Australian Field Ornithology 2017, **34**, 144–150
http://dx.doi.org/10.20938/afo34144150

A nesting record and vocalisations of the Night Parrot *Pezoporus occidentalis* from the East Murchison, Western Australia

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Abstract. The Night Parrot *Pezoporus occidentalis* is a poorly known, nationally endangered species that historically occurred throughout semi-arid and arid Australia, including Western Australia where the type specimen was collected during the 19th century. Despite recent sightings in Western Australia, no evidence has been provided to definitively prove the existence of an extant population in the state. In March 2017, we discovered living Night Parrots in the East Murchison biogeographic subregion of Western Australia, and documented an active nest, associated calling behaviour including previously undescribed duets, and roosting habitat of a pair of this species at the site.

Introduction

In 2013, the first photographs of a living Night Parrot *Pezoporus occidentalis*, listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (DotE 2017), were taken in western Queensland by John Young (see his photos in Dooley 2013 and Murphy 2013). Prior to this discovery (and the discovery of dead specimens in western Queensland, e.g. Cuppitt & Cuppitt 2008) and the subsequent research at Pullen Pullen Reserve, the habits of this arid-dwelling nocturnal species were poorly understood. In Western Australia, where the type specimen was collected near Mt Farmer in 1854 (Forshaw *et al*. 1976), there had been no well-documented sightings of the species after 1912 (Wilson 1937) until 2005 when three individuals were purportedly observed at a well, adjacent to the Fortescue Marshes in the Pilbara (Davis & Metcalf 2008). Since this record, there have been several additional unconfirmed sightings of Night Parrots, in the East Murchison at Matuwa and Millrose pastoral station (Hamilton *et al*. 2017b).

Since 2013, detailed studies at Pullen Pullen Reserve in western Queensland have provided critical information relating to breeding behaviour, physiology, roosting and foraging habitat, nocturnal movements, and calling behaviour (Murphy & Night Parrot Recovery Team 2015; Kearney *et al*. 2016; Murphy *et al.* 2017a,b, 2018). However, in Western Australia, these important aspects of their biology are mostly unknown, although the literature (e.g. Wilson 1937; Ives 1971) and recent sightings (Davis & Metcalf 2008; Hamilton *et al*. 2017b) provide some clues.

We reasoned that a search was warranted in Western Australia's East Murchison region on the following grounds: historical records of Night Parrots exist for this region; details of recent findings in Queensland (cited above) suggested similar suitable roosting and foraging habitat is still present and, finally, there have been credible sightings of Night Parrots within the region in recent years. Accordingly, in March 2017, during a five-night search for Night Parrots in the East Murchison, we recorded vocalisations, captured photographs and discovered an active nest of Night Parrots. In this paper we provide irrefutable proof of the species' continued existence within Western Australia, and aim to provide information that will assist in detecting new populations.

Methods

Study area and site selection

A desktop assessment of potential Night Parrot habitat was conducted in 2014 using Google Earth (Google Inc., CA, USA) satellite imagery. The assessment targeted regions in Western Australia where Night Parrots had been recorded historically (Davis & Metcalf 2008). Based on preliminary habitat descriptions from the first known location at Pullen Pullen (J. Young pers. comm.), spinifex (*Triodia* spp.) that formed interconnected rings (clearly visible from the satellite imagery), were selected as potential Night Parrot roosting sites. Spinifex sites located in close proximity to low-lying saline lakes or drainage channels, in particular where samphire was evidently present, were selected as sites with the highest priority for targeted surveys, as these have been highlighted as likely habitat for the species in Western Australia (e.g. Davis & Metcalf 2008; Burbidge & Hamilton 2013). The East Murchison biogeographic subregion (Cowan 2001) was determined to contain drainage areas containing both ring-forming spinifex, as well as samphire.

A reconnaissance survey of drainage systems in the East Murchison was conducted by B. Greatwich in February 2016. The purpose of the survey was to ground-truth potential Night Parrot habitats identified during the desktop assessment. The reconnaissance survey confirmed ring-forming spinifex, close to samphire, was present, and further searches for Night Parrot within these drainage systems were warranted. Discussions with Neil Hamilton provided further valuable insights into potential locations within the East Murchison where Night Parrots could exist.

