

THE

SUNBIRD



Journal of the Queensland Ornithological Society



Volume 52

Pages 13 - 23

2025

THE SUNBIRD

Chief Editor

Richard Noske

Assistant Editor

Stephen Prowse

Production Editor

Cameron Davidson

The Sunbird is published by the Queensland Ornithological Society Incorporated (Birds Queensland). All issues of *Sunbird* and individual articles are available for download in PDF format to both members and non-members from [the Birds Queensland website](http://thebirdsqueensland.org.au). They are also available online via the Informat e-Library (<https://search.informat.org>), by agreement with Birds Queensland.

The aims of Birds Queensland are to promote awareness and appreciation, as well as conservation and scientific study of birds, with particular emphasis on the birds of Queensland. The society holds a general meeting and several field excursions each month. All members receive a monthly newsletter.

For enquiries, including membership, please contact us via:

our website <https://birdsqueensland.org.au> or

by email secretary@birdsqueensland.org.au

ISSN 1037-258X

Queensland Ornithological Society Inc.

Front Cover: Albert's Lyrebirds: Lyrebird A displaying at platform 5 to a subadult male receiver . Photo by Anna Fearnley

Display Platforms of Albert's Lyrebird *Menura alberti*.

Part 2. Dispersion, Ownership and Temporal Patterns of Use

Anna Fearnley^{1,6}, Sandy Gilmore², Felix Cehak³, Mike Fitzgerald⁴ and Richard Noske⁵

¹ PO Box 62, Killarney, Qld. 4373;

² "Morinda" 240 Mafeking Rd, Goonengerry, NSW 2482;

³ 9A Knoll Road, Tamborine Mountain, Qld. 4272;

⁴ 65 Dees Lane, Lynwood, NSW 2477;

⁵ Centre for Biodiversity & Conservation Science, Univ. of Qld, St Lucia, Qld, 4072.

⁶ Corresponding author: anna_fearnley@hotmail.com

Abstract

Albert's Lyrebirds breed in winter when males perform multimodal displays at display platforms for female assessment of song, dance and vigour. Although some characteristics of display platforms have been described, their dispersion, ownership and temporal patterns of use have not previously been documented. We studied a group of seven males over 12 months using direct observations, time-lapse photography and video at display platforms. Within the 40 ha study area, density was 0.3 males ha⁻¹, or one male per 3.3 ha. Territories ranged in size from 0.9 to 2.2 ha, averaging 1.3 ha. Within each territory, the male used one tree for roosting, and most roost trees were located near the periphery of territories. Display behaviour peaked in June and July, but there was a secondary peak in summer, hitherto undocumented. All resident males used 5-7 display platforms per year. Two males that were intensively observed over 30 days in winter spent 29.3% and 26.7% of the day, respectively, at display platforms. Each visited one platform more often, and for longer periods, than the other platforms in their respective territories. Both males arrived at their respective first platforms by 06:44 hrs on 83% of days during June-July, and frequently performed displays simultaneously. Displays ceased at 17:00 hrs, when males ascended their roost trees, well before dusk. Simultaneous displays by males may reduce aggression between them, and allow females to compare male performance in short, dedicated periods, leaving more time for obtaining the necessary nutrients to undertake nest building and all parental duties. Outside winter, display platforms were occasionally visited by groups of 2-4 birds of varying sex and maturity that displayed to each other.

Introduction

Albert's Lyrebirds inhabit subtropical and temperate rainforest and wet sclerophyll forest with a mesic understorey in south-east Queensland and north-east New South Wales. Males display during winter where they are in auditory but not visual contact with other mature males. They sing a strongly-directional Territorial Song from their roost tree, commencing at civil dawn, before descending to perform multimodal displays at display platforms to attract potential mates (Higgins *et al.* 2001). Displays commence with the Territorial Song, continue with stereotypic mimetic song and sounds (Sequential Song), and occasionally finish with the Gronking Song and dance. The Territorial Song probably serves to differentiate neighbouring males from other visitors (Temeles 1994; Dong & Clayton 2009) and reduce aggression (Searcy & Beecher 2009; Akçay *et al.* 2015; Liu *et al.*

2018). The Sequential Song and Gronking Song and dance allow females to assess vocal consistency and athleticism, respectively.

Densities of singing male Albert's Lyrebirds have been roughly estimated to be 0.1–0.7 birds per ha (Curtis in Higgins *et al.* 2001), while estimates of the distances between singing males along transects have ranged from 100 m in the Mistake Range to 400-750 m in the McPherson Range (H.S. Curtis & G. Holmes in Higgins 2001). However these estimates of density may be unreliable as the male's Territorial Song is audible through 500 m of dense rainforest on flat terrain and 1.5 km when listening above the forest canopy from an escarpment (AMG, pers obs.). The long distances over which males can be heard may cause observers to underestimate the area they are surveying, while observers conducting a transect survey can easily double-count males that move

between display platforms. Both of these issues may lead to observers overestimating male density.

The display platforms of Albert's Lyrebirds have been characterised for several habitats across the species' range (Curtis 1972; Backhouse *et al.* 2024a; Fearnley *et al.* 2025). In temperate rainforest and wet sclerophyll forest at five locations across the species range Backhouse *et al.* (2024a) found that display platforms differed from their surroundings only in having a greater number of vegetative structures. In sharp contrast, Fearnley *et al.* (2025) found that all display platforms in low-lit cool subtropical rainforest were raised platforms of vines or vines atop mounded soil, and the vast majority had a small canopy opening either directly overhead or in the direction of the early morning sun. Moreover, in semi-open wet sclerophyll forest, where vines were absent, all platforms were composed of mounded soil with sticks, twigs and stems of the surrounding vegetation deliberately bent by the male to ground level, and had large canopy openings overhead (Fearnley *et al.* 2025).

