

A trial helicopter survey of crane nesting on floodplains in the Gulf Plains Bioregion, north-western Queensland, and the first record of a three-egg clutch for the Australian Sarus Crane *Grus antigone gillae*

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Abstract. Nesting ecology of the Australian Sarus Crane *Grus antigone gillae* is the least well known of the four global Sarus Crane populations. All confirmed breeding sites are in Queensland, concentrated on seasonally flooded wetlands in the Gulf Plains bioregion, where the Australian Sarus Crane is sympatric with the Brolga *G. rubicunda*. This article describes a trial helicopter survey of crane nesting in February 2017, carried out under the auspices of the International Crane Foundation and with the participation of the Normanton Land and Sea Rangers. We report the first record of a three-egg clutch for the Australian Sarus Crane. All Australian Sarus Crane nests were found in habitats with trees, whereas only Brolgas were found nesting in treeless tussock grassland and in saline habitats. Since the last nest survey in 1984, numbers of Estuarine Crocodiles *Crocodylus porosus* have grown to the point where foot surveys are no longer safe, and this study shows that helicopters could provide a useful alternative method for further surveys of crane nests in the Gulf Plains bioregion.

Introduction

Nesting ecology is less well known for the phylogenetically distinct Australian Sarus Crane *Grus antigone gillae* than for the other three global Sarus Crane populations (Nevard *et al.* 2020; Nevard & Scambler 2023), with all confirmed breeding sites in Queensland, concentrated in the Gulf Plains Bioregion. Sympatric with Brolgas *G. rubicunda*, Australian Sarus Cranes use floodplains draining into the southern and eastern Gulf of Carpentaria (Marchant & Higgins 1993; Mirande & Harris 2019). The first Australian Sarus Crane nest to be recorded and described was in the Gulf Plains in 1969, near where breeding in Australia was first confirmed 2 years earlier by the sighting of two pairs with unfledged young (Gill 1969; Walkinshaw 1973). The only detailed study of Australian Sarus Crane nesting was from 13 January to 16 February 1984, at Delta Downs (Morr Morr) Station (16°59'S, 141°19'E) (Archibald & Swengel 1987). In that survey, GWA and Kurtjar Aboriginal Corporation assistant Roy Beasley located 76 crane nests, of which 79% (36 Australian Sarus Crane nests and 24 Brolga nests) were able to be revisited to record their contents (Archibald & Swengel 1987). The BirdLife Australia Nest Record Scheme (NRS) reported a “large colony” of 193 Brolga nests and 114 Australian Sarus Crane nests (Marchant & Higgins 1993, p. 475), but the source for this record cannot now be found (G. Ehmke pers. comm.) and the date, location and nesting details therefore remain unknown.

Scambler *et al.* (2020) reviewed clutch and family size in the species and found 45 confirmed Australian Sarus Crane clutches, all of one or two eggs, with an average clutch size of 1.87. Three-egg clutches are very rare across the Sarus Crane’s global range and no records were found from Australia, but Scambler *et al.* (2020) described two observations of Australian Sarus Crane pairs with three dependent young of the year on the Atherton Tablelands,

Far North Queensland, in the nonbreeding season. After reviewing behavioural and other evidence from a range of crane species they concluded that the successful raising of three-egg clutches, rather than adoption, was the most probable explanation.

Breeding success of Australian Sarus Cranes in the Gulf Plains has been estimated from landscape-scale surveys of pairs with recently fledged young remaining on or close to breeding territories along roadsides in the late wet season (Sundar *et al.* 2019; J.D.A. Grant unpubl. data). Nests are built in the early to mid wet season when flooding renders the Gulf Plains largely inaccessible by vehicle, so there are no direct measures of nest success. In 1984, nests were located by tramping on foot over ~200 km² of seasonally flooded woodland and swamps (Archibald & Swengel 1987). This was possible because Queensland populations of Estuarine Crocodiles *Crocodylus porosus* had been greatly reduced by intensive hunting after World War II and until 1974, when protection was enacted, after which recovery of the species was initially slow (Brien *et al.* 2017). Since the survey of 1984, crocodile numbers have increased greatly, rendering surveys on foot in the wet season too dangerous (GWA & TDN pers. obs.); even surveys along Gulf roads in the late crane breeding season, when floodwaters have receded, must be conducted under strict safety guidelines (J.D.A. Grant pers. comm.).

