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Front cover: Egrets in a freshwater riverine colony, Gulf Plains. Photograph by Normanton Land & Sea Rangers, Carpentaria Land Council Aboriginal Corporation.

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THE BIRDS OF REMNANT FOREST RED GUM (*EUCALYPTUS TERETICORNIS*) FOREST

GEOFFREY C. SMITH & LUKE D. HOGAN

ABSTRACT

Bird surveys were conducted in remnant ecosystems comprising forest red-gum (*Eucalyptus tereticornis*) forest and woodland on alluvial plains in Regional Ecosystems 11.3.4 and 12.3.3. Surveys conducted across six sites for a period spanning 10 years produced a list of 124 species. Ninety-three species occurred on all (*n*=6) of the 2-ha survey plots combined. The remaining 31 species were recorded either off-site or as incidentals from plots beyond standard survey events. Mean estimated density of species was 10.2/ha (range 6.5–19). The average density of individual birds was 19.8/ha (range 7 –35.5). Approximately half of the species were recorded five or fewer times over the 10-year study. Many of the species (e.g., lorikeets and honeyeaters) have broad home ranges, utilising the food resources of these ecosystems as they become available seasonally. Hollow-nesting and/or nectar-feeding parrots, particularly the Sulphur-crested Cockatoo (*Cacatua galerita*), Rainbow Lorikeet (*Trichoglossus haematodus*), Scaly-breasted Lorikeet (*T. chlorolepidotus*) and Little Lorikeet (*Glossopsitta pusilla*), were the most abundant species. Nectar- and insect-feeding honeyeaters, comprising 15 species, were recorded consistently. The 'near threatened' Black-chinned Honeyeater (*Melithreptus gularis*), a shy species, was detected on eight occasions. Other species detected (and known to be in decline in southern Australia) included the Speckled Warbler (*Chthonicola sagittata*) and Grey-crowned Babbler (*Pomatostomus temporalis*), albeit in low numbers. Noisy Miners (*Manorina melanocephala*) were noted at three of the six sites. Despite their presence at one of these, species richness and density of birds were comparably highest, most likely because of a complex shrub layer. We found no other published data on the diversity and density of birds in comparable habitats against which to compare our measures. However, our estimates were low compared with those of other forests and woodland types in south-east Queensland. Forest red-gum forests and woodlands on alluvial soils occur in the most nutrient-rich part of the landscape, providing high value habitat for hollow nesting species, as well as seasonal nectar and insect resources for a range of bird species. Therefore it is surprising that diversity and density were comparatively low. While we cannot rule out other factors, it is possible that the reduced size and connectivity of remnants of these ecosystems have negatively affected bird populations.

INTRODUCTION

Open forest red-gum (*Eucalyptus tereticornis*) forests and woodlands on alluvial soils have been extensively cleared in eastern Australia to provide areas for grazing cattle. In September 2009, remnants of these ecosystems in the Southeast Queensland Bioregion occupied less than 10% of their pre-clearing distribution and are currently listed as endangered (*Vegetation Management Act 2009*).

Mature, intact *E. tereticornis* stands offer a range of resources for bird fauna. These include, but are not restricted to, provision of hollows in trees, used for nesting by hollow-dependent species (Gibbons & Lindenmayer 2002), fallen woody debris (MacNally *et al.* 2002; Hannah *et al.* 2007) and nectar from flowers. Importantly, *E. tereticornis* flowers seasonally, with nectar abundant from July to November (Blake & Roff 1988), when other food resources may be scarce (White 1999; Dobson *et al.* 2005; Smith *et al.* 2007). Efforts to protect and rehabilitate these ecosystems will contribute to the conservation of species dependent on them.

Regional Ecosystems (REs) are vegetation communities described on the basis of bioregion, geology, landform, type of soil and plant species composition, particularly in the uppermost plant layer (Sattler & Williams 1999). REs have been the foundation of vegetation planning and management in Queensland (*Lands Act 1994*; Anon. 1997; *Vegetation Management Act 2009*). There have been few published studies of the bird communities of individual REs (e.g., Eyre *et al.* 1998; Woinarski & Catterall 2004), although unpublished Environmental Impact Studies incorporate lists for REs. Readily available information on the birds that are typical of these ecosystems is scarce. Information such as this is useful for providing targets by which to assess the success of revegetation and ecosystem management projects .