Although the species is long-lived and individual males are thought to use display sites over many years (Ratcliffe 1938; Curtis in Higgins *et al.* 2001, Bird *et al.* 2020), the dispersion and longevity of display platforms within territories has not been investigated. The present study is part of an ongoing longitudinal study of lyrebird behaviour that began in 2017, and the first to examine behaviour of an Albert's Lyrebird population restricted to a forest fragment. From June 2023 to June 2024, we determined the spatial arrangement of territories, roosts and display platforms, and the daily and seasonal patterns and function of visits by resident males.

Methods

Study area

The study was conducted on a population of Albert's Lyrebirds near Killarney at the junction of Main Range and MacPherson Range. The exact location of the study site is withheld to protect the population from human disturbance, but it was situated on the eastern fall of a remnant (~80 ha) of cool sub-tropical rainforest and wet sclerophyll forest with a mesic understory at 930 – 1040m asl. The mean annual rainfall for 14 years (2010–2024) at Weather Station 41085, ~5 km from the study site, was 1,260 mm (BOM 2025). The time of civil dawn, sunrise, sunset

and civil twilight was determined on the NOAA (2025) website.

Mapping of display platforms, roost sites and feeding areas

The display platforms of seven male lyrebirds were located by listening to Territorial Songs during the dawn chorus and noting their direction, time and amplitude. We used binaural mapping, i.e. the consistency of males singing simultaneously for prolonged periods during the morning to determine the location of different individuals and assign ownership of display platforms (Hinsch & Komdeur 2017). All display platforms were mapped, photographed and their usage confirmed by video footage.

Roost sites were located by direct observations of males singing in, or descending from, their roosting trees at civil dawn. The areas around the roost site and the display platforms were also observed for lyrebird presence and activity on a regular basis (~4 h per day during the 30 day intensive study period and 2 h per day for the remaining 11 months). The locations of roost sites, display platforms, and foraging areas close (< 30 m) to the display platforms were recorded using the Gaia GPS app and mapped. A territory was defined as the area bounded by locations of roost sites, display platforms and foraging areas, with a 15m-wide buffer zone. Territory size was calculated using Gaia GPS, based on the geodesic area of an irregular polygon, (Chamberlain & Duquette 2007). Two peripheral male territories, and four areas used for communal roosting and foraging by at least three non-territorial mature males, were also located, but not fully integrated into this study due to difficult access and inconsistent early morning song.

Monitoring of display platforms

Once ownership of display platform had been ascribed to individual resident males, the five platforms belonging to each of two individual male lyrebirds (Lyrebird A and Lyrebird B, hereafter ALA and ALB, respectively) were intensively monitored for 30 days (26 June – 25 July 2023), although a sixth display platform of ALB was located and monitored during the last 12 days only (14–25 July). Monitoring of the five display platforms of ALA continued for 12 months (June 2023 – June 2024). Monitoring involved time-lapse photography (>1.44M photographs assessed), and motion-activated video (n = 180 h). The sex and maturity of birds were categorised as mature male (or simply 'male' hereafter), subadult male, immature or female

according to plumage characteristics described in Higgins *et al.* (2001). As Albert's Lyrebird undergoes a prolonged, asynchronous tail moult during the non-breeding season (AF, unpubl. data), individual males were also distinguished by the readily visible innermost tail feather (T1).

During the first five days of the study period, we used eight Reconyx Ultrafire XR6 cameras, which had maximum video length of 2 min in daylight and 30 sec (infra-red imagery) in low light and three Reconyx Ultrafire XP9 cameras, but thereafter we replaced the Reconyx Ultrafire XR6 cameras and used only Reconyx Ultrafire XP9 cameras due to longer maximum video length, which was 10 min regardless of light level. Both cameras were set to take a photo every minute and maximum video length from 0600 – 1800 h. All photos (8MP) and videos (1080P, 30 frames per s) were stamped with location, time and date, after checking all clocks were synchronised. The cameras were positioned c.2 m from the display platform edge and 1.5 m above the ground with the silhouette of the camera trap broken by surrounding vegetation. Camera SD cards and batteries were changed after 5–7 days, when no lyrebirds were present. Audiovisual recordings were assessed using QuickTime Player at normal, half speed or frame by frame.

Data analysis

A one-tailed t-test was used to compare distances between display platforms within and between territories, and the number of daily visits and the amount of time spent at display platforms by ALA and ALB (for the 12 days when all 11 display platforms were monitored). Analyses of Variance (ANOVA) were used to compare the number of daily visits and the amount of time spent by both birds at each of their display platforms, and the length of visits by single mature males to display platforms of ALA during December 2023, January and February 2024. Pearson's correlation tests were performed to determine the correlation between arrival times of ALA and ALB at their first display platforms and the presence of both lyrebirds at their respective display platforms over hourly intervals from 06:00 hrs to 10:00 hrs and four-hour periods 1000-1400 and 1400-1800 h. A Chi-square test was used to determine if the birds preferred to use the display platform closest to their roost sites for the first and last visits of the day.

Results

Territory size and roost trees

Within the 40 ha study area, there were nine mature territorial males, and a minimum of three mature non-territorial males, indicating an overall density of one mature male per 3.3 ha or 0.3 males ha⁻¹. The territories of the seven resident males ranged from 0.9 to 2.2 ha (mean \pm SD, 1.3 \pm 0.5 ha), the largest being held by ALA (1.9 ha) and ALB (2.2 ha). Territories were located from the lowest elevation to near the ridge line (930–1020 m asl). Within each territory, the male used one tree for roosting, descending at civil dawn and before sunrise by gliding either directly to the ground or by flying to a nearby tree, where it perched for a few minutes prior to descending. Most roost sites were near the periphery of territories (Fig. 1).