Nevertheless, to expand knowledge of Australian Sarus Crane nesting and to give more systematic data for crane breeding and abundance in the Gulf Plains, surveys of habitats away from roads are necessary (Sundar *et al.* 2019). Observers in high-wing small aircraft cannot satisfactorily identify Australian cranes to species (Kingsford *et al.* 2012). Although observers in ultralight aircraft can distinguish crane species on open plains, these aircraft do not have sufficient manoeuvrability to satisfactorily detect cranes in wooded habitats (J.D.A. Grant pers. comm.; R. Jackson pers. comm.), which are favoured by the Australian Sarus

Crane for breeding (Archibald & Swengel 1987; Sundar *et al.* 2019) and as post-breeding habitat (Nevard *et al.* 2024). Most previous studies using helicopters for surveys of large bird nests have combined aerial methods with foot or boat surveys. Maxson & Riggs (1996) used low-level helicopter flights to locate cryptically grey-coloured Greater Sandhill Cranes *G. canadensis tabida* and their nests in north-western Minnesota, USA. Nests were marked by dropping weighted flagging tapes and plotted on aerial photographs to document selection of nest habitat, with subsequent nest success determined by monitoring on the ground. Barzen *et al.* (2016) studied habitat density of Sandhill Crane nests in central Wisconsin, USA, and, although nests were found only in open wetlands, they used helicopters to search upland (wooded) habitats. Johns (2010) confirmed that fixed-wing pre-survey nest-locating techniques were suitable only for highly visible species such as Whooping Cranes *G. americana*, but not appropriate for more cryptically coloured Sandhill Cranes, which, like Brolgas and Australian Sarus Cranes, are grey and hence well camouflaged. Helicopter surveys have not, to our knowledge, been previously used for this purpose in Australia. In this article we report the results of a trial helicopter survey of Australian Sarus Crane and Brolga nests at Delta Downs Station, north-western Queensland, including the first record of a three-egg clutch for the Australian Sarus Crane (seen from the helicopter). We also consider the utility of helicopters for further surveys of crane nests in the Gulf Plains Bioregion.

Study site and methods

Except for salt pans and mangroves on the coastline, the Gulf Plains bioregion is covered by extensive tropical savanna grasslands and varying types and densities of grassy woodlands (mainly dominated by eucalypts), which have mostly been left uncleared (Kutt *et al.* 2009). Rainfall is strongly seasonal, falling mainly in a short wet season from January to March (Bureau of Meteorology 2023), causing widespread flooding on alluvial plains. The extensive wetlands in the Smithburne–Gilbert Fan Aggregation are listed as a nationally important wetland (Directory of Important Wetlands in Australia, 'DIWA': Australian Government 2023), an area of ~2505 km² significant for many bird and other species (BirdLife International 2024). Cranes in the Gulf Plains breed in a variety of wetland types in the wet season (Archibald & Swengel 1987; Marchant & Higgins 1993; Sundar *et al.* 2019).