The climate in the East Murchison is described as arid (Cowan 2001), with rainfall at the nearest regional centre (Wiluna; BoM Station 013012) to our study area averaging

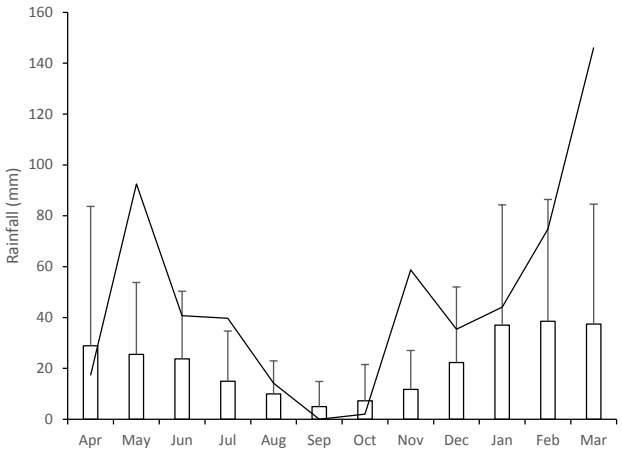

Figure 1. Rainfall recorded at Wiluna (BoM station 013012). Line: rainfall during the 12 months prior to visiting the study area (April 2016–Mar 2017). Columns: rainfall long-term mean (1898–2017) and standard deviation for that month. Data sourced from Bureau of Meteorology (2017).

260.3 mm per year (BoM 2017). Above average rainfall occurred in the four months prior to our search in March 2017 (Figure 1).

Dominant plant species recorded within the study area were identified by taxonomist Andrew Craigie (Research Associate at the Western Australian Herbarium) using high resolution images. A complete floristic survey was not undertaken.

Detection of vocalisations

All four authors (each experienced with arid-zone bird calls) conducted stationary listening surveys each evening for five consecutive evenings commencing 12 March 2017. Based on typical peak calling patterns recorded at Pullen Pullen (Murphy *et al*. 2017a), listening surveys commenced at sunset, until a maximum duration of 120 min post-sunset. A single pre-sunrise listening survey was also conducted from 90 min prior to sunrise.

Observers were stationed 200–400 m apart, in ring-shaped spinifex (*Triodia* spp.) that was considered suitable for roosting Night Parrots (Murphy *et al*. 2017a). When a presumed Night Parrot was heard, observers noted a description of the call, the exact time of the call, the approximate direction from which the calls were heard and an estimated distance to the call. Observers were each equipped with simple sound recorders (Olympus LS-10, Olympus Corporation, Tokyo, Japan; and Apple iPhone 5s, Apple Inc., CA, USA) in an attempt to record any calls heard.

A single automatic recording device (Song Meter 2; Wildlife Acoustics Inc., MA, USA) was positioned in suitable roosting habitat for Night Parrots for seven consecutive nights from 12 March 2017. The device was retrieved at a later date. It was set to record continuously from sunset until sunrise (~12 hours) each night and was positioned in two locations: in a small expanse of potential roosting habitat (three nights), and 12.5 m from an active Night Parrot nest within a larger expanse of spinifex (four nights).

Figure 2. Night Parrot flushed from active nest hummock. Photo: Bruce Greatwich.

Figure 3. Active nest hummock with nest chamber containing a single egg. Photo: Adrian Boyle.

Figure 4. Location of active Night Parrot nest hummock. Photo: Adrian Boyle.

Figure 5. *Triodia* expanse where Night Parrots were first detected. Photo: Bruce Greatwich

Figure 6. *Tecticornia* plain adjacent to Night Parrot roosting habitat. Photo: Bruce Greatwich.

Figure 7. *Scaevola* plain adjacent to Night Parrot roosting habitat. Photo: Bruce Greatwich.

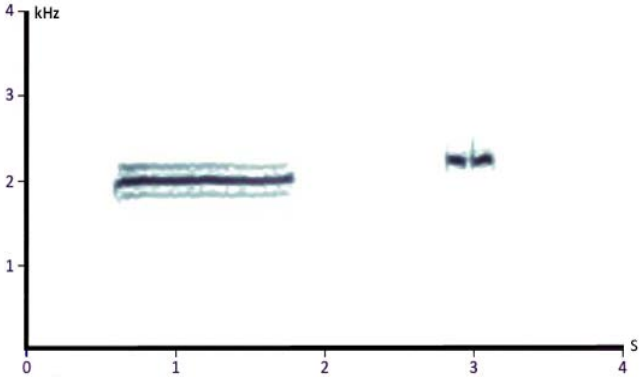

Figure 8. Example of apparent *hollow whistle-didit* duet of Night Parrot pair recorded near the nest site. Note the temporal relationship of the two vocalisations.

