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2. Research update: Australian Sarus Cranes *Antigone a. gillae* and Brolgas *A. rubicunda*

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Plate 1. A (left), Brolga at Diamantina Lakes, Lake Eyre Basin (Graham Winterflood); B (right), Sarus Cranes, Atherton Tablelands (John D.A. Grant)

Introduction

Almost all records of Australian Sarus Crane *Antigone antigone gillae* (Plate 1B), and all known breeding sites, are in Queensland (Mirande & Harris 2019; Sundar *et al*. 2019). Based on four surveys over different areas of Queensland in October 2008 (National Waterbird Survey, Kingsford *et al*. 2012; Eastern Australian Waterbird Surveys, 2019; Scambler *et al*. 2020a; ECS unpubl. data), at least 13,780 Brolgas *A. rubicunda* (Plate 1A) are found in Queensland, approximately 14% of the maximum estimated national (and global) population of 100,000 (Mirande & Harris 2019). Unusually in such closely-related crane species, the two species are sympatric in northern Queensland, a fact that has inspired a number of interesting questions since Sarus Cranes were first formally identified in Australia in 1966 (Gill 1969; Archibald & Swengel 1987). Until recently, most knowledge of the Australian Sarus Crane dated from nearly thirty years ago (Marchant & Higgins 1993), and research on Brolgas focussed on the remnant threatened population of south-eastern Australia.

Two recent reviews have addressed the status of Sarus Cranes and Brolgas. Mirande & Harris (2019) gave a blueprint for crane research and conservation action for all the world's fifteen crane species, but a number of significant papers and project data were not available before the draft publication date. The latest *Action Plan for Australian Birds* (Garnett & Baker 2021) includes the most recent research on the Australian Sarus Crane.

The purpose of this review is to provide a summary of recent papers which have provided important data on the ecology of the Sarus Crane and Brolga in Australia, particularly Queensland. Secondly, it draws attention to some remaining knowledge gaps and new work in progress. The final section is a review of eBird data for Brolgas and Sarus Cranes, with suggestions for using eBird most effectively to support crane research and conservation.

Recent literature

In the last few years important contributions have been made to knowledge of Australian cranes, after a long period with limited progress. A major research focus has been on the populations of Brolgas and Sarus Cranes which congregate on the Atherton Tablelands in the dry, non-breeding season and are presumed to breed in the Gulf Plains. Techniques in genetic and spatial analyses and satellite tracking have been applied to Australian crane populations for the first time, with significant findings for both species.

To encourage readers to access research materials, papers made freely available online by publishers and authors are noted [F] in the Reference list, with links. Other papers cited may be available through searches, e.g., Google Scholar or ResearchGate.

- Jackson *et al*. (2016) recorded at least 3,870 Brolgas flying to roost in the Greater Mapoon area, western Cape York Peninsula (CYP), while conducting shorebird surveys in 2015. Significant sightings at Mapoon were made previously by the 2008 aerial National Waterbird Survey (Kingsford *et al*. 2012), though not referenced by Jackson *et al*. (2016).
- Nevard *et al*. (2018) found flocks of Brolgas and Sarus Cranes on the Atherton Tablelands feeding on crop stubble after harvest, but at times they fed on newly planted grains. Farmer attitudes were surveyed through questionnaires and interviews. Overall, farmers tolerated cranes but crop losses were concerning, and illegal persecution (poisoning) has occurred in the past. Many farmers were turning to perennial horticulture or tree crops which give much greater financial returns than do grains. This may reduce the number of cranes wintering in the area but may also increase damage (and the potential for conflict) on remaining annual crops.
- Miller *et al*. (2019) conducted genetic analyses of blood, tissue and feather samples from southern and northern populations of Brolgas, which provided evidence of limited gene flow between the populations. More work is indicated to explore the extent of breeding separation.
- Nevard *et al*. (2019) analysed spatial and temporal aspects of the foraging behaviour of Brolgas and Sarus Cranes wintering on the Atherton Tablelands. Some feeding sites were shared, but Sarus Cranes fed more in the central Tablelands on fertile volcanic soils, previously occupied by rainforest and wet sclerophyll forest, including the Atherton Tablelands Key Biodiversity Area (KBA, established based on early results of Scambler *et al*. 2020a: see below). Brolgas were more abundant on poorer soils to the north-west and south-west of the KBA. Sarus Cranes fed further away from roosts than Brolgas. Both species were considered adaptable and likely to seek new wintering areas if disadvantaged by land use changes on the Tablelands. See also Nevard (2019).
- Sundar *et al*. (2019) conducted surveys of both species in the Gulf Plains, immediately following the 2017 breeding season. Nesting was initiated by the first significant rainfall of the season in each catchment, and breeding success (adults with newly-fledged young) was the highest reported globally: 60% for Sarus Cranes and 50% for Brolgas. Breeding habitats often overlapped but Sarus Cranes preferred wetlands in wooded sites and Brolgas favoured more open grassland. Analysis of moulted feathers showed that in the breeding season, Sarus Cranes fed mostly on grasses while the Brolgas' diet included plant tubers and animal foods.
- Veltheim *et al*. (2019) used satellite transmitters to track eleven pre-fledged Brolga chicks, which moved 442 m on average, to and from night roost wetlands (range: 0 m–1964 m). The home range area of breeding Brolga pairs averaged 232 ha, and pairs with unfledged young used an average of 2.8 wetlands in the fragmented Victorian wetland landscape. The study recommended that buffers for building infrastructure including wind farms should take account of territory extent and movement corridors within each territory (see also Veltheim 2018).
- Nevard *et al* (2020a) performed genetic analyses of blood samples and shed feathers and showed hybridisation between the two species occurs significantly more often than evident from field