An important area for breeding Australian Sarus Cranes under one ownership is Delta Downs Station, which is an aggregation of three pastoral properties of the Kurtjar Aboriginal Corporation totalling 390,000 ha. It stretches from the Gilbert River in the north, south to near Karumba in the Norman River catchment and has been used for cattle grazing since the late 1880s (McLelland Rural Services Pty Ltd 2014). We obtained mapping of vegetation types (Broad Vegetation Groups – BVGs: Neldner *et al.* 2023) and of wetlands (Queensland Government 2023). The southern part of the property near Karumba has wide areas of tussock grassland adjoining salt pans and the tidal zone, and the Delta Downs homestead ('the homestead') is surrounded by a complex mosaic of *Eucalyptus* and *Melaleuca* grassy woodlands, and herb and sedge

swamps. We refer to grassland with scattered trees as 'savanna'. Most of the northern part of Delta Downs Station lies within the DIWA-listed area. Pairs of cranes occupy breeding territories at least until their young have fledged (Mirande & Harris 2019; Sundar *et al.* 2019), by which time floodwaters have receded. We thus used wetland mapping (Queensland Government 2005) to identify the nearest permanent or semi-permanent water source (natural or artificial) to each nest site, and their salinity status, either 'fresh' or 'hyposaline' (i.e. brackish, with much less salt content than seawater).

The opportunity to conduct a trial helicopter survey of the area of Delta Downs first surveyed on foot by GWA and Beasley in 1984 was suggested by GWA. The trial would build on their groundbreaking work and be designed to test the feasibility and potential efficacy of a more comprehensive helicopter-based survey of the original survey area and make recommendations about this. The project was organised and sponsored by the International Crane Foundation (ICF), with a survey team consisting of GWA and TDN (ICF observers, one on each side of the aircraft); Kurtjar traditional owner Lance Rapson (Normanton Land and Sea Rangers); and Richard Baker (pilot). The survey was conducted between 0715 and 1200 h on 19 February 2017 in a 4-seater Robinson helicopter, commencing at Karumba. The Delta Downs homestead was reached at 0815 h and the survey recommenced from c. 0930 h, after refuelling: total survey time was thus c. 4 hours, including 3 hours around The Delta Downs homestead (Area 3, see below). Flight speed was ~30–50 knots at ~50–70 m above ground level. In all areas the helicopter navigated close to potential nest sites but did not land at or near nests and proximity was strictly limited to <60 seconds, to minimise disturbance.

Three areas were surveyed (see Figure 1): (1) ~40-km transect of low tussock grasslands adjoining the tidal zone, from north of Karumba to the southern boundary of the DIWA-listed site; (2) 25-km transect of sparsely wooded grassland on river deltas; and (3) ~200 km² of woodland, grassland and swamps surrounding the homestead. Area 3 was approximately the same as the 1984 Archibald–Beasley survey area. Roadsides on a small area in the south of Area 3 were surveyed by Sundar *et al.* (2019) in April–May 2017, later in the same breeding season, but otherwise this trial survey covered off-road areas not traversed for their extensive study. Areas 1 and 2 were surveyed on both outward and return journeys, and the observers scanned for nests up to a width of ~1 km on either side of the aircraft. In Area 3 an irregular flight path was used to scan swamps and wetlands, including within the woodlands. Nest locations were recorded using GPS. Nests of the Australian Sarus Crane and Brolga are very similar (Marchant & Higgins 1993), thus could be identified to species only if adults were present. Pairs observed with young chicks away from a nest were presumed to be close to the nest site.

Results

Nest records

The survey (see Figure 1) produced 35 nesting records (Table 1), comprising 33 nests and two crane pairs each

