Near-exclusive use of non-native grasses by the Variegated Fairy-wren (*Malurus lamberti*) in a heavily modified habitat

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ABSTRACT

Successful breeding is a critical component of a bird's life-history, but preferred nesting habitats remain little studied in many Australian species. In southeastern Queensland, a revegetated site shows high bird biodiversity and density, despite being dominated by invasive understory plants. Here, we describe the relative cover of grass species present (Poaceae) at our study site and determine how often Variegated Fairy-wren (*Malurus lamberti*) nests were built in each species during the 2023 breeding season. We found that the majority of grass cover involved invasive species. Birds used invasive grass species almost exclusively as construction substrate, and as material to build their nests. Our results suggest that invasive grass species may not have had a negative impact on the breeding habits of fairy-wrens.

INTRODUCTION

Nesting is an essential part in a bird's life cycle, with almost all species constructing a structure to raise their young (Healy *et al.* 2023). The substrate onto which nests are built can affect traits from the individual-level, such as territory size, to the species-level, such as their distribution (Nilsson 1984). The importance of nesting niches is such that the decline of some species can be directly linked to the lack of proper nesting sites (Weerheim *et al.* 2003; Brightsmith 2005). For instance, the decline of some ground-nesting seabirds in isolated islands can be directly linked to the introduction of a single plant species that alters the available nesting habitat (Feenstra and Clements 2008; Fullagar and Heyligers 2014).

Australian ecosystems have been heavily impacted by the introduction of non-native species since European colonization in the late 1700s (Grice 2006). The shift in the floral composition, together with the degradation of existing habitats, has led to taxa becoming threatened with extinction (Watson *et al.* 2002; Grice *et al.* 2013). For example, the fragmentation of forests by

the advances of agriculture in southern and eastern Australia has affected bird populations both in cleared and in preserved spaces (Ford *et al.* 2001; Mac Nally *et al.* 2009). Nesting success is linked to habitat quality (Wilkin *et al.* 2009), and it has been shown that invasive species often change the nesting behavior of nesting birds (Schlossberg and King 2010; Gleditsch and Carlo 2014). For most species, however, the extent to which non-native plants impact survival and breeding success remains unknown.

Fairy-wrens (*Malurus* sp.) are widespread across Australia. None of the ten Australian species appear particularly sensitive to changes in their habitat and are all listed under Least Concern by the IUCN (IUCN 2025). The Variegated Fairy-wren (*Malurus lamberti*) is endemic to eastern Australia, and has a plural breeding system (Boersma *et al.* 2023). Females build dome-shaped nests low to the ground shortly before laying eggs (Tidemann 1983). Nests are then incubated for 12–14 days and provisioned for up to 12 days before the nestlings fledge (Tidemann 1983). Nests have never been observed to be used more than once.

Figure 1. A female Variegated Fairy-wren at the entrance of her nest in a typical habitat at our study site in south-east Queensland, Australia. Illustration by Paulo Ditzel.

While the nesting behaviour of fairy-wrens has been well-documented in the past (Tidemann 1983; Tibbetts and Pruett-Jones 1999), there are few reports of how they interact with non-native grasses (BirdLife Australia 2023). The aim of this study was to better understand the nesting behavior of Variegated Fairy-wrens in a highly modified ecosystem, and examine whether they show any preference for the different plant species at our study site. We identified the distribution of grass (Poaceae) species at the site and whether birds exhibit particular nesting preferences for a given species. We also provide insights into nest construction behaviour.

METHODS

Research was conducted along the shore of Lake Samsonvale (-27.27, 152.86) in south-east Queensland, Australia, between August and December 2023. Vegetation at this location comprises dry-mesic forest to open-scrub, dominated by *Eucalyptus, Acacia* and *Melaleuca* spp., but with small patches of remnant old-growth forest. The avifauna, and in particular the breeding ecology of three fairy-wren species at the site (Red-backed [*Malurus melanocephalus*], Superb [*M. cyaneus*], and Variegated) are monitored as part of long-term research efforts at this location (e.g. Feeney et al. 2018; Kennerley et al. 2019; Poje et al. 2019; Richardson et al. 2019; Carr et

al. 2020; Boersma et al. 2023; Resendiz et al. 2024; Kessler et al. 2024; Corneliussen et al. 2025; Feeney et al. 2025). Most of the habitat used by Variegated Fairy-wrens has a high density of the invasive species *Lantana camara* or *Setaria sphacelata*. Despite this, population density for Variegated fairy-wrens is high at the site, with an estimated 100–150 birds per km². This location is part of an ongoing revegetation project, and was previously used for cattle.