A relatively small revegetation project on cleared pasture on alluvial soils, formerly vegetated with *E. tereticornis* forests and woodlands, is being undertaken in mid-east Queensland, to offset areas of intact *E. tereticornis*-dominated communities in REs 11.3.4 and 12.3.3 that were affected by the raising of the Awoonga Dam (near Gladstone) in 2002 (T. Lewis personal communication). We have been monitoring changes to the fauna of planted and rehabilitating offsets as they develop toward ecosystem maturity. This study of the bird communities of remnant patches of REs is a component of a larger project that is currently in progress. The aim of the study is to establish baseline data on the bird communities of relatively intact ecosystems in order to appraise revegetation efforts .

STUDY AREA AND METHODS

Study Area

Sites were located in two biogeographic regions: the Brigalow Belt South Bioregion (Bioregion 11) and the Southeast Queensland Bioregion (Bioregion 12) (Figure 1). The Brigalow Belt Bioregion is large, extending from northern New South Wales to the Townsville area. It contains a landscape mixture that includes undulating hilly areas with low ridges, deep valleys and alluvial plains (Young *et al.* 1999). Mean annual rainfall is in the 449–1015 mm range. Major vegetation types include mixed eucalypt woodland, brigalow scrub and Mitchell grass plains. The Southeast Queensland Bioregion occurs along the coastal lowlands and into the adjacent hills and ranges from the New South Wales border to just north of Gladstone (Young & Dillewaard 1999). Within this region, mean annual rainfall varies between 800 and 1500 mm. Major vegetation types include rainforest, vine thicket, tall open eucalypt forest, eucalypt open forest and woodland.

Six survey sites were established in *E. tereticornis* remnants within these bioregions. Two of these sites (Dan Dan Scrub and Bunyip Hole) were located in the Brigalow Belt Bioregion. One site (Rosedale) was located on the border between the two bioregions. The remaining three sites were located in the Southeast Queensland Bioregion. Sites were variously surveyed over a 10-year period in March, May or November to make a total of 14 surveys. Site locations and survey years are as follows: Site 1 – Rosedale (24.2°S, 151.3°E), surveyed in 2007, 2009, 2011 and 2013; Site 2 – Bunyip Hole (25.0°S, 151.1°E) in Abercorn State Forest (SF) near Monto, surveyed in 2009 and 2013; Site 3 – Goomeri (26.2°S, 152.1°E), adjacent to Nangur Creek, near the township of Goomeri, surveyed in 2009, 2011 and 2013; Site 4 – Tarong SF (26.7°S, 151.9°E) near Nanango, surveyed in 2009, 2011 and 2013; Site 5 – Imbil SF (26.5°S, 152.6°E), surveyed in 2009; and Site 6 – Dan Dan Scrub (24.2°S, 151.1°E), surveyed in 2003 (Figure 1).

Methods

A bird survey in any one period at a site was comprised of two diurnal bird survey events (an early and a late census), one nocturnal playback event and a 30 minute nocturnal spotlight event. Early diurnal survey events were conducted within 2 hours of dawn and late survey events between 2–4 hours after dawn. These were based on a 200 x 100 m (2 ha) plot. The observer traversed a 200 m long line down the centre of the plot over a period of 30 minutes. Birds were recorded as either on-site (i.e. estimated to be within 50 m of the centre line) or off-site, if detected beyond the plot boundary. Incidental sightings of species not encountered during survey periods but which occurred on each plot were also recorded; these were not included as on-site records. Nocturnal call playback events (bird call broadcast) were undertaken within 2 hours of sunset at each site. The calls of three forest owls known to occur across the study area were broadcast at each site/survey period at the 0 m point of the 200 m transect. Calls included those of the Powerful Owl (*Ninox strenua*), Barking Owl (*Ninox connivens*) and Masked Owl (*Tyto novaehollandiae*). Each playback session was preceded by a 10-minute listening period, after which three minutes of call broadcast, followed by a 2-minute listening period was conducted for each species consecutively. This was followed by a 30 minute spotlight survey event along the 200 m transect. All nocturnal and diurnal species seen or heard were recorded.