observations. The evolutionary trajectory and conservation implications are still uncertain. Although long-suspected, migration between the Gulf Plains breeding grounds and the Atherton Tablelands wintering area was also proven for the first time by genetic analysis of feathers.

- Nevard *et al*. (2020b) conducted genetic analyses that supported the recognition of the Australian Sarus Crane as a distinct subspecies, possibly more closely related to the extinct Philippines Sarus Crane than to extant populations in Asia. This contradicted the former view that different populations of Sarus Crane in Asia and Australia were simply clinal forms.
- Scambler *et al*. (2020a) analysed 21 years of annual Birdlife Northern Queensland Crane Counts at communal night roosts on the Atherton Tablelands. Annual numbers were highly variable for both species, but the Australian Sarus Crane population was estimated to number at least 3,255, representing 19.5% of the estimated global population. The study showed that Sarus Cranes were mostly concentrated in the central, more fertile Tablelands while Brolgas roosted mostly in areas of poorer soils to the north-west and south-west of the KBA. Sarus Cranes tended to arrive much later at night roosts than Brolgas, and at shared roosts, groups of the two species usually mingled (rather than separating into different areas), which is unusual at mixed-species wintering crane roosts (e.g. Pae & Won 1994; Jia *et al*. 2019). The arrival of cranes in failing light affects identification and while night optics may help improve the reliability of identification, the authors provide a method to enable data on unidentified cranes to be used in population estimates.
- Scambler (2020) scrutinised the personal records of pioneer farmer-ornithologist Jim Bravery in the (former) Atherton Shire to reveal new information about Tablelands cranes. At least 1,000 Brolgas were apparently present by 1920, only decades after significant clearing for agriculture began on the Tablelands. Probably 1,500 cranes were present in the early 1970s, some 30% Sarus Cranes and 70% Brolgas. Average numbers are much the same today but the species balance has since reversed, with Sarus Cranes now greatly in the majority. The paper includes mapping of habitat change in woody wetlands south of Atherton, which was previously significant habitat for roosting Brolgas but has since been largely drained and cleared. This may have contributed to the changed species balance in what is now the KBA.
- Scambler *et al*. (2020b) reported the first observations of pairs of Australian Sarus Cranes apparently supporting three young ('triplets'). A review of clutch size in the Sarus Crane and Brolga suggests that successful clutches of three eggs (*vs* the normal two) are more likely to explain apparent 'triplets' than adoption of additional chicks.
- Dunne & Scambler (2020) described predation of eggs of an Australasian Grebe *Tachybaptus novaehollandiae* by a Brolga, representing the first report of egg predation by cranes in Australia.
- Veltheim *et al*. (2022) tracked local migration by 23 Brolgas of different age classes in the threatened south-eastern Brolga population, over two breeding and non-breeding seasons. Some Brolgas remained resident but in the non-breeding season some moved as far as 111 km from their breeding sites.

Knowledge gaps and current research

Research on a number of the above projects is ongoing in Queensland. The Gulf breeding study (Sundar *et al*. 2019; J.D.A. Grant unpubl. data) surveyed more areas of the Gulf in 2018, 2019 and 2021 and is ongoing. Using moulted feathers, Tim Nevard is expanding work on crane migration patterns between the Gulf Plains and the Tablelands, and is applying this technique to study the New Guinea Brolga population including possible migration to Australia. He is also studying potential past Sarus/Brolga introgression, and crane relationships with agricultural development in PNG. John Grant records annual recruitment in Atherton Tablelands Sarus Cranes (see Grant 2005) and is in the process of integrating this long-term (25-year) dataset with environmental data to tease apart the influences of variable rainfall and flooding regimes on breeding success. His records of landscape use by Sarus Cranes and Brolgas on the Atherton Tablelands also extend back for two decades and may allow an analysis of the effects of changing

land use. Elinor Scambler, Mary Barram, Margie Barram and Rebecca Enright are working on the history of significant Brolga flocking sites in Queensland and their current status.