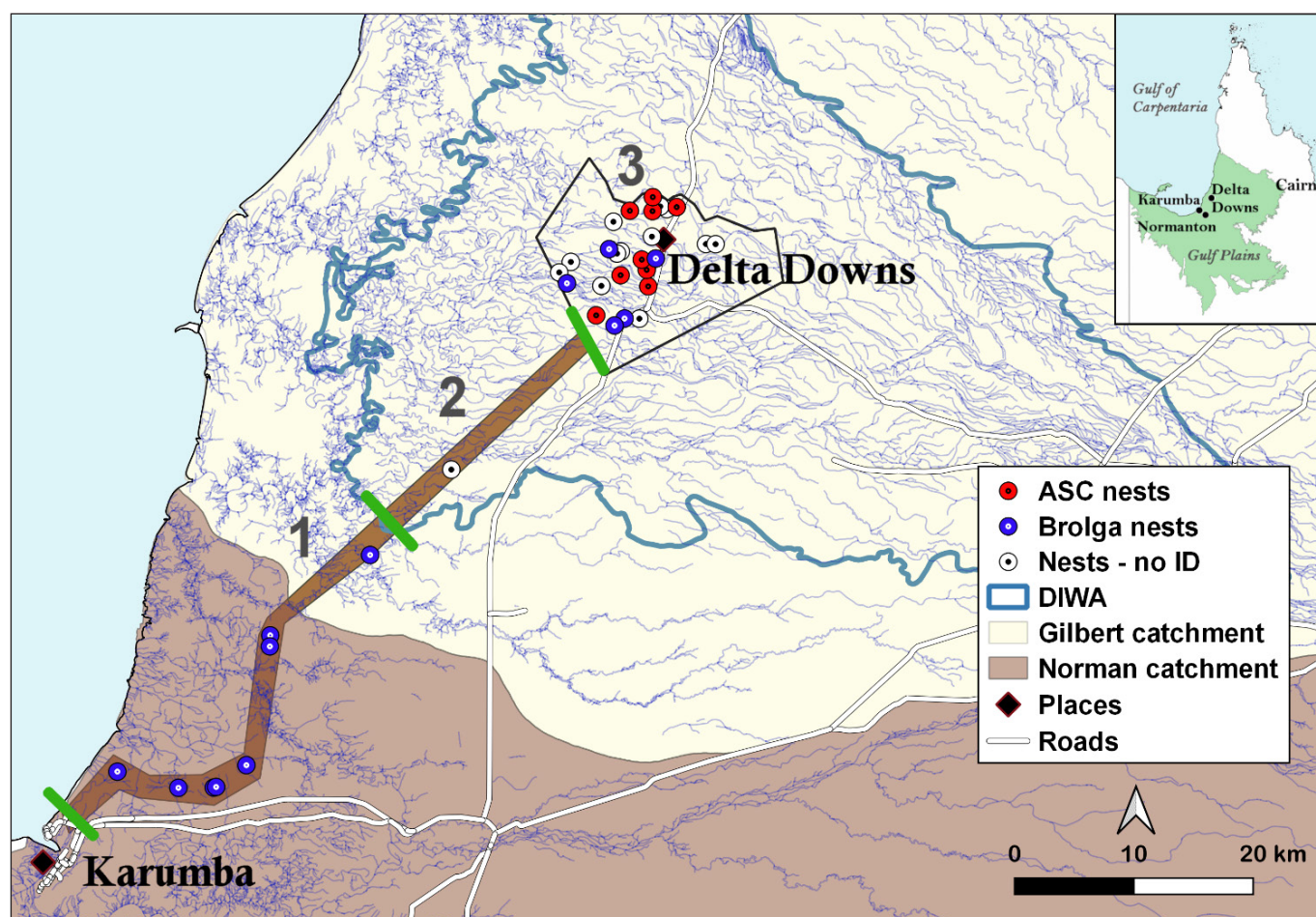


Figure 1. Crane nests recorded in a trial helicopter survey from Karumba to Delta Downs homestead and return, on 19 February 2017. For survey areas 1, 2 and 3, see Methods. Beginning and end of survey Areas 1 and 2 (transects shown in brown) are indicated by green bars. ASC = Australian Sarus Crane; DIWA (Directory of Important Wetlands in Australia) = boundary of the Smithburne–Gilbert Fan Aggregation, a DIWA-listed nationally important wetland.