All resident males used up to seven display platforms each year (Fig. 1). The mean (\pm SD) number of display platforms in 2023 was 5.4 (\pm 1.9), and in 2024, 6.7 (\pm 1.8). Distances between the roost site and display platforms of each male varied from 3 to 112 m, but the mean distance between the roost and the closest display platform was 25.3 (\pm 14.7) m. Display platforms belonging to different males were as close as 30 m (Fig. 2). The maximum distance between display platforms within the same territory ($\bar{x} \pm$ SD = 110.8 \pm 42.2 m) was not significantly different from the minimum distance between display platforms in adjacent territories ($\bar{x} \pm$ SD = 89.5 \pm 41.5 m) (one-tailed $t = 0.78$, $df = 11$, $p > 0.01$), indicating that such distances cannot be used to assign platform ownership to a particular male. All males discontinued visiting some of their display platforms after the 2023 display season, and replaced them by the start of the 2024 display season.

During winter, display platforms were primarily used for display performances by their male owners. ALA and ALB gave multimodal (vocal and visual) displays on 93.6% and 95.8% of visits to their display platforms, respectively, and solely vocal displays (Territorial Songs) on 1.6% and 2.3% of visits ($n = 376$ and 259 , respectively). The remaining visits (4.8% and 1.9%, respectively) involved the birds simply traversing the platforms. The frequency and duration of displays by males peaked in the early to mid-winter months of June and July (Fig. 3), but displays occurred in all months of the year, with a secondary peak in summer (Fig. 4). There were no significant differences between the summer months in display duration (ANOVA, $F = 1.17$, $p > 0.1$). The longest period



Figure 1. Spatial relationships of roosts, display platforms, foraging sites and territory boundaries of seven resident males during 2023 and 2024 winter display seasons.

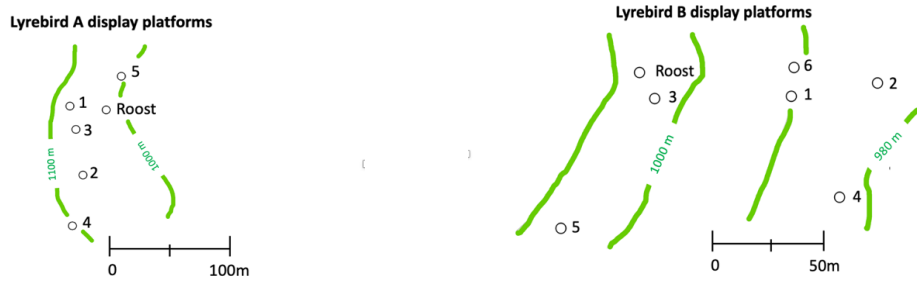


Figure 2. Spatial relationship between roost site and display platforms of Lyrebird A and Lyrebird B. Platforms are numbered 1 to 5 or 6 in order of decreasing number of visits.

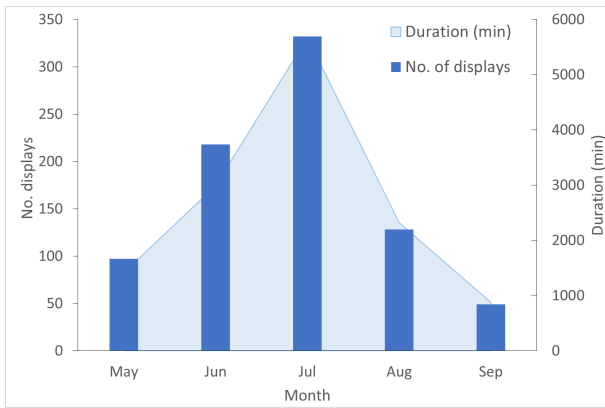


Figure 3. Number and duration of displays from May to September 2023.

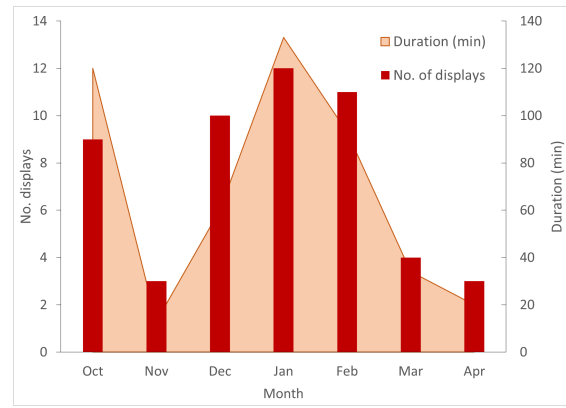


Figure 4. Number and duration of displays from October 2023 to April 2024

of absence from all display platforms during the 12 months was 22 consecutive days from 12 April to 4 May 2024.

There were no significant differences between ALA and ALB in the total number of visits to display platforms each day for the 12 days from 14 to 25 July 2023 (one-tailed $t = 0.89$, $df = 22$, $p > 0.01$) or in the duration of these visits ($t = 0.51$, $df = 22$, $p > 0.01$). Both birds showed a significant preference for one platform (hereafter, Platform 1) over each of their other display platforms (for ALA, ANOVA, $F = 92.8$, $p < 0.001$, Tukey test, $p < 0.001$; for ALB, $F = 33.4$, $p < 0.001$, Tukey test, $p < 0.01$), as well as for spending more time each day at that platform (for ALA, ANOVA, $F = 75.62$, $p < 0.001$, Tukey test $p < 0.01$; for ALB, $F = 84.71$, $p < 0.001$, Tukey test $p < 0.01$, for LB) (Table 1; Fig. 5).

ALA and ALB visited their respective Platforms 1 and 2 every day during the 30 days, and the platforms closest to their roosts were favoured for the first and the last visit each day (Table 2). The order in which ALB visited his display platforms for the first eight displays followed a similar pattern each day. The display platform closest to his roost tree (Platform 3) was visited first, followed by Platform 1, and then a combination of Platforms 1 and 2 as well as Platform 3. Platforms 4-6 were rarely used during the first five displays (Fig. 6). The order in which display platforms were visited was not determined for ALA as the platform closest to his roost site was also his most preferred platform.