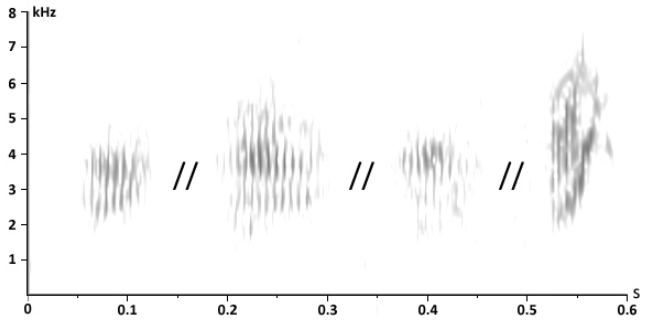

Figure 9. Examples of *croak* calls recorded near the nest site. Separatrices indicate non-defined intervals.

We scanned by eye for Night Parrot vocalisations within the audio recordings using the software Song Scope (Version 4.1.5, Wildlife Acoustics Inc., MA, USA). We measured the frequency and duration of each individual call using the software Audacity (Version 2.1.1, Audacity Team 2015).

Representative recordings of the Night Parrot vocalisations identified in this paper are available on the website xeno-canto (www.xeno-canto.org); catalogue numbers XC380403, XC380406 and XC380407.

Results

Nest description and habitat

On 14 March 2017, single Night Parrots were flushed twice as observers walked through spinifex (Figure 2). The spinifex hummocks from where they flushed were separated by 17.5 m. An immediate inspection of the hummock where one of the two Night Parrots flushed revealed a nest chamber containing a single, round, white egg (Figure 3). A steep, downwards-angled entrance to the nest chamber (from which the Night Parrot exited when flushed) was visible from above, but the nest chamber could also be observed from ground level. The nest was built within a circular, excavated depression on sandy substrate at the centre of the *Triodia* hummock, and the egg was placed on a small collection of chewed *Triodia* leaves. The hummock containing the nest was comparable to others in the immediate vicinity (Figure 4), being measured at 0.5 m in height (excluding the seed stalks), but was smaller in height than the majority of hummocks within the expanse (see also Hamilton *et al.* 2017a).

The nearby *Triodia* hummock from where the other of the two flushed birds exited was not inspected to reduce potential disturbance, as it was suspected of being a roost site.

The spinifex surrounding the nest comprised an expanse (~1.8 km x 0.5 km) of interconnected ring-shaped hummocks of the seeding grass *Triodia* aff. *plurinervata*, interspersed with sparse Sturts Pigface *Gunniopsis quadrifida*, Mallow *Lawrencia* aff. *squamata*, Lobed Bluebush *Maireana lobiflora*, Currant Bush *Scaevola spinescens* and stands of Mulga *Acacia aneura* on a reddish-brown sand-loam without rocks (Figure 5). Reddish-coloured termitaria were also scattered throughout.

At a broader scale, the *Triodia* expanse was encompassed by mulga woodland along the southern boundary and a breakaway (a rocky, mesa-like hill) along the northern boundary. Separating the *Triodia* from the breakaway was an open plain of samphire (*Tecticornia* aff. *undulata* and *T. halocnemoides sens. lat.*; Figure 6), purslane *Calandrinia pleiopetala*, bluebush (*M. amoena*, *M. lobiflora*), scaevolas (*S. spinescens*, *S. collaris*), Mallee Hemichroa *Surreya diandra* and Pigweed *Trianthema turgidifolium* (Figure 7), within which was a series of disconnected, ephemeral, freshwater pools.

Vocalisations

In a total of 48 hours of recordings adjacent to the active nest site over four consecutive nights (nights of 14—17 March 2017), 237 Night Parrot calls comprising three vocalisation types were recorded and are described below. The total number of recordings for each vocalisation type is noted by *n*, although not every vocalisation was of sufficient quality to allow accurate measurements.

Vocalisation 1 (*n* = 76): A drawn-out, constant frequency, single-note, *hollow whistle* (Figure 8) with a peak frequency of 1960–2134 Hz (mean 2029 ± 31 Hz; *n* = 40) and duration of 0.491–0.621 s (mean 0.546 ± 0.032 s, *n* = 39).

Vocalisation 2 (*n* = 18): Often in apparent response to the *hollow whistle*, was a rapid, disyllabic, electronic-sounding, whistled *didit* (Figure 8). The *didit* vocalisation had a peak frequency of 2196–2231 Hz (mean 2217 ± 12 Hz; *n* = 13) and duration of 0.149–0.155 s (mean 0.152 ± 0.003 s; *n* = 8).