Relative grass abundance, nest placement and structure

First, we used subplot cover assessment transects to assess the grass species composition at the study site. Ten linear transects were laid out within Variegated Fairy-wren territories and partial ground coverage of all identified grass species was estimated visually for a 4 m x 4 m area, in 25 m intervals, through the 250 m transect. Selection of transect locations was semi-random, with each parallel to pre-existing straight paths that run indiscriminately through the plot, to facilitate access. To avoid edge effects, the closest edges of the subplots were a minimum of 2 m from any path. We identified grass species using several different digital aids and databases (Mäder *et al.* 2021; Australian Government 2023). With these transects, we calculated the total ground cover of each species, and the relative cover of each grass species was calculated by multiplying by the proportion of the total area covered by grass. Next, we assessed the dominant grass species around (within 30 cm radius) of 122 Variegated Fairy-wren nests. Nests were located and monitored as part of ongoing long-term research at this study site (Boersma et al. 2023; Feeney et al. 2025). Finally, 10 nests were chosen at random to be deconstructed to have their structure and construction closely analysed, including plant species used in its build. We collected these nests and deconstructed them after they had fledged or failed.

Statistical analyses

We estimated the total grass cover for the site by extrapolation, using the mean values for all transects as an estimate of relative cover by different grass species. We used a Spearman rank test to examine the relationship between relative cover and number of nests. A Chi-squared test with a simulated p-value (n = 10,000) was performed to determine whether the observed distribution of nests among grass species differed from that expected under random selection. All analyses were conducted using R Statistical Software (R Core Team 2022).

RESULTS

Relative grass abundance and use for nest placement

Ten grass species were identified at the study site (Table 1), which were all common in the region (Brisbane City Council 2023). Although several other species were present, none were abundant and they were not used by Variegated Fairy-wrens. Two morphologically distinct varieties of *Megathyrsus maximus* were found, but only one variety (*var. maximus*) could be confidently identified, due to the lack of fresh reproductive anatomy on the second, hereafter referred to as *M. maximus var. 2*.

Our surveys revealed that the site was dominated by non-native grass species, with native species making up only 6.7% of total ground cover, despite overall grass cover being 78.2% (n = 10, sd = 0.1) (Table 1). We found that the number of nests per grass species was positively correlated with the relative cover of that species (Spearman's S = 38.062, p = 0.009), and that the distribution of nests among grass species differed significantly from that expected under random selection (χ^2 = 45.097, p < 0.001), indicating preference for certain species (e.g., *Setaria sphacelata* and *Melinis minutiflora*). Of the 122 nests sampled during the 2023 breeding season, only 2 were built on non-grass species, and instead on *Lantana camara* and *L. montevidensis*.

Table 1: Relative grass abundance and use as nest material. Total ground cover and relative cover of grass species according to 10 m x 250 m transects (1600 m² in total). Relative cover was calculated by dividing the percentage of total ground cover by the percentage of total grass cover (78.2%). The percentage of Variegated Fairy-wren nests (n = 120) for which a grass species was identified as the dominant species in the immediate vicinity (30 radius) is also shown. Native grasses are marked with an asterisk*.

Grass species	Total ground cover	Relative cover	Percentage of nests	Number of nests
Setaria sphacelata	31.2%	39.9%	56.6%	69
Megathyrsus maximus var. 2	22.8%	29.2%	13.1%	16
Melinis minutiflora	6.5%	8.3%	18.0%	22
*Cynodon dactylon**	5.6%	7.2%	0.8%	1
Paspalum dilatatum	4.1%	5.2%	1.6%	2
Megathyrsus maximus var. maximus	3.8%	4.9%	4.1%	5
Hyparrhenia hirta	1.4%	1.8%	1.6%	2
Melinis repens	1.2%	1.5%	0.8%	1
*Themeda triandra**	1.1%	1.4%	1.6%	2
Chloris gayana	0.5%	0.6%	0%	0

