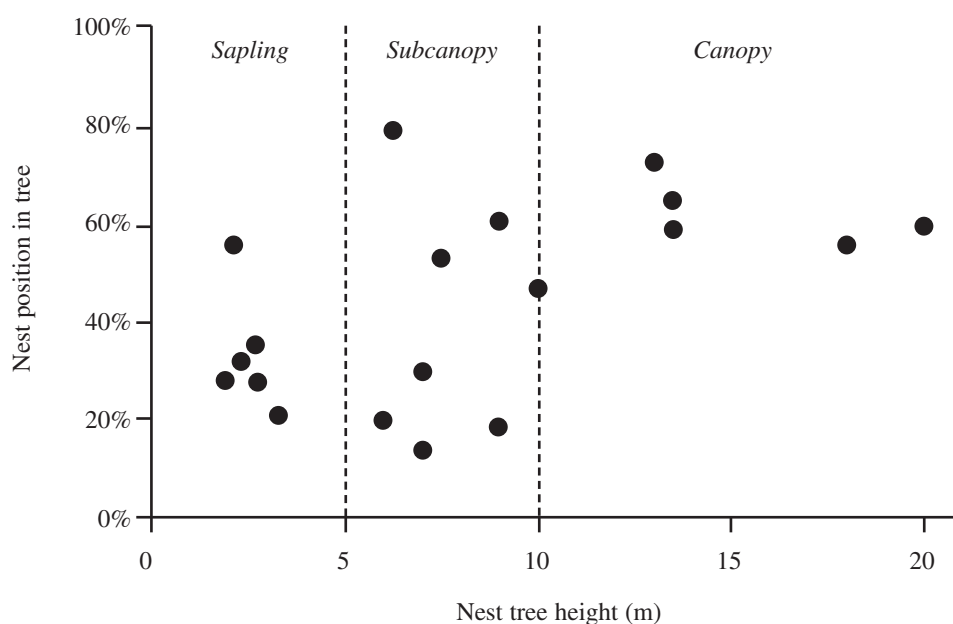


Figure 2. Position of the nest as a function of the height of the nesting tree, showing the size boundaries of sapling, subcanopy and canopy trees.

TABLE 1

Microhabitat attributes in 10m x 10m plots surrounding nest sites and random points. Numbers in parentheses for each category heading represent sample size. Results reported as mean \pm standard error with range in parentheses. 'U' represents calculated test statistic derived from Mann-Whitney test. 'Z' represents Z-scores calculated from the U distribution mean and modified standard error for tied ranks. 'Shrub' and 'Ground vegetation' refers to percentage cover in plots, 'Leaf litter' refers to abundance index in plot while 'Sapsub' and 'Canopy' refer to numbers of Sapling/Subcanopy and Canopy trees in plots, respectively.

Habitat Attribute	Nest Site (16)	Random Point (80)	U	Z	p-value
Shrub	11.89 \pm 1.43 (4.3 - 24.9)	15.91 \pm 1.55 (0.8 - 63.6)	603.5	0.3539	0.7234
Ground Vegetation	20.42 \pm 5.65 (2.0 - 90.9)	28.07 \pm 2.09 (2.6 - 85.3)	438.5	1.9761	0.0481
Leaf Litter	0.62 \pm 0.10 (0.1 - 1.4)	0.52 \pm 0.05 (0 - 1.6)	745	1.031	0.3026
Sapsub	7.88 \pm 2.49 (0 - 36)	5.15 \pm 1.07 (0 - 47)	795	1.5483	0.1215
Canopy	1.31 \pm 0.42 (0 - 6)	0.90 \pm 0.10 (0 - 5)	690.5	0.9516	0.3413