The interval between a *hollow whistle* and *didit* was 0.46–1.17 s (mean 0.72 ± 0.23 s; *n* = 10). The *didit* was never found to immediately precede the *hollow whistle* in any recordings. Both vocalisations were recorded at the active nest site, as well as at listening survey points located up to 850 m from the active nest (based on the available evidence suggesting only a single pair occupied the site).

Vocalisation 3 (*n* = 143): A short, sharp, harsh, single-note *croak* (described in Murphy *et al.* 2017a), given singly or repeated in long series for up to ~5 min. The *croak* syllable comprised multiple thin elements (Figure 9) that

together gave a rapid grating quality to the call, with a variable broad frequency range between ~1.8–6.5 kHz, and duration of 0.052–0.108 s (mean 0.071 ± 0.012; *n* = 33).

Furthermore, a flushed Night Parrot was also heard to give a series of short harsh, single notes in flight, but these could not be recorded.

As the recording devices were only set to record between sunset and sunrise, no Night Parrots calls were recorded during the day. The earliest call recorded occurred 24 min after sunset, when an individual gave the *didit* call from (or very near to) the active nest. The results of the automatic sound recordings showed Night Parrots progressed to calling throughout the night, with two major peaks (each peak representing >40% of total recorded calls at the nest site) in their calling times at the nest between 210–270 min after sunset, and 240–180 min before sunrise. The latest call detected was 68 min prior to sunrise during a listening survey.

Discussion

This paper presents the first confirmed evidence of the Night Parrot in Western Australia since a specimen was collected in 1912 (Wilson 1937). We also document the first confirmed active nest of the Night Parrot in Western Australia, which closely follows the discovery of an active nest at Pullen Pullen Reserve in Queensland in April 2016 (Murphy *et al*. 2017a). The rainfall pattern preceding the nesting attempt was consistent with the findings in Queensland, which suggested that Night Parrot breeding attempts follow significant rainfall (Murphy *et al*. 2017a). Much of the *Triodia* throughout the nesting habitat was in full seed (although it was not determined if the seed was fertile), but Murphy *et al*. (2017a) have shown that the presence of large amounts of *Triodia* seed is not a pre-requisite for instigating nesting behaviour.

The structure of the *Triodia* at our nest site was similar to that described by Murphy *et al.* (2017a) at Pullen Pullen, being dense, and ring-shaped. However, whereas the Pullen Pullen nests occurred within isolated, small (~20 m) tight clusters of hummocks on a gently undulating ironstone pavement, our nest was found within a much larger, continuous expanse of dense spinifex (~1.8 km x 0.5 km) on a level, low-lying sand-loam substrate devoid of rocks. This finding suggests that Night Parrot nest site selection may be more reliant on the structure of the spinifex and not necessarily the size of the spinifex expanse, or the substrate type. Although we currently lack an understanding of the movements of Night Parrots in Western Australia, Murphy *et al.* (2017b) highlighted that the proximity of dense ground layer vegetation (e.g., *Triodia*) to suitable foraging grounds is likely to play a role in nest (and roost) site selection, suggesting the samphire and herbfields adjacent to the *Triodia* expanse could be a food source. An additional feature potentially influencing nest site selection, was the available surface water present, which Kearney *et al*. (2016) determined was an essential requirement during hot conditions.

The close proximity of samphire (*Tecticornia* spp.) to where the Night Parrots were recorded has not been a feature of recent sites discovered in western Queensland (e.g. Murphy *et al.* 2017a). However, there has been a historical association between Night Parrots and samphire, particularly in central Australia, where they have been noted nesting and roosting within such habitats (Andrews 1883; McGilp 1931; Forshaw *et al*. 1976). Other recent Night Parrot sightings in Western Australia (i.e. Davis & Metcalf 2008; Hamilton *et al*. 2017b) have occurred in association with samphire and spinifex mosaic habitats, within low-lying drainage systems, that strongly resemble our study area.

Ives (1971) documented a possible nest of the Night Parrot from the Pilbara region of Western Australia. His description of the nest – a depression lined with the terminal sections of spinifex leaves at the base of a hummock – was consistent with our observation as well as with nest descriptions by Murphy *et al*. (2017a).

The *hollow whistle* and *didit* vocalisations may be associated with the breeding repertoire of Night Parrots at this particular site. Due to the brevity of our observations, it is unknown whether these two vocalisations are produced during non-breeding periods. There was no evidence to suggest that a specific individual Night Parrot gave both the *hollow whistle* and *didit*. Based on the spatial separation and timing of the calls heard in the field, it appeared the *hollow whistle* was unique to one individual, with the *didit* being unique to another.