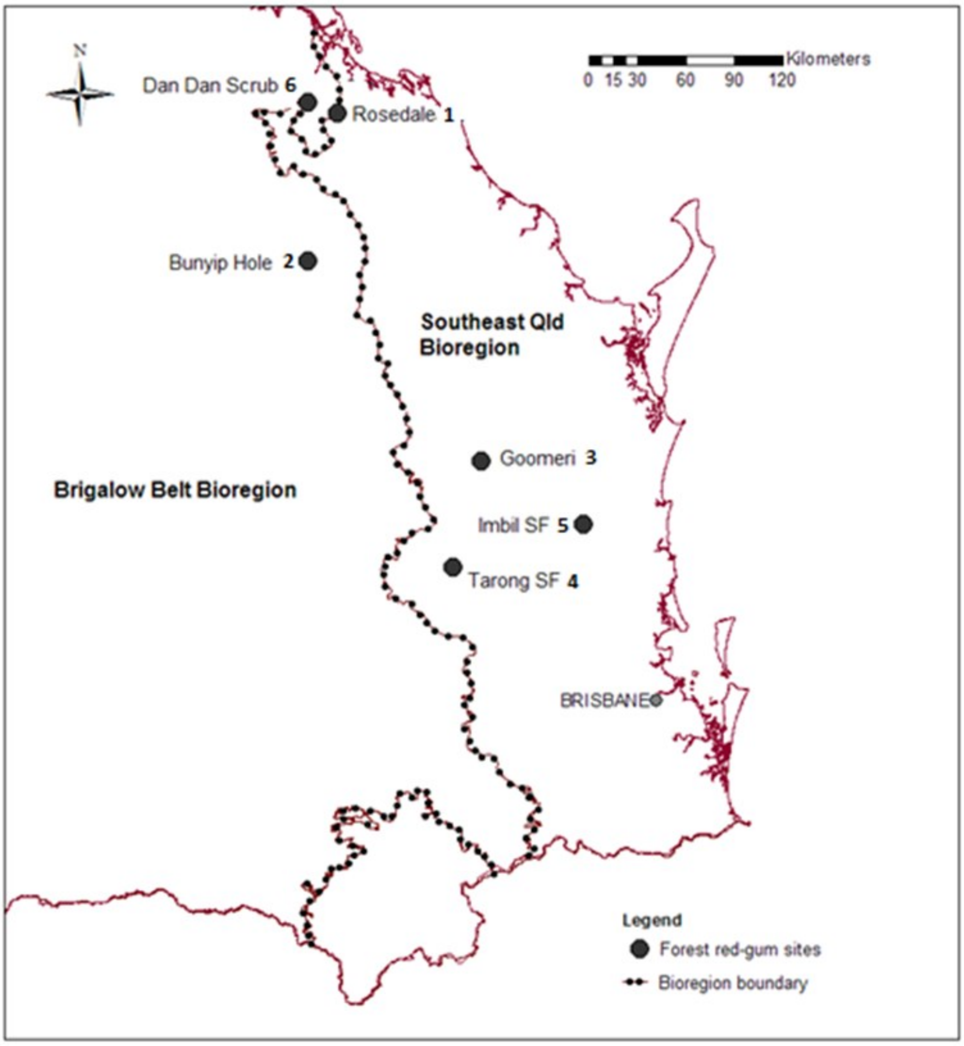

Figure 1. Map showing locations of sites with names and numbers, where bird surveys were undertaken in remnant forest red-gum (*E. tereticornis*) forest on alluvium.

For any one survey at a site, species richness density was estimated from the on-site species recorded from the early, late, call playback and nocturnal transect survey events and divided by 2 to give a species density/ha. A tally of species encountered across all six survey sites was used to track species accumulation through time and to produce a final species tally for the study as a whole. Bird density estimates were calculated by dividing raw count data in diurnal survey events by a 2-ha area to provide estimates for comparison with results from other studies. Numbers of species at each site from combined survey events are provided in Appendix 1; data are shown as species 'on and off' transects, as well as species 'on' transects recorded during standard survey events.