ALB often commenced his first display at similar times to those of ALA (Pearson’s correlation $r = 0.67$, $p < 0.001$), and both males were present at their respective first platforms by

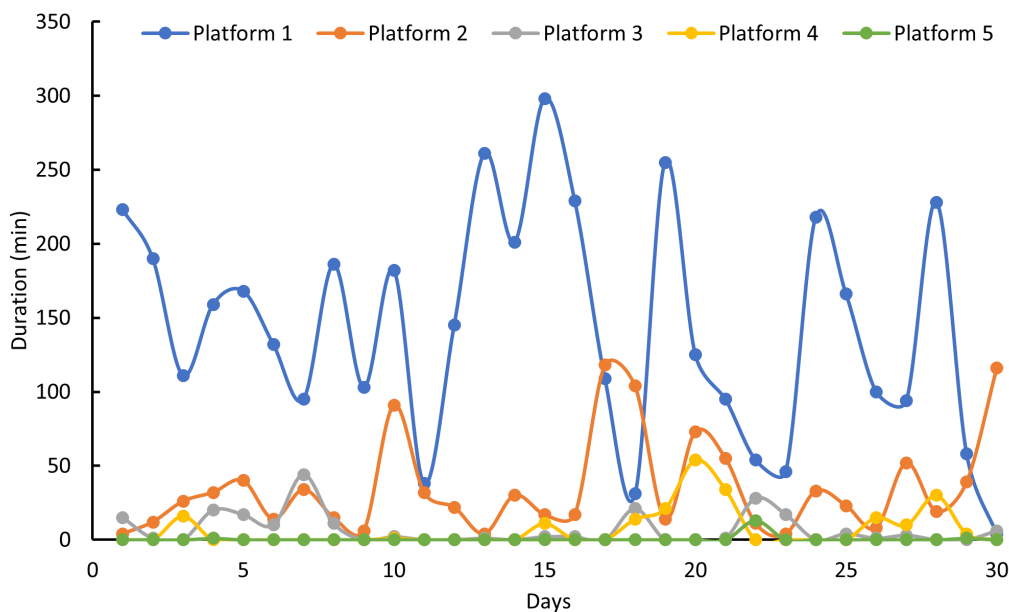


Figure 5. Daily duration (min) of visits by Lyrebird A to each display platform (26 June – 25 July 2023).

Table 1. The duration (minutes) of each visit at each display platform each day and total visits over 30 days (26 June – 25 July) by Lyrebird A and Lyrebird B.

Lyre-bird	Display platform	Mean (\pm SD) duration of visit	Mean (\pm SD) daily duration (min)	Total duration (min)	Mean (\pm SD) daily visits	Total visits
A	1	19.2 \pm 14.0	143.5 \pm 76.2	4304	7.5 \pm 3.3	224
	2	10.9 \pm 8.4	35.5 \pm 32.7	1065	3.3 \pm 1.8	95
	3	7.5 \pm 7.7	6.9 \pm 10.3	206	0.9 \pm 1.0	28
	4	10.8 \pm 6.8	7.0 \pm 12.9	210	0.6 \pm 1.0	19
	5	5.0 \pm 6.9	0.5 \pm 2.4	15	0.1 \pm 0.3	3
B	1	32.9 \pm 20.4	105.4 \pm 44.6	3163	3.2 \pm 0.9	96
	2	10.3 \pm 9.5	23.1 \pm 17.8	692	2.2 \pm 0.5	67
	3	10.4 \pm 6.8	18.8 \pm 13.7	563	1.8 \pm 1.0	54
	4*	14.8 \pm 6.7	19.7 \pm 17.5	236	1.3 \pm 1.0	16
	5	10.2 \pm 6.7	6.8 \pm 8.5	203	0.7 \pm 0.8	20
	6	13.5 \pm 7.3	2.7 \pm 7.1	81	0.2 \pm 0.5	6

* display platform 4 for ALB was monitored for only 12 days (14 – 25 July)

Table 2. The use of each display platform by Lyrebird A and Lyrebird B for their first and final displays each day from 26 June to 25 July 2023.

Lyrebird	Visit	Display Platform						Chi-square test	
		1	2	3	4	5	6	χ^2	<i>p</i>
A	First	28 [†]	1	1	0	0	n/a	101.0	<0.01
	Last	25 (12) [†]	3 (1)	1 (0)	0	1 (0)	n/a	76.0	<0.01
B	First	4	1	23 [†]	0*	0	2	61.7	<0.01
	Last	10 (1)	5 (2)	10 (6) [†]	2* (0)	3 (2)	0	9.7	0.046

* monitored 14 – 25 July only;

Values in parenthesis: displays that commenced after 16:00 hrs;

[†]bold values indicate platforms closest to each bird's roost tree

Table 3. Percentage (%) of time Lyrebird A and Lyrebird B were simultaneously present at their display platforms compared to the total presence (when either lyrebird was present), and correlation between the presence of the two males each minute over 30 days.

Time of Day	Simultaneous presence	Pearson's correlation	
	(as % of total presence)	<i>r</i>	<i>p</i>
0600 - 1000	41.4	0.82	<0.001
0600 - 0700	60.9	-	-
0700 - 0800	52.3	-	-
0800 - 0900	23.1	-	-
0900 - 1000	11.0	-	-
1000 - 1400	13.4	0.65	<0.001
1400 - 1800	16.4	0.69	<0.001