Our recorded *hollow whistle* bears resemblance to the call described in Wilson (1937), who reviewed M.A. Bourgoin's records from the Lake Nabberu area of Western Australia. Bourgoin (in Wilson 1937, p. 79) stated, "When coming in to water or leaving, they [Night Parrots] give a long drawn-out mournful whistle which can be heard at great distance". The 'long drawn-out mournful whistle' aptly describes the *hollow whistle*, although we cannot quantify the distance over which this call can be heard.

The *hollow whistle* vocalisation has not been described from populations in western Queensland (S. Murphy, N. Leseberg pers. comm.). The *didit* vocalisation bears closest resemblance to the *dink-dink* (or *ding-ding*) vocalisations (Murphy & Night Parrot Recovery Team 2015) from Pullen Pullen, but appears to be faster and slightly lower-pitched.

Duets in birds occur when an individual (the responder) produces a vocalisation with a characteristic form and time relative to another individual's (the initiator) ongoing vocalisations (Dahlin & Benedict 2014). The *didit* vocalisation heard following a *hollow whistle* (see Figure 8), was given by the apparently responding individual in a predictable way highly suggestive of duetting (R. Heinsohn pers. comm.).

Duetting has been documented in over 360 bird species (Hall 2009), including parrots (Power 1966; Wright & Dahlin 2007; Dahlin & Wright 2009; Zdenek *et. al.* 2015), but has not previously been noted in the Night Parrot. Duetting functions as an important means of communication within and between different pair-bonds or social groups (Dahlin & Benedict 2014), with joint resource defence believed to be the primary function (Hall 2009). Established pair-bonds are more likely to produce highly-coordinated duets than new pairs, which may create a higher threat level to intruders of occupied territories (Hall 2009). The relatively high temporal precision recorded in the apparent *hollow*

whistle–didit duet of the Night Parrot pair within our study area, may be suggestive of an established pair-bond.

The study area is currently managed as an active pastoral lease for cattle grazing. Low-density grazing was noted during the survey period, but we could not detect any observable impact to the spinifex and samphire habitats from trampling or overgrazing.

A review of the fire history (North Australia and Rangelands Fire Information 2017) surrounding the study area indicates an absence of fires for the entirety of the available dataset (2000-2016). However, it is likely the majority of the study area has not burnt for a considerably longer period than this, as the mosaic of spinifex and samphire is likely to create numerous natural barriers to fire. Historically, burning regimes by Traditional Owners in desert landscapes resulted in higher food production (an increase in diversity of both plants and animals), when burning was conducted during the cool season and using a small-scale, mosaic approach (Jupp *et al.* 2015). Land management of this type is likely beneficial to species such as the Night Parrot, as the resulting heterogeneous landscape continually provided refugia and food sources.

Our observations (and those of Hamilton *et al.* 2017a), although limited, complement the breeding observations recorded at Pullen Pullen, and contribute to the knowledge of vocalisations and nesting habitat of Night Parrots overall, as well as more specifically within Western Australia. We hope that they will assist with searches for additional populations, and aid government regulators and land managers in making better-informed decisions regarding the conservation and management of the species across its range and within Western Australia.

Acknowledgements

We sincerely thank Neil Hamilton for his ongoing discussions regarding Night Parrot surveys at Matuwa, facilitation of access to the study site, and for his persistence in retrieving our acoustic recording device during difficult weather conditions. Tegan Douglas assisted Neil Hamilton with the retrieval of our acoustic recording device for which we are grateful. Allan Burbidge encouraged us to publish this paper and contributed additional flora species to our results. We are thankful to Leo Joseph, Steve Murphy, Allan Burbidge and an anonymous referee for their constructive comments. Tim Wright and Robert Heinsohn provided extensive avian duet reference material that encouraged us to describe the apparent duet. John Young provided support and motivation to find Night Parrots in Western Australia. Andrew Craigie identified flora recorded at the site, which contributed significantly. Additionally, Steve Murphy and Nick Leseberg provided reference calls from Pullen Pullen, and helped us interpret our recordings. The site's land managers allowed us to access their property. The BirdLife Australia Rarities Committee reviewed our submission and it was accepted unanimously (Case #974). Lastly, we thank our families and friends for being supportive of us attempting such ambitious searches throughout the years.

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Received 6 August 2017, accepted 7 December 2017, published online 21 December 2017