Skye Davis has begun a PhD study through Macquarie University in collaboration with the University of New South Wales, entitled "Informing the conservation of Australia's waterbirds from genetic connectivity analyses and eDNA". For Brolgas, the study will examine genetic connectivity between northern and southern populations and explore the influence of current and future landscape features on gene flow. Genetic data will be obtained by employing a next-generation sequencing approach on DNA extracted from naturally-discarded feathers. Study results will be used to inform conservation plans, particularly for threatened southern Brolga populations. Brolga feather samples were collected previously for the Feather Map of Australia (ANSTO 2020; UNSW 2020) and Skye's project is seeking more samples from Queensland, NT and WA. To contribute by collecting Brolga feathers, contact Skye (k.skye.davis@gmail.com) or Kate Brandis (kate.brandis@unsw.edu.au).

BirdLife Northern Queensland continues to conduct an Atherton Tablelands Crane Count each September. Wetland surveys including Brolgas are conducted by BirdLife Capricornia at Kinka Beach and by BirdLife Townsville at the Town Common and Wongaloo (Cromarty) wetlands. Research updates on Australian cranes are posted on the Australian Crane Network site, Ozcranes http://ozcranes.net/.

Key areas for conservation attention can be found in Mirande & Harris (2019) and Garnett *et al*. (2021). Some remaining knowledge gaps:

- Nests and eggs of Australian Sarus Cranes are virtually unknown; many features such as incubation period and time to fledging are based mostly on overseas data.
- Diet studies for both species Australia-wide are minimal. Brolgas can tolerate saline water with a special gland (Hughes & Blackman 1973), but no study has systematically measured salinity in water and foods they actually use.
- Characteristics of roost sites selected by Sarus Cranes, compared with Brolgas, on the Atherton Tablelands are not understood.
- Brolgas have been recorded in Torres Strait but it is not known if they migrate to New Guinea
- Sarus Crane breeding is strongly suspected on eastern CYP, e.g., at Rinyirru (Lakefield) National Park, but not yet proven.
- Movements of large numbers of Brolgas in response to arid region rains and droughts (e.g., in the Lake Eyre Basin), are not understood.
- Current status of Brolga breeding in the historically important Townsville/Ayr region is unknown
- The number of Sarus Cranes remaining in the Gulf Plains or on CYP in the non-breeding season (rather than migrating to the Atherton Tablelands) is unknown.
- There are two social models for Australian crane populations in the non-breeding season: to spread out widely across a region in pairs, family parties or small groups; or to concentrate in particular areas with foraging flocks and communal night roosts. Major Queensland flocking sites for Brolgas are largely undocumented, and the Atherton Tablelands is the only known flocking concentration of Australian Sarus Cranes.

Using eBird to support crane research and conservation

Recording personal surveys in eBird is valuable. Incidental volunteer records may not be the sole source of data, but they supplement detailed studies and indicate new areas for enquiry. Queensland eBird data for Brolgas and Sarus Cranes in 2018 were chosen to illustrate how eBird can best support crane research and conservation.

Brolga records

After removing duplicates, 914 Brolga records were contributed to eBird in 2018, of which 97% reported numbers. As above, the social structure of many crane populations in Australia is not well known, and group or flock size is useful information. Flock numbers also help to assess the importance of different locations and habitats as flocking sites which support concentrations of Brolgas in the non-breeding season. Observers can record multiple crane flocks while travelling long distances by entering GPS details for each flock recorded, or entering an accurate location name (e.g., 'Bromfield Swamp') which allows data users to infer the correct coordinates. Surveys that recorded all species totalled 786 (86% of records), but incidental records of cranes only (excluding other species) are also useful.

Compared with the known distribution of Brolgas in Queensland, eBird records for 2018 were highly skewed. Forty-three percent (394 records) were in the Brigalow Belt North (BBN) Bioregion, of which 284 were at the Townsville Town Common (72% of BBN records and 30% of all Queensland Brolga records for 2018). This reflects regular monthly surveys by BirdLife Townsville and multiple visits by individuals. The highest number recorded at the Town Common was 24 Brolgas. More than 58% of Queensland was drought-affected in 2018 (State of Queensland 2020). Large Brolga flocks were recorded at two drought-declared locations: 357 on fields along the Warrego River at Cunnamulla (Mulga Lands Bioregion) and 320 at Spoonbill Road, Clermont (BBN). Other high counts were recorded in the Gulf Plains, north of the 2018 drought zone: 500 at Karumba and 350 at the Bynoe River Crossing near Normanton.