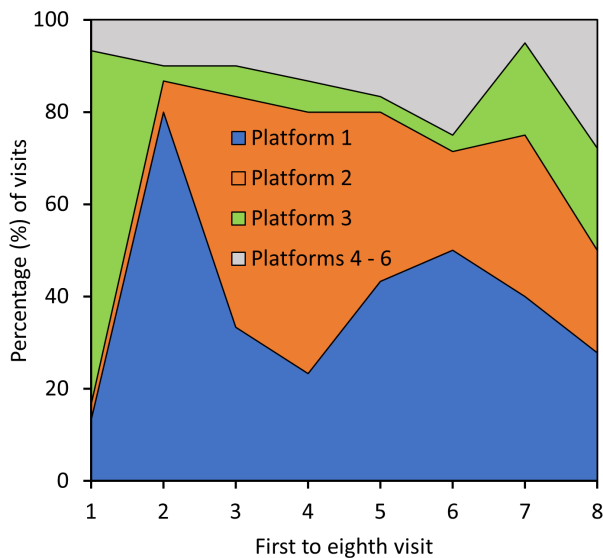


Figure 6. The percentage of visits by Lyrebird B to each of six display platforms during the first eight visits of the day from 26 June to 25 July 2023. Platform 3 was closest to the roost;

06:44 hrs on 83% of days. From the time of first arrival until ~07:30 hrs the males were simultaneously present at their platforms for more than 50% of the time, followed by a steady decline in presence until noon (Table 3). In the afternoon there were three smaller peaks before visits ceased at c.17:00 hrs (Fig. 7).

During the 30 days from 26 June to 25 July 2023, the time of arrival of ALA at his first display platform was closely related to the time of first light, 89% of arrivals occurring between civil dawn and sunrise, which occurred at 06:43 hrs on 26 June and 06:38 hrs on 25 July. From August to May, however, the arrival times of males at their first display platforms were unpredictable (Fig. 8). Males ascended their roost trees around 17:00 hrs, well before dusk

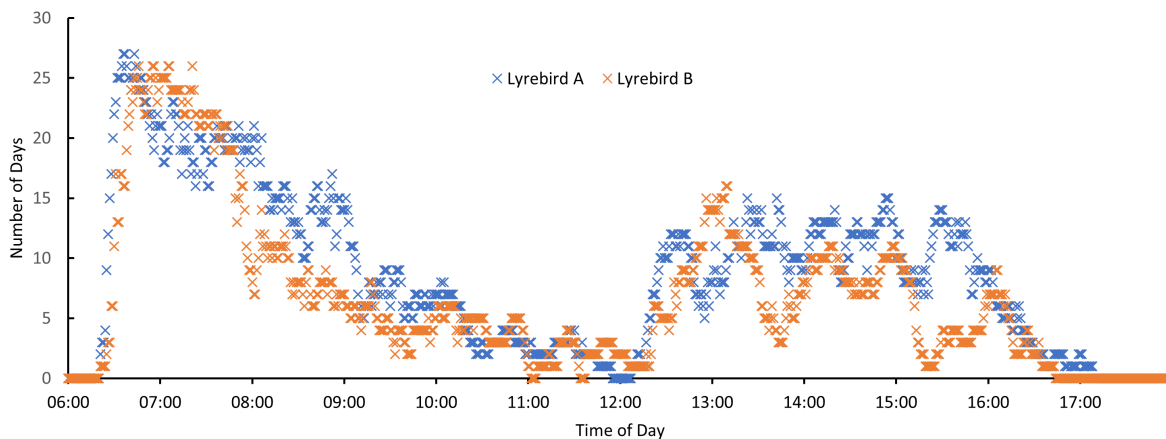


Figure 7. Number of days Lyrebird A and Lyrebird B were present at display platforms each minute from 06:00 to 18:00 hrs (26 June – 25 July 2023).

and usually fairly quickly after the last display at the platform closest to their roost tree (Table 2).

From August 2023 to February 2024, we recorded five instances of single males visiting a display platform and singing, but not performing any other display component. The songs comprised a diverse range of lyrebird-specific and heterospecific models, including novel mimicry of Eastern Whipbird *Psophodes olivaceus*, Torresian Crow *Corvus orru* and Australian Magpie *Gymnorhina tibicen*. All such visits from November to January involved the same individual, identified by its unique progressive growth of an emergent T1 feather. No other males that visited during this period were at the same stage of moult.

Groups of two to four birds (mean 2.9 ± 0.8) also visited the display platforms on 13 occasions between August 2023 and February 2024. Groups always contained one or three males (mean 1.8 ± 1.0), of which one to three were subadults (mean 1.6 ± 0.7 ; $n=8$), and on two occasions, one female or immature. During 62% of visits, either a male or subadult male displayed to the group. Otherwise the group traversed the platform with males briefly pulling platform vines, but not preparing or maintaining the platform (as described in Fearnley *et al.* 2025). On four separate occasions the same group visited two display platforms within short periods of time (mean 12.0 ± 16.1 min).

Discussion

Based on direct observation, and audio and audio-visual recordings of males displaying across the species range, the breeding season of Albert's Lyrebird extends from May to August

(Robinson & Curtis 1996; Higgins *et al.* 2001; Backhouse *et al.* 2021, 2022, 2024b). At our study site, the arrival of the male at its first display platform at first light during June and July 2023 strongly suggested that these months corresponded with the peak of the display season, and is in keeping with prior observations (2017–2022). However, this peak of display activity may not be applicable to other populations as the onset of frequent, high amplitude Territorial Song occurs earlier (April – May) at lower elevations at Mt Jerusalem to the east (S. Millard pers. comm.) and Uralba to the south-east (MF pers. obs.).

Territories

To map territories, we assumed each display platform was used by a single male. Ownership determined by binaural mapping was fully supported by the photographic time-lines of male presence at their assigned display platforms and one male was easily identified by a mid-shaft break of the right T1 feather. There were no observations or photographic evidence of different males displaying simultaneously at different display platforms within the same territory. Contrary to expectation, the distance between display platforms was unsuitable for ascribing ownership when territories were adjacent as the maximum distance between display platforms within a territory was similar to the minimum distance between display platforms in adjacent territories. By accurately mapping and ascribing ownership of each display platform we were able to determine the density of mature males to be 0.30 male ha⁻¹. This lies between previous estimates of three males in 25 ha (0.12 male ha⁻¹) of temperate rainforest, and of eight

males in 12 ha (0.67 male ha⁻¹) of undefined habitat (Higgins *et al.* 2001). Reported estimates of the distances between singing males along transects have ranged from 100 m to 750 m (H.S. Curtis and G. Holmes, in Higgins *et al.* 2001). Our mapping suggests that seven males could potentially be counted over a distance of ~ 930 m, i.e. one male per 133 m.