RESULTS

We recorded 2035 identified bird observations of 124 species over the duration of the study in and around surveyed plots (Appendix 1). One thousand two hundred and forty-eight observations of 93 species were recorded on the 2-ha plots during standardised survey events; 31 species were recorded outside of the plots and/or standardised survey events.

After 14 survey periods at six sites over 10 years, the species accumulation curve of species recorded on the plots has reached a plateau (Figure 2). The average density of species in a survey period recorded on site was 10.2 (s=3.5, n=14, range 6.5–19) species/ha. The Tarong State Forest site returned high species counts and was responsible for the upper range of species richness values.

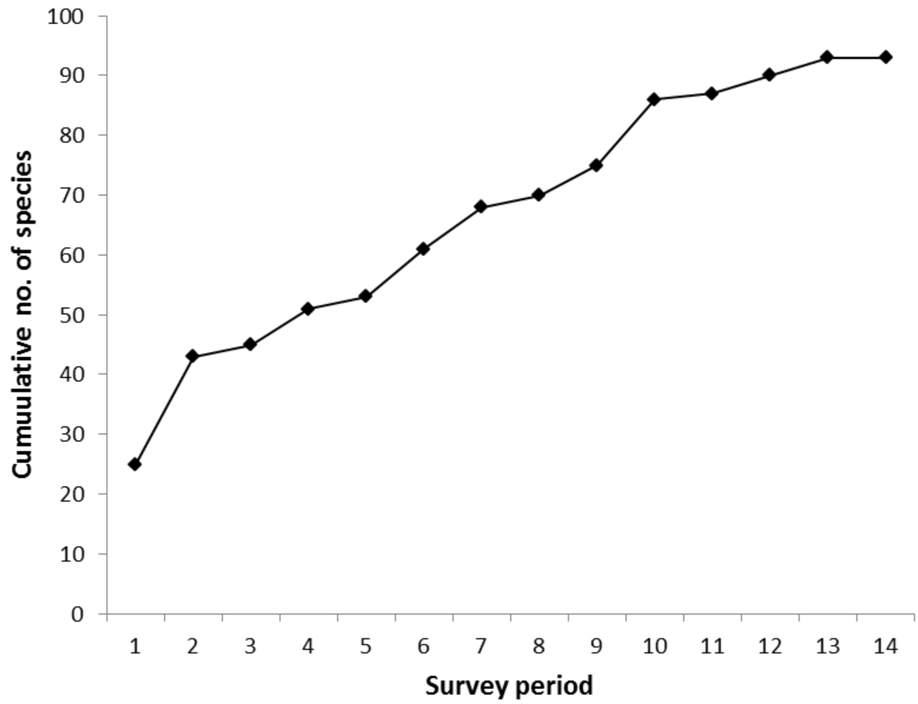

Figure 2. Cumulative number of species encountered during on-site standard survey events, plotted against cumulative number of survey periods.

Bird density/diurnal survey event did not differ significantly between early and late survey events (Paired t=0.8, df=26, P>0.05). Bird density during each diurnal survey event averaged 19.8 (*s*=7.7, *n*=28, range 7–35.5) individuals/ha.

Five or fewer individuals of 51 species (41%) were recorded during the study (Appendix 1). Less abundant species were from a large range of family groups. For many species (e.g., many of the water birds, Eastern Whipbirds (*Psophodes olivaceus*) and Grey-crowned Babblers (*Pomatostomus temporalis*)), this vegetation type is either not preferred habitat or it occurs on the margin of preferred habitat. A number were shy or cryptic species (quail, button-quail, cuckoos), making them difficult to detect, while some were top predators (raptors, owls and other nocturnal relatives) that are typically sparse. Many species were typically in low abundance (e.g., Spotted Pardalotes (*Pardalotus punctatus*), White-bellied Cuckoo-shrikes (*Coracina papuensis*) and Varied Trillers (*Lalage leucomela*)).