attending a chick away from the nest (one Australian Sarus Crane, one Brolga). All occupied nests ($n = 22$) were identified to species, nine Australian Sarus Crane (Figure 2a) and 13 Brolga (Figure 2b). A further 13 nests were unidentified because no adults were present – all were empty and their condition showed that they had been used and vacated (i.e. they were not newly constructed and awaiting laying). Adult cranes disturbed by the helicopter remained on the ground and quickly returned to their nests. Three of the Australian Sarus Crane nests

contained eggs, with two clutches of two eggs and one clutch of three eggs (Table 1). The 3-egg clutch was 2.07 km from the nearest other pair observed, precluding the possibility of ‘egg dumping’ by a neighbouring pair. The eggs could be seen and counted clearly from the helicopter at 50–70 m altitude. No Brolga nests contained eggs. One young Australian Sarus Crane was seen close to a nest and six young Brolgas were seen at or close to five nests (Table 1). Although disturbed chicks ‘hid’ in grass or sedge near nest sites, they were often still visible from the air (Figure 2c).

Table 1. Number of nests, eggs and chicks of Australian Sarus Crane (ASC) and Brolga, surveyed by helicopter in the Gulf Plains, north-western Queensland, on 19 February 2017. There were also 13 vacated nests (species unidentified). C/x denotes clutch size.

Species	ASC	Brolga
Nest with eggs	3 (1 x C/3, 2 x C/2)	0
Nests attended by adults, empty	5	6
Adult/s with 1 chick:		
at nest	0	4
not at nest	1	1
Adult/s with 2 chicks:		
at nest	0	2
Total nesting records	9	13

Nest locations and habitats

Of the 35 nest records, eight were in Area 1 (all Brolgas); one was in Area 2 (unidentified); and 26 were in Area 3 near the homestead (nine Australian Sarus Crane, five Brolga and 12 unidentified). All nest sites were on active floodplains and either in, or immediately adjacent to, waterbodies, but varying in distance from the closest identified permanent or semi-permanent waterbody (Queensland Government 2023). In Area 3 near the Delta Downs homestead, half the nests directly adjoined a freshwater source (one Australian Sarus Crane, five Brolga and seven unidentified), and 13 were within 500 m of fresh water (eight Australian Sarus Crane and five unidentified). The single nest sighted in Area 2 was ~425 m from fresh water. Only Brolgas nested