Sarus Crane records

EBird volunteers contributed 210 unique Sarus Crane records in Queensland in 2018, with 68% on the Atherton Tablelands, mostly in the KBA, 25% in the Gulf Plains, and the remainder on CYP. Fourteen (6.7%) records were presence-only, mostly at Tablelands locations where a count would have been possible.

Unidentified cranes

Distinguishing Brolgas and Sarus Cranes can be difficult in poor light or in the distance; sometimes part or even all of a flock cannot be identified to species. This issue was recognised in 1997 for the BirdLife Northern Queensland annual Crane Count, which has always recorded Brolga, Sarus Crane, or Unidentified crane (Scambler *et al*. 2020a). In 2011 BirdLife introduced a new category 'Crane sp.' to accept unidentified crane records in Birdata, but it remained unused. Fortunately, the category also exists in eBird and is now being used to enter both current and historical records. To June 2021, 55 unique 'Crane sp.' records had been contributed to eBird. These ranged from a few birds to over 200, many in mixed flocks with Brolgas, Sarus Cranes or both. The largest mixed flock was of 300 cranes, 200 of which were unidentified and would not have been reported if identification to species were mandatory.

Significant sites

An accepted standard for a significant site, locality or region is that it regularly supports 1% or more of the national or global population of a species. However, where the population has an estimated range rather than a single figure, there are different methods to calculate the 1% threshold. In practice, Mirande & Harris (2019) allow 1% based on the minimum population estimate for a crane species. Wetlands International (2012) use the maximum of the estimated range (e.g., for RAMSAR site reviews such as Cape

Bowling Green: Driscoll et al. 2012), but for new or revised thresholds, they apply the geometric mean. To simplify the application of thresholds given these different international treatments, and bearing in mind that Sarus Cranes have a minimum of two threshold numbers, national and global, Scambler et al. (2020a) applied the geometric mean for all thresholds for both Australian crane species. All methods use rounding rules when calculating 1% thresholds.

What does this mean for eBird users? For Brolgas, the Australian population is treated as the global range: 50,000–100,000 (Mirande & Harris 2019). The global and Australian populations of Sarus Crane are estimated as 13,550–20,650, and 5,000–10,000 respectively (Mirande & Harris 2019). The various 1% thresholds are shown in Table 1.

Table 1. One percent (1%) population thresholds for Brolgas and Sarus Cranes

Species (populations)	Method of calculation		
	***Minimum*[1]**	***Maximum*[2]**	***Geometric mean*[3]**
Brolga (global & national)	500	1000	710
Sarus Crane (global)	140	210	170
Sarus Crane (national)	50	100	70

[1]Mirande & Harris (2019); [2]Wetlands International (2012) WPE5; [3]Wetlands International (2012) new/ revised; Scambler *et al*. (2020a).

In 2018, only one Brolga record in Queensland (500 at Karumba) was ≥1% of the global population, and only by the 'minimum' method' (Mirande & Harris 2019). Of 196 Sarus Crane records which gave numbers, one Tablelands site in the KBA reported 325, globally significant by all methods, and a nearby site reported 200 on two occasions, globally significant by the 'minimum' and 'geometric mean' methods. Of the remaining 193 records, seven (ranging from 50 to 137 birds) were nationally significant by at least one method, four on the Tablelands and three near Normanton and Karumba in the Gulf Plains.

Conclusion

In summary, eBirders can best support crane research and conservation if they report numbers and use the 'Crane sp.' tool for unidentified cranes. In addition, it is important to recognise that a sighting of as few as 50 Sarus Cranes can be nationally significant, and 140 can be globally significant. For Brolgas, the heavily-skewed reporting from a few well-studied, popular sites suggests that they may sometimes be regarded as too common to inspire record-keeping. Due to knowledge gaps on the social structure of Queensland Brolgas, and on major flocking sites, eBirders should be encouraged to be 'Brolga-conscious' on their travels. Given the complexity of applying all three 1% threshold methods to determine 'significant' sightings, the Queensland Bird Report could adopt one explicit method for assessing Brolga and Sarus Crane records in the bioregions.

Plate 2. Brolgas in sorghum between Clermont and Mazeppa, a major Brolga flocking site in central Queensland (Bob and Olive McTrusty).

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