The most abundant species recorded were the parrots (Appendix 1): the Sulphur-crested Cockatoo (*Cacatua galerita*), Rainbow Lorikeet (*Trichoglossus haematodus*), Scaly-breasted Lorikeet (*Trichoglossus chlorolepidotus*), Galah (*Eolophus roseicapillus*) and Little Lorikeet (*Glossopsitta pusilla*). There were 13 species of honeyeaters present across all surveys: the White-throated Honeyeater (*Melithreptus albogularis*) was typically the most abundant. Noisy Miners (*Manorina melanocephala*) were commonly recorded across samples but did not dominate numerically or behaviourally. The canopy-feeding Striated Pardalote (*Pardalotus striatus*) and Mistletoebird (*Dicaeum hirundinaceum*) were commonly recorded. Two of the 'black and white' species (the Australian Magpie (*Gymnorhina tibicen*) and Torresian Crow (*Corvus orru*)) were also common.

The species detected on our survey plots to date belong to a range of taxonomic groupings and ecological guilds (i.e. groups of species that exploit the same resources for feeding, nesting or roosting; Appendix 1), reflecting the diversity of resources in remnant ecosystems of *E. tereticornis*. While the presence of numerous waterbird- and wetland-related species reflects the proximity of our study areas to water bodies (streams, lakes and billabongs), it also reflects the use water birds make of hollows in trees for nesting. Hollow trees are an important resource in *E. tereticornis* forests and woodlands and at least 29 (23%) of the species recorded make use of this habitat feature, with a further 69 (56%) species (excluding parasitic species) classified as nesting in trees. Floral resources are also an important resource in these ecosystems. Nectar-feeding species were well represented by some

21 (17%) species. Furthermore, in these nutrient-rich alluvial communities, insects probably make up a significant component of the available resource, as reflected by some 68 (55%) insectivorous species (excluding omnivores) representing the predominant guild.

DISCUSSION

The composition of bird species occurring within and around our plots in REs 11.3.4 and 12.3.3 (*E. tereticornis* on alluvial plains) generally corresponded to the species recorded in the forests and woodlands of the greater south-east Queensland area (Leach 1988; Catterall *et al.* 1993; Woinarski *et al.* 2006; Debus 2007; Hannah *et al.* 2007). In general, nectar-feeding and hollow-nesting parrots were the most commonly encountered birds, while canopy-feeding insectivores such as the Striated Pardalote (*Pardalotus striatus*) were detected across most sites and sampling periods. Where the shrub layer was well-developed, small insectivorous birds, such as the Red-backed Fairy Wren (*Malurus melanocephalus*), Rufous Whistler (*Pachycephala rufiventris*) and Leaden Flycatcher (*Myiagra rubecula*) were common. Honeyeaters were commonly observed, including relatively small numbers of the Black-chinned Honeyeater (*Melithreptus gularis*), which is listed under the *Nature Conservation (Wildlife) Regulation 1994* as 'near threatened' and represents one of a number of 'declining' species in these ecosystems (Montague-Drake *et al.* 2009). Other species found in this study that are considered to be 'declining' in the southern states of Australia included the Speckled Warbler (*Chthonicola sagittata*) and Grey-crowned Babbler (*Pomatostomus temporalis*). Species such as the Regent Honeyeater (*Anthochaera phrygia*) and White-eared Honeyeater (*Lichenostomus leucotis*), which were not detected in our study, may have already disappeared from woodlands in this region (Catterall & Woinarski 2003).

Species richness declines?

Species richness and total bird abundance estimates in our study appear to be low relative to those from other studies. Firstly, mean species richness estimates of 10.7 species/ha were half the estimates of Hannah *et al.* (2007), who observed 19.9 species/ha in woodlands dominated by poplar box (*Eucalyptus populnea*) and/or silver-leaved ironbark (*E. melanophloia*), in southern Queensland. This may relate to a number of factors, including (1) the timing of surveys, (2) their size and extent and (3) the presence of aggressive competitors. We cannot rule out any of these factors. However, both species richness and abundance of birds may also be related to remnant size and this is discussed further below.

(1) Timing of surveys. Catterall *et al.* (1993) have shown that species richness is lower in summer in south-east Queensland; our surveys were undertaken in early summer and autumn and may have therefore coincided with periods of lower richness, suggesting that timing may have been an important factor.