DISCUSSION

The average nest height of Western Yellow Robins in the present study (4.13 ± 0.87 m) is slightly higher than that previously published in Higgins and Peter (2002) (3.40 ± 0.47 m, mean \pm SE, $n = 55$: Nest Record Scheme) or Johnstone and Storr (2004) whom state that they usually nest 1–3 metres above the ground. This probably reflects the broader habitat types covered in these records, especially given the prevalence of mallee woodlands throughout the range of the species (Higgins and Peter 2002). The position of nests within nesting trees corresponds with the basal crown height (Fig. 1). Nest placement at the basal crown height reflects the relatively unobstructed view of the ground afforded in this position, allowing nesting robins to spot potential predators, while simultaneously affording them greater protection from an overstorey canopy. This seemingly 'intermediate concealment' has previously been suggested by Götmark *et al.* (1995) to represent a trade-off between nest concealment while maintaining some view of the surroundings of the nest; permitting incubating females to view approaching predators that they might not otherwise see if nesting in dense surrounding vegetation. This hypothesis is further supported by the highly camouflaged construction of the nest of the Western Yellow Robin; characteristic of many of the species of Petroicidae (Boles 1988). In adorning their nests with thin strips of bark, the Western Yellow Robin's nest is almost completely camouflaged from the ground. The importance of concealment in the present study is further emphasised by the presence of the greater height of surrounding trees. While there was no significant difference between the height of nesting trees and surrounding trees, a relatively large proportion of nesting trees (42.1%) were smaller than all of the four closest trees. Sieg and Becker (1990) found similar results, and attribute this to the role that taller surrounding trees play in maximising concealment and security of nests, especially from avian predators.

Microhabitat at nest plots differed from random plots only by a reduced cover of ground vegetation in the former. However, taking Bonferroni correction into account suggests no difference in microhabitat between nest plots and random plots. While nest site selection has often been associated with microhabitat attributes maximising nest concealment through selection for shrub patchiness (Hoover and Brittingham 1998) or overall vegetation density (Kilgo *et al.* 1996), others suggest that selection is also influenced by cues representing greater potential food availability (e.g. dense leaf litter, see Rodewald and Yahner 2000). In the present study, the location of nests in the basal crown may allow adults to opportunistically spot potential prey, given the ground-foraging behaviour of the species (Cousin 2004b). Prior to the fledgling stage, sitting females were occasionally seen diving from the nest to the ground to collect prey; thus supplementing regular prey delivered by the male (pers. obs.). However, given that Western Yellow Robins have previously been shown to exhibit strong selection for foraging microhabitat at the same 10 metre x 10 metre scale examined in the present study (Cousin 2004b), the absence of selection for similar microhabitat attributes at nesting sites indicates that foraging opportunity does not appear to influence selection of nest sites. It suggests that the aforementioned foraging behaviour of females tending nests reflects opportunistic foraging events, rather than selection for sites maximising foraging opportunities.

The absence of any apparent selection for microhabitat attributes maximising concealment immediately under nests is unexpected. However, it is possible that microhabitat cues selected for by Western Yellow Robins at nest sites operate at different spatial scales. Spatial heterogeneity of surrounding habitat has been implicated as an important attribute in the nest site selection of some species, increasing predator search time, thus reducing incidences of predators locating nests (Bowman and Harris 1980; Martin and Roper 1988). It is possible that

selection for spatial heterogeneity responses may operate at larger spatial scales than the 10 metres x 10 metres plot examined in the present study, and thus would account for the absence of apparent selection at the scale examined. Given that Western Yellow Robin nests were generally located within the centre of territories (pers. obs.), it is possible that nests are merely placed centrally within a territory that encompasses productive foraging microhabitat, thus reducing energy expenditure associated with supplying resources to (and defending from predators) nesting females and young (see Rosenberg and McKelvey 1999 for discussion of central-place foraging). As such, it is therefore possible that elements of the selection of nest sites are constrained by initial selection of habitat maximising foraging productivity.

CONCLUSION

Western Yellow Robins nest in the vicinity of the basal crown height of trees, affording them a greater overstorey canopy and thus concealment from avian predators. Concealment from aerial predators is maximised further through the selection of nest trees that are surrounded by larger trees. Nesting at the basal crown height also provides an unobstructed view of the ground, minimising detectability by any potential approaching predators. An absence of selection for microhabitat attributes beneath the nest supports the view that selection may be driven by detectability of predators rather than selection reflecting foraging opportunities. Furthermore, nests may also be merely placed centrally within a productive territory, suggesting the potential of nest site selection being constrained by selection of habitat initially maximising foraging productivity.

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