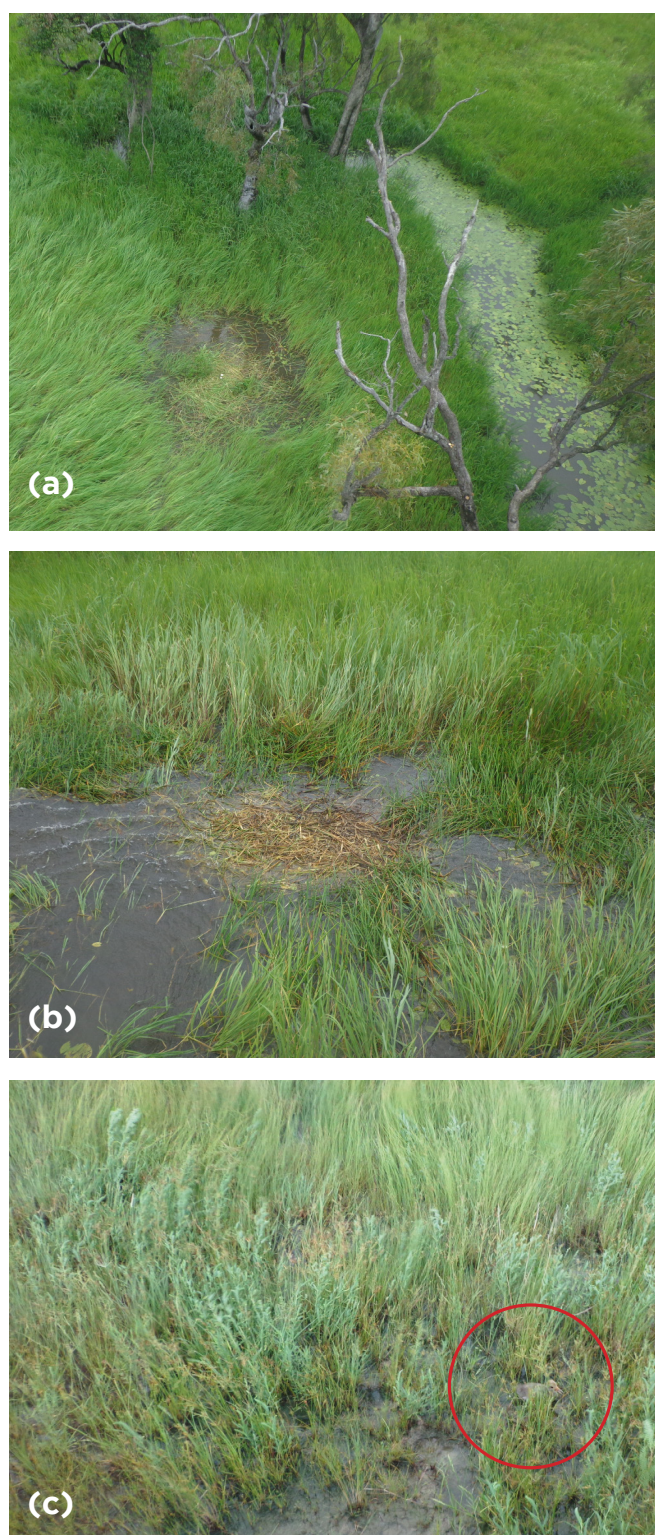


Figure 2. Nests photographed from helicopter on Delta Downs Station, Gulf Plains, on 19 February 2017: (a) Australian Sarus Crane nest, (b) Brolga nest, (c) Brolga chick (outlined). Photos: Timothy D. Nevard

adjacent to the tidal zone (Area 1), where two nests were in small freshwater swamps within salt pans; three were within 750–1610 m of an identified source of fresh water; and for three nests, the nearest identified water source within 600–1800 m was hyposaline (i.e. fresher than seawater). On average, Brolga nest sites were further from an identified water source (average 605 m) than Australian Sarus Crane nest sites (average 325 m). No estimates could be made of territory size, but the two closest Brolga



Figure 3. Suspected woody weed growth on floodplain north-east of the Delta Downs homestead, photographed from helicopter on 19 February 2017. Red circle identifies a representative area of the suspected weed. Photo: Timothy D. Nevard

nests in Area 1 were ~210 m apart, and the two closest in Area 3 (both unidentified to species) were ~350 m apart.

Only Brolgas nested in treeless tussock grassland (eight nests: Table 2), with two nests in sparsely treed savanna and three in woodlands. All Australian Sarus Crane nests were in habitats with trees, five in woodlands and four in savanna. Although the substrate could not be sampled during this trial survey, eight nests (seven Brolga and one unidentified) recorded along the flightpath transect in Areas 1 and 2 (Figure 1), are likely to be on a saline substrate, rendering any standing water slightly brackish at the height of the wet/breeding season.

In Area 3, only two nests were sighted east of the north–south Delta Downs management road, whereas surveys in 1984 found nests of both species evenly distributed east and west of the road (Archibald & Swengel 1987). We photographed what appeared to be weedy shrub growth, apparently covering a significant area east of the road (Figure 3). Satellite imagery (Queensland Globe 2024: February 2024) suggests that it extends north-east to cover ~150 ha.