Nest structure and composition

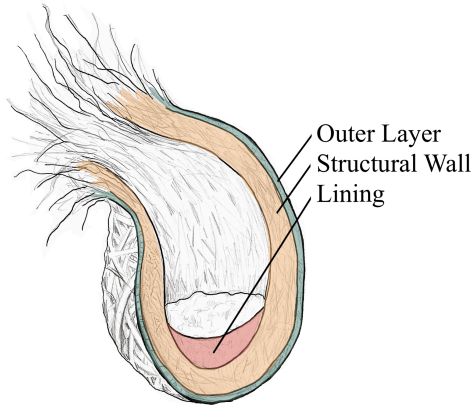

Figure 2. Cross section of the layers that compose a Variegated Fairy-wren nest. Each layer is made of different materials, with building conducted from the outside in. Illustration by Paulo Ditzel.

Like Biddle et al. (2015) (Fig. 2), we found that nest structure was separated into three distinct layers: the outer layer, the structural wall and the lining. Both field observations and our deconstruction of nests indicates that nest building follows these three stages, beginning with the construction of the thin outer layer of the nest. This consists of long (>10 cm) and wide (>5 mm) interlaced blades of grass stuck together by bits of spider web. The blades used for this stage were not of any specific type of grass, reflecting whatever species was dominant around the nest. For instance, in areas dominated by *Setaria*, this was the only species used for this part. Conversely, in areas where *Melinis* species were dominant, these were preferred. In some nests, the fibrous bark of some trees such as messmate (*Eucalyptus obliqua*) was also found in this layer. The structural wall, the thicker layer inside the nest, was the most consistent layer between nests, with all being made almost exclusively from the dessicated ears of *Megathyrsus maximus*. Often, the ears protruded from the top of the entrance, forming a characteristic "thatching" look (Fig. 1). The base of the interior area of the nest was lined with soft material. This lining was made up of a mix of down feathers, animal furs, the feathery bristles (pappus) of wind-dispersed seeds, and/or strips of the soft bark of *Melaleuca* sp. ("Paperbarks").

DISCUSSION

Our results suggest that Variegated Fairy-wrens typically construct their nests in grass species that are more prevalent in the environment but that they also show preference towards certain grass species, such as *Setaria sphacelata* and *Melinis minutiflora*. We found that our study site is dominated by invasive grass species, making up over 90% of the grass coverage. This is almost certainly a result of the site's history of being used for cattle, as most grasses are species introduced to feed cows (Cook and Grice 2013). Our finding that the overwhelming majority of nests (120 of 122) were constructed among non-native species, along with the relatively high density and fledging rate of Variegated Fairy-wrens at this location, suggests that this bird species is relatively robust towards anthropic changes to their habitat.

Despite being of potential importance for management and conservation decisions, the impact of alien plant species on bird behaviour is often unresolved (Heckscher 2004; Schlossberg and King 2010). For instance, some species of ground-nesting birds, particularly seabirds, are very sensitive to the floral composition of their nesting sites and are often unable to nest in the

presence of some invasive species (Weerheim et al. 2003; Feenstra and Clements 2008; Fullagar and Heyligers 2014). Similar effects have been found in some terrestrial bird species (Nelson et al. 2017), including ground-nesting grassland passerines (Maresh Nelson et al. 2018). That being said, many passerine species have been shown to readily use invasive species for nesting substrate without any clear negative effects (Whelan and Dilger 1992). For example, gray catbirds (*Dumetella carolinensis*) in Pennsylvania, USA, had a preference for placing their nests in invasive honeysuckle bushes (*Lonicera* spp.), and even showed better fledgling condition from that nesting substrate compared to others (Gleditsch & Carlo (2014).

To our knowledge, this study presents the first examination of which grass species Variegated Fairy-wrens use to construct nests and whether they have grass preferences in their nesting behaviour. Our data show that, while birds mostly follow the general availability of grasses in their habitat, they do show a preference for some species of grass. Overall, this study highlights how heavily modified areas can still be productive nesting habitats for native Australian bird species. This may be relevant for future conservation initiatives, as we find that as long as suitable grasses are available for nesting, whether those species are native or not does not affect Variegated Fairy-wren breeding success.

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