Territories were distributed from the gully up to the ridge line, and were not confined to the lower slope or moist gullies as occurs in drier and lower quality habitat (AMG in Higgins *et al.* 2001). Territories ranged 2.4 fold in size from 0.9 to 2.2 ha and did not overlap, although in one instance boundaries were very close (Fig. 1). Although the territories of ALA and ALB were estimated to be the largest, this may have been partly due to more intensive investigation, leading to increased observations of foraging areas. Our method of calculating territory size, based primarily on the location of display platforms, probably underestimated the area defended by the resident male. We determined the interior area bounded by the roost, display platforms and areas where a mature male was observed foraging or walking close to these sites, and added a 15m wide buffer zone around the interior area. This distance was chosen as it was half of the smallest minimum distance between display platforms of neighbouring males. However, as direct observation of foraging was difficult due to the species' wary nature, it is highly likely that some areas used for foraging by resident males went undetected. In addition, as the birds were unmarked, identification of individuals observed far from roosts or display platforms was not always possible.

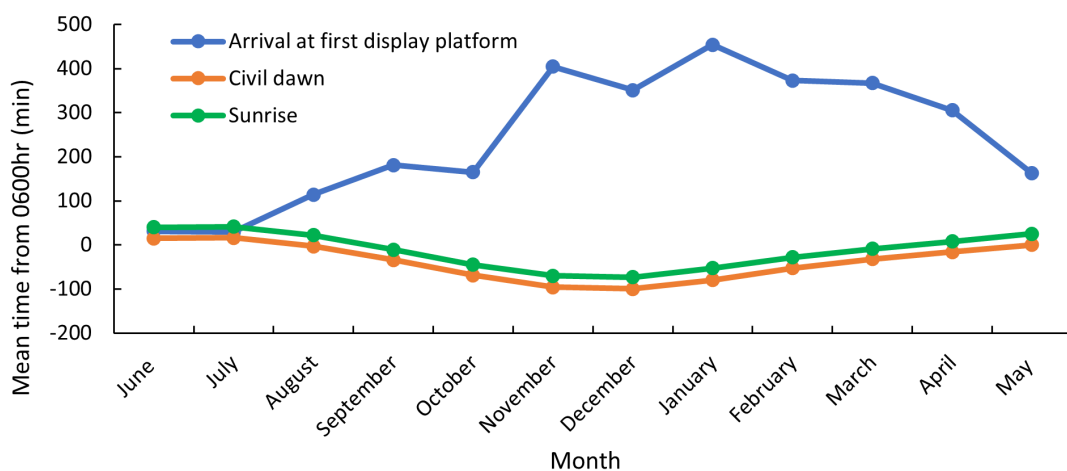


Figure 8. Mean times of arrival of Lyrebird A at its first display platform each month, in relation to civil dawn and sunrise

Territory size of male Superb Lyrebirds ranged approximately fourfold (0.9–3.7 ha) at Tidbinbilla Nature Reserve, ACT, and twofold (2.5–5.0 ha) at Maroondah Catchment, Victoria (Higgins *et al.* 2001). Thus, the minimum territory size for this species is similar to that of male Albert's Lyrebirds in our study (0.9 ha), while maximum values (3.7–5.0 ha) exceed those of the latter. However, these values are not directly comparable as those for the Superb Lyrebird were based on the defensive response of marked males to song playback (Robinson & Frith 1981; Reilly 1988; Lill 1996). Nevertheless, the number of display platforms of male Albert's Lyrebirds (up to seven) is considerably lower than the number of display mounds of male Superb Lyrebirds, which ranges from 20 to 83, averaging 42 (Robinson & Frith 1981).

Contrary to previous reports (Keast 1944; Curtis & Neilsen in Higgins *et al.* 2001), we found no evidence of clumping of display platforms near the roost site or centre of the territory (Fig. 1). Each resident male roosted on its own in roost sites which tended to be towards the periphery of territories. The same roost tree was used by the respective male during both display seasons. We propose fidelity to a particular roost site may be due to a limited number of satisfactory sites in the floristically diverse canopy of cool subtropical rainforest, where trees have a large range of foliage densities and branch angles (Lowman 1986). After gliding to the ground from the roost tree or a nearby tree, males walked quickly to the first display platform, which was usually the closest platform to the roost (Fig. 1). We did not see or hear any resident male singing at a territory boundary prior to visiting display platforms, as suggested by Reilly (1988). Similarly, the last display each day tended to be at the display platform closest to the roost, shortly before ascending the roost tree (Table 3).

During the day each male preferentially displayed at one platform, with one or more relatively long visits every day, in stark contrast to most other display platforms that were visited infrequently or for short periods (Table 1). Visits to the less utilised display platforms could not be attributed to remoteness from the roost (Fig. 2), and instead we suggest that visitation of less preferred platforms represents a balance between aversion to locations where previous singing failed to attract females (Riters & Stevenson 2012), dishabituation to familiar song when sung from an unexpected location (Smulders & Jarvis 2013) and a defensive strategy to communicate the resident male's

continued claim of exclusive ownership to neighbouring males.