Discussion

Nest habitats, timing and clutch size

Types of nest habitat noted in this trial survey were consistent with breeding-territory habitats identified by Sundar *et al.* (2019) across three Gulf catchments in the same breeding season, with Brolgas occurring mainly in more open habitats (but some in woodlands), whereas most Australian Sarus Cranes nested in woodlands. This pattern was also observed during roadside surveys later in the breeding season (Nevard *et al.* 2024). The avoidance of treeless areas by nesting Australian Sarus Cranes is supported by observations that their nests are often at the base, or in the shade of, a tree (Archibald & Swengel 1987; Beruldsen 1997) but there have been no systematic studies of the characteristics of Australian Sarus Crane

Table 2. Habitat types of nest sites ($n = 35$) surveyed by helicopter in the Gulf Plains, north-western Queensland, on 19 February 2017. ASC = Australian Sarus Crane; BVG = Broad Vegetation Group; No ID = unidentified to species.

BVG	Description	Number of nests		
		ASC	Brolga	No ID
Grassland				
32a	Tussock grassland adjoining tidal zone	0	8	0
Savanna				
32a	Tussock grassland with a few eucalypts	4	2	5
Woodland				
16b	Mixed <i>Eucalyptus</i> grassy woodland on sandy levees	1	1	0
16c	Mixed <i>Eucalyptus</i> grassy woodland on floodplains	4	2	6
22c	<i>Melaleuca</i> woodland fringing watercourses	0	0	2
Total		9	13	13

nest habitat. Salinity at crane nesting sites has not been investigated in the Gulf and our records of Brolga nests on saline substrates are apparently the first for the region. Roadside surveys also found that Brolgas were the only species to occupy saline habitats (Nevard *et al.* 2024). Near Townsville, North Queensland, some Brolgas were recorded nesting on brackish swamps (Blackman 1983), presumably facilitated by their nasal gland which excretes salt, unique among cranes (Hughes & Blackman 1973). Blackman (1983) also noted that Brolgas nesting in brackish swamps had larger territories than those nesting in freshwater swamps. The relatively long distances of six of the eight Brolga nests in Area 1 from an identified semi-permanent fresh (or hyposaline) water source, suggest the possibility of comparatively large territory sizes as noted by Blackman (1983) near Townsville.

Weed infestations in the Gulf Plains are poorly known, yet could exert a significant influence on crane breeding and are therefore a priority for crane conservation. Areas of the Gulf Plains with high water tables, as in the Gilbert catchment, are at high risk of infestation with e.g. Rubber Vine *Cryptostegia grandiflora*, even away from water courses (Mackey 1996). The area of suspected weed growth noted above was not recorded in 1984 and requires onground investigation to identify species and extent, encompassing a discussion with the management team of Delta Downs and Normanton Land and Sea Rangers regarding control plans and presence of any additional infested areas. Lance Rapson (pers. comm.) also reported that by 2023, unlike during the 1984 survey, there were now anecdotal reports of higher numbers of both crocodiles and feral pigs *Sus scrofa domesticus* potentially disturbing or predating crane nests, which needs to be investigated further.

The staggered timing of nesting identified by Sundar *et al.* (2019) and in this trial survey is a key factor in understanding the breeding ecology of both crane species in the Gulf Plains. Staggered timing also affects planning for nest surveys in the region (see below). Sundar *et al.* (2019) found that on average Brolgas in the Gulf consistently nested earlier than Australian Sarus Cranes, which for unknown reasons nested over a longer period. However, there is no indication of which species might have occupied the completed nests observed in this trial survey; at the time these nests were presumably initiated,

equal numbers of both species began nesting in the Gilbert catchment (Sundar *et al.* 2019). The three-egg Australian Sarus Crane clutch identified in this trial survey is the first recorded for the Australian Sarus Crane and supports the conclusions of Scambler *et al.* (2020) that successful three-egg clutches are the likely source of two observations of Australian Sarus Crane pairs attending three young on the Atherton Tablelands. One of these observations was in October 2017 and was either the same pair observed in the current study, or there were additional three-egg clutches.