(2) Size, extent and method of surveys. Recent work by Totterman (2012) has indicated that area searches provide a better indication of species present than transect searches over small areas. Our transect surveys of 2-ha strips could have underestimated species richness. However, our plots were also contained entirely within specific forest/woodland ecosystems, rather than being spread across broad survey areas encompassing multiple habitat types (e.g. Leach & Hines 1987; Templeton 1992; Danson *et al.* 2005). Such focus could have meant that between-habitat diversity was not incorporated in our estimates, which could have meant lower values. Unfortunately, we could find no information specifically on *E. tereticornis* vegetation in the published literature for comparison.

(3) Aggressive competitors. The Noisy Miner is a species that has benefited from widespread habitat modification (Eyre *et al.* 2009; Maron *et al.* 2011). It is considered to be hyper-aggressive toward smaller bush birds (Eyre *et al.* 2009) and its increases in abundance correspond with a decline in small passerine species (Maron *et al.* 2011). Due to habitat change and disturbance, particularly associated with grazing, logging and clearing (Eyre *et al.* 2009), Noisy Miners have increased in abundance, which has led to greater impact on smaller bush birds. There is evidence, however, that where habitat structure is sufficiently complex, small passerines are able to coexist (Hastings and Beattie 2006). Despite Noisy Miners being at one of our sites (Tarong State Forest), this site consistently returned high species richness, probably because of a well-defined shrub layer, relative to the simpler vegetative architecture of the other sites with their grass-dominated understoreys (MacArthur *et al.* 1966; Karr 1971; Holmes *et al.* 1979; Wiens 1989).

Density declines?

Published estimates of bird density in south-east and central Queensland eucalypt woodland communities range from 9.2 to 53.8 birds/ha, with some suggestion that occurrence and densities are seasonally dependent (Catterall *et al.* 1993; Debus 2007; Searle *et al.* 2012). From smallest to largest: Gilmore (1985) estimated bird densities of 9.2/ha in poplar box woodland; Catterall *et al.* (1993) reported 9.9 birds/ha in summer and 25.5 birds/ha in winter for open forests and woodlands in coastal ranges; Woinarski *et al*. (2006) estimated 21.7 birds/ha in eucalypt and brigalow woodland; and Hannah *et al*. (2007) estimated 53.8 birds/ha in poplar box woodland. While our average estimate of 19.7 birds/ha was in the lower half of the range of estimates, it was only slightly below the average. As for species richness estimates, low abundance estimates could relate to the restriction of our surveys to summer (Catterall *et al*. 1993), to the presence of aggressive competitors (Maron *et al*. 2011) – even though these were found in other studies – or to the size and extent of survey areas (Totterman 2012). However, it is also possible that the sizes of remnants, and thus their functionality, are now so reduced that bird populations have been affected.

Remnant size and functionality

The magnitude of change to the area of REs such as 12.3.3 and 11.3.4 has probably had a significant effect on the total population size that we are unable to detect because of a lack of historical context to surveys. Widespread clearing of RE 12.3.3 has meant that species dependent upon *E. tereticornis* remnant ecosystems cannot now rely upon an adequate *E. tereticornis* flower resource (Woinarski *et al*. 2006). Forest red-gum ecosystems are now only small fragments of what were previously more widespread forests and woodlands. While some of the bird species that are resident within fragments are probably being impacted by remnant size, many operate over much wider areas and use these remnants when resources within these patches become available. Whatever the scale at which bird species utilise forest red-gum resources, it is reasonable to think that diminishment in extent and integrity of the rich seasonal resources contained within these ecosystems has had, and continues to have, negative consequences for dependent birds. Efforts to maintain and restore these ecosystems to full ecological functionality are required. Furthermore, data such as ours on species composition and density of birds for remnants in good condition will help to inform restoration projects with particular targets for restoring functionality.

Will bird communities be restored through restoration and planting of Regional Ecosystems 11.3.4 and 12.3.3?