The mating system of lyrebirds has been described as a dispersed lek (Robinson & Curtis 1996; Backhouse 2021) as several behaviours are suggestive of a lek-like mating system (as defined by Frith 2024). Males are present at display platforms for prolonged periods (~30% of daylight hours; Table 1) and play no role in nest-building, incubation of eggs or raising of young. However, the requirement for lekking behaviour of clumped dispersion of display platforms has not been demonstrated. True (exclusive) clumping within a large area of similar topography and habitat is required, in order to preclude the possibility that display locations are influenced by microhabitat characteristics (Frith & Frith 1995). Our study of a group of mature males within ~40 ha did not exclude the influence of microhabitat characteristics on territory location, as the seven territories (and the two undefined territories) effectively occupied the whole study site. A study of a larger area of similar microhabitat would be required to demonstrate a lek-like mating system in Albert's Lyrebird.

Simultaneous displays by multiple males

The simultaneous arrival of ALA and ALB at their respective display platforms for their first performance, and subsequent displays during the day, suggest both proximal and ultimate causes. Environmental conditions, such as ambient temperature, humidity, precipitation, cloud cover, light, wind, lunar phases, and Julian date (Henwood & Fabrick 1979; Hutchinson 2002; Brown & Handford 2003; Bruni *et al.* 2014; Gupta *et al.* 2023) and phylogenetic factors (Berg *et al.* 2006), influence the time of the dawn chorus in other species, and it is reasonable to assume these factors may similarly influence the timing of dawn song at roost sites, and the more intense periods of display during the day (Table 3; Figs. 7, 8), in Albert's Lyrebirds. Previous field reports have noted males seemingly responding to their neighbour's Territorial Song with their own (Higgins *et al.* 2001). Auditory contact between neighbours may be stimulus for synchronised displays and help reduce physical aggression (Temeles 1994; Searcy & Beecher 2009). Further investigation is warranted to determine whether the simultaneous singing of males is a deliberate response to the Territorial Song of neighbours (counter-singing), or a coincidence of frequent song from males within a small area.

Simultaneous display performances may confer benefits to females. During the winter display season the female's time is allocated to nest building (as sole builder), possible territory defence (as occurs in the Superb Lyrebird) (Austin *et al.* 2019) and assessment of suitors' genetic qualities, as well as foraging. Simultaneous male displays would allow females to compare a number of suitors in short, dedicated periods, particularly during the early to mid-morning when foraging is less profitable (Hutchinson 2002), thereby increasing time available for other activities. The ability to endure prolonged displaying activity (the 'endurance rivalry' of Andersson 1994, in Shuker & Kvarnemo 2021) between males may signal superior genetic quality to females, though there was no difference in the number of daily visits or duration of displays between ALA and ALB.

Displays outside winter

Exclusive use of display platforms by the resident male was relinquished following the winter display season when groups of mixed sex and maturity occasionally visited, and at times moved as a group from one platform to another within a short period. Visits by males outside the winter display season may serve important functions. Males of different ages displaying in each other's presence allows intimate social transmission of mimetic courtship song, while the single male's mimicry of novel song and sounds may function as song practice which subsequently improves performance of stereotypic courtship song in the presence of a female (Alvarado *et al.* 2021).

Summer displays (Fig. 4) may serve to communicate a continued claim of platform ownership to neighbouring males or nearby groups, and may be analogous to Black Grouse *Tetrao tetrix* lekking behaviour which acts as a "preview" to influence early mate choice in the next breeding season (Rintamäki *et al.* 1999). In addition, summer displays may indicate a male's ability to rapidly regain body condition by late spring to support the metabolic demand of testicular recrudescence, if testicles undergo immediate atrophy after breeding rather than being maintained for several months (Vézina & Salvante 2010). After the conclusion of the summer display season, the complete absence of display song from the forest soundscape from mid-April to early May might function to dishabituate females prior to a dramatic increase in song in late May and the onset of the winter display season.

Acknowledgements

We are very grateful to Cliff Frith and Alex Maisey for their insightful, constructive advice and corrections. This research was conducted on behalf of the Albert's Lyrebird Conservancy and we thank T. Lomax, V. Sloane, B. Stewart, S. Millard, E. Clarke, R. Eley and Protect the Bush Alliance for their encouragement and assistance. Queensland Department of Environment, Science & Innovation gave approval for all activities and provided funding for camera traps (DESI grant NRLG4060). We wish to acknowledge the Gidabul people, the traditional custodians of "Cambanoora" where this study was conducted.

References

- Akçay, C., Anderson, R.C., Nowicki, S., Beecher, M.D. & Searcy, W.A. 2015. Quiet threats: soft song as an aggressive signal in birds *Animal behaviour* 105: 267-274.
- Alvarado, J.A., Goffinet, J., Michael, V., Liberti, W., Hatfield, J., Gardner, T., Pearson, J., & Mooney, R. 2021. Neural dynamics underlying birdsong practice and performance. *Nature* 599: 635-639.
- Austin, V.I., Welbergen, J.A., Maisey, A.C., Lindsay, M.G. & Dalziell, A.H. 2019. Destruction of a conspecific nest by a female superb lyrebird: Evidence for reproductive suppression in a bird with female-only parental care. *Behaviour* 156: 1459-1469.
- Backhouse, F. 2021. Explaining geographic variation in the elaborate vocal display of the male Albert's Lyrebird *Menura alberti*. PhD Thesis. University of Western Sydney, New South Wales.
- Backhouse, F., Dalziell, A.H., Magrath, R.D., Rice, A.N., Crisologo, T.L. & Welbergen, J.A. 2021. Differential geographic patterns in song components of male Albert's lyrebirds. *Ecology and Evolution* 11: 2701-2716.
- Backhouse, F., Dalziell, A.H., Magrath, R.D. & Welbergen, J.A. 2022. Higher-order sequences of vocal mimicry performed by male Albert's lyrebirds are socially transmitted and enhance acoustic contrast. *Proceedings of the Royal Society B* 289: 20212498.
- Backhouse, F., Mirando, H., Herwood, T., Odom, K., Dalziell, A.H. & Welbergen, J.A. 2024a. Display court ecology in male Albert's Lyrebirds. *Emu* <https://doi.org/10.1080/01584197.2024.2400931>
- Backhouse, F., Welbergen, J.A., Robinson, B.W. & Dalziell, A.H. 2024b. Performative manipulation of the environment by displaying Albert's lyrebirds. *American Naturalist* 24: 181-190.
- Berg, K.S., Brumfield, R.T., & Apanius, V. 2006. Phylogenetic and ecological determinants of the neotropical dawn chorus. *Proceedings of the Royal Society B: Biological Sciences* 273: 999-1005