Survey techniques

Subject to overcoming constraints of timing and costs, we consider helicopter survey to be an effective and efficient method for studies of cranes nesting in the Gulf Plains, given the unsuitability of other forms of aerial survey, difficult accessibility in the wet season, and safety considerations inhibiting ground surveys. In 3 hours in the vicinity of Delta Downs homestead the trial helicopter survey located one-third of the number of nests found in a month of foot surveys in 1984. All occupied nests, including those in woodland and on coastal plains inaccessible by road, were identified to species and nest contents recorded. However, clutch sizes or chick numbers were recorded for only half the occupied nests, as the remaining pairs were yet to lay. Together with the number of completed nests observed, this underlines a requirement for repeated surveys covering more of the nesting season, especially for Australian Sarus Cranes, which lay over a prolonged period (Sundar *et al.* 2019).

Although the cost of operating available landscape-scale drones (\$440–880/day: S. Nowakowski pers. comm.) is significantly less than for small helicopters (e.g. Robinson 44, \$3600–4500/day: R. Jackson pers. comm.), the potential for using drones to survey nests in the Gulf Plains during the wet season is severely constrained, as they have a maximum consistent operational limit of ~5 km (with no interference) and hence require readily accessible tracks to cover a large area from different multiple sites. Another serious constraint could be the recovery of a downed drone, as trees in the Gulf Plains inhibit line of sight and hence its location, and crocodiles are able to move

across virtually the entire landscape. Notwithstanding cost, this makes helicopter charter significantly more feasible, especially as piloting expertise in the Gulf Plains (gained from cattle mustering) is ideal for surveying crane nests. Johns (2010) made helpful comments on methods for surveying crane nests by helicopter, based on experience in North America. To minimise disturbance while locating nests, approaches were limited to the downwind side, facing 45° to incubating birds, at ~300 m above ground level. Once a nest was identified, the helicopter slowly descended towards the occupying bird, which usually stood when approached. If the bird did not stand, the pilot turned the helicopter towards the nest to direct rotor noise towards the bird. Once incubating birds were standing, the helicopter observers used binoculars (image-stabilised, 10× magnification) to determine clutch size.

The area surrounding Delta Downs homestead has iconic status as the first known significant nesting site for the Australian Sarus Crane and, importantly, has an historical baseline against which new surveys could be compared. Additionally, the coastal tussock grasslands *en route* to the homestead are remote from roads and in the wet season can be surveyed only from the air. We recommend that, in collaboration with the Kurtjar Aboriginal Corporation, at least one season of nest surveys should be conducted at these sites. As Australian Sarus Cranes commence nesting over several months, three 6-hour survey days, approximately monthly over 3 months are recommended, commencing c. 3 weeks after the first major rains, when nest initiation begins (Sundar *et al.* 2019). Helicopter surveys could be extended to study other focal sites identified as important for Australian Sarus Crane nesting and conservation in the Gulf Plains.

Acknowledgements

We thank the Kurtjar Aboriginal Corporation for welcoming and assisting this International Crane Foundation (ICF) trial survey of their Delta Downs Station properties, and Kurtjar traditional owner Lance Rapson (Normanton Land and Sea Rangers) who participated in the flights. Jennifer Speers, an ICF benefactor, generously sponsored the project and provided ground support, assisted by Ben Blewitt (Sicklebill Safaris). Richard Baker's exceptional piloting skills were essential to the success of the trial survey. We also thank Charles Carlow of Wild Bush Luxury for arranging the logistics, Richard Jackson (aviation consultant) for advice on helicopter costs, Steven Nowakowski (commercial drone operator) for drone cost and operational advice, John D.A. Grant for permission to cite unpublished data and Glenn Ehmke (BirdLife Australia) for investigating Nest Record Scheme archives. We are grateful to John D.A. Grant, Richard Loyn and Peter Valentine for helpful advice on revising the manuscript. This research was conducted under Queensland Department of Environment & Science Scientific Research Permit: WISP13984714.

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Received 9 April 2024, accepted 12 July 2024,
published online 30 August 2024