- Bird, J.P., Martin, R., Akçakaya, H.R., Gilroy, J., Burfield, I.J., Garnett, S.T., Symes, A., Taylor, J., Şekercioğlu, Ç.H. & Butchart, S.H.M. 2020. Generation lengths of the world's birds and their implications for extinction risk. *Conservation Biology* 34: 1252-1261.
- BOM. 2025. Australian Bureau of Meteorology. http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=41085. Accessed 1 February 2025.
- Brown, T.J. & Handford, P. 2003. Why birds sing at dawn: the role of consistent song transmission. *Ibis* 145: 120–129.
- Bruni, A., Mennill, D.J. & Foote, J.R. 2014. Dawn chorus start time variation in a temperate bird community: relationships with seasonality, weather, and ambient light. *Journal of Ornithology* 155: 877–890.
- Chamberlain, R.G. & Duquette, W.H. 2007. *Some algorithms for polygons on a sphere*. Jet Propulsion Laboratory NASA, Pasadena CA. ntrs.nasa.gov/citations/202100005701
- Curtis, H.S. 1972. The Albert's Lyrebird in display. *Emu* 72: 81–84.
- Dong, S. & Clayton, D.F. 2009. Habituation in songbirds. *Neurobiology of Learning and Memory* 92: 183–188.
- Fearnley, A., Gilmore A.M., Cehak, F. & Fitzgerald, M. 2025. Display platforms of Albert's Lyrebird *Menura alberti*, Part 1. Influence of habitat on location and characteristics. *Sunbird* 52: 1–12.
- Frith, C.B. 2025. Use and definitions of the terms arena, lek and court in describing avian courtship sites. *Ibis* 167: 295–298.
- Frith, C.B. & Frith, D.W. 1995. Court site constancy, dispersion, male survival and court ownership in the male Tooth-billed Bowerbird *Scenopoeetes dentirostris* (Ptilononorchidae) *Emu* 95: 84–98.
- Gupta, P., Sinha, A., Malik, S. & Rani, S. 2023. Dawn and dusk chorus as a potential zeitgeber. *Biological Rhythm Research* 54: 41–51.
- Henwood, K. & Fabrick, A. 1979. A quantitative analysis of the dawn chorus: temporal selection for communicatory optimization. *American Naturalist* 114: 260–274.
- Higgins, P.J., Elliott, A., Peter, J.M. & Steele, W.K. (Ed) 2001. *Handbook of Australian, New Zealand and Antarctic Birds. Volume 5: Tyrant-flycatchers to Chats*. Oxford University Press, Melbourne.
- Hinsch, M. & Komdeur, J. 2017. What do territory owners defend against? *Proceedings of the Royal Society of Biology* 284: 20162356.
- Hutchinson, J.M.C. 2002. Two explanations of the dawn chorus compared: how monotonically changing light levels favour a short break from singing. *Animal Behaviour* 64: 527–539.
- Keast, J.A. 1944. A winter list from the Tweed River District, N.S.W., with remarks on some nomadic species. *Emu* 43: 177–187.
- Lill, A. 1996. Foraging behavioural ecology of the Superb Lyrebird. *Corella* 20: 77–87.
- Liu, I.A., Soha, J.A. & Nowicki, S. 2018. Song type matching and vocal performance in territorial signalling by male swamp sparrows. *Animal Behaviour* 139: 117–125.
- Lowman, M.D. 1986. Light interception and its relation to structural differences in three Australian rainforest canopies. *Australian Journal of Ecology* 11: 163–170.
- NOAA. 2025. National Oceanic and Atmospheric Administration Solar Calculator. Available at <https://gml.noaa.gov/grad/solcalc>. Accessed 5 May 2025.
- Ratcliffe, F. 1938. *Flying Fox and Drifting Sand*. Chatto & Windus, London.
- Reilly, P. 1988. *The Lyrebird. A Natural History*. New South Wales University Press, Kensington.
- Rintamäki, R.T., Karvonen, E., Alatalo, R.V. & Lundberg, A. 1999. Why do Black Grouse males perform on lek sites outside the breeding season? *Journal of Avian Biology* 30: 359–366.
- Riters, L.V. & Stevenson, S.A. 2012. Reward and vocal production: Song-associated place preference in songbirds. *Physiology & Behaviour* 106: 87–94.
- Robinson, F.N. & Curtis, H.S. 1996. The vocal displays of the lyrebirds (Menuridae). *Emu* 96: 258–275.
- Robinson, F.N. & Frith, H.J. 1981. The superb lyrebird *Menura novaehollandiae* at Tidbinbilla, ACT. *Emu* 81: 145–157.
- Searcy, W.A. & Beecher, M.D. 2009. Song as an aggressive signal in songbirds. *Animal Behaviour* 78: 1281-1292.
- Shuker, D.M. & Kvarnemo, C. 2021. The definition of sexual selection. *Behavioural Ecology*. 32: 781–794.
- Smulders, T.V. & Jarvis, E. D. 2013. Different mechanisms are responsible for dishabituation of electrophysiological auditory responses to a change in acoustic identity than to a change in stimulus location. *Neurobiology of learning and memory* 106: 163–176.
- Temeles, E.J. 1994. The role of neighbours in territorial systems: when are they 'dear enemies'? *Animal Behaviour* 47: 339–350.
- Vézina, F. & Salvante, K.G. 2010. Behavioural and physiological flexibility are used by birds to manage energy and support investment in the early stages of reproduction. *Current Zoology* 56: 767–792.