Restoration and replanting of forest is widespread across the globe because of a range of concerns associated with vegetation loss and its degradation. One of these concerns is a decline in biodiversity. While there is a general belief that reforestation can restore functional ecosystems and improve biodiversity outcomes, a scarcity of data exists to support this view (Catterall *et al.* 2012). Our preliminary data (unpublished observations) suggest that the revegetated and rehabilitating *E. tereticornis* forest/woodlands we are currently studying will need to develop habitat attributes such as hollows, a well-developed canopy, accumulated woody debris and reproductive maturity (to provide floral resources) before a greater diversity and abundance of species use them. Accumulation of these resources will enhance habitat for generalist species such as parrots and honeyeaters and more specifically for species such as the Varied Sittella (*Daphoenositta chrysoptera*) and White-throated Treecreeper (*Cormobates leucophaea*). However, as a cautionary note (Vesk *et al.* 2008), there will be a considerable time lag before a full suite of species can be re-established.

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REFERENCES

ANON. 1997. *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia*. Joint ANZECC/MCFFA National Forest Policy Statement Implementation Subcommittee (JANIS): Canberra.

BLAKE, S.T. & ROFF, C. 1988. *The Honey Flora of Queensland*. Queensland Department of Primary Industries.

CATTERALL, C.P. & WOINARSKI, J.C.Z. 2003. Birds of Coomooboolaroo, central Queensland, from 1873 to 1999. *Sunbird* 33: 77–98.

CATTERALL, C.P., DRISCOLL, P.V., HULSMAN, K., MUIR, D. & TAPLIN, A. 1993. *Birds and their Habitats: Status and Conservation in Queensland*. Queensland Ornithological Society: Brisbane.

CATTERALL, C.P., FREEMAN, A.N.D., KANOWSKI, J. & FREEBODY, K. 2012. Can active restoration of tropical rainforest rescue biodiversity? A case with bird community indicators. *Biological Conservation* 146: 53-61.

DANSON, A., PALMER, G., THOMSON, R., THORNTON, J. & WOODALL, P.F. 2005. Surveys of terrestrial birds in the Brisbane Valley, 1981-2004. *Sunbird* 35: 1–19.

DEBUS, S.J.S. (2007). Avifauna of remnant bushland in south-east Queensland. I: Brisbane and hinterland. *Sunbird* 37: 14–24.

DOBSON, M., GOLDINGAY, R. & SHARPE, D. 2005. Feeding behaviour of the squirrel glider in remnant habitat in Brisbane. *Australian Mammalogy* 27: 27–35.

EYRE, T., KRIEGER, G., VENZ, M., HASELER, M., HINES, B. & HANNAH, D. 1998. Systematic vertebrate fauna survey project. Stage 1 – vertebrate survey in the south-east Queensland bioregion. Report to Queensland CRA/RFA Steering Committee.

EYRE, T.J., MARON, M., MATHIESON, M.T. & HASELER, M. 2009. Impacts of grazing, selective logging and hyper-aggressors on diurnal bird fauna in intact forest landscapes of the Brigalow Belt, Queensland. *Austral Ecology* 34: 705–716.

GIBBONS, P. & LINDENMAYER, D.B. 2002. *Tree Hollows and Wildlife Conservation in Australia*. CSIRO Publishing: Melbourne.

GILMORE, A.M. 1985. The influence of vegetation structure on the density of insectivorous birds. Pp 21–31 in *Birds of Eucalypt Forests and Woodlands: Ecology, Conservation, Management*, ed. by A. Keast, H.F. Recher, H. Ford & D. Saunders. Surrey Beatty and Sons: Chipping Norton, NSW.

HANNAH, D., WOINARSKI, J.C.Z., CATTERALL, C. P., MCCOSKER, J.C., THURGATE, N.Y. & FENSHAM, R.J. 2007. Impacts of clearing, fragmentation and disturbance on the bird fauna of eucalypt savanna woodlands in central Queensland, Australia. *Austral Ecology* 32: 261–276.

HASTINGS, R.A. & BEATTIE, A.J. (2006). Stop the bullying in the corridors: can including shrubs make your revegetation more Noisy Miner free? *Ecological Management & Restoration* 7: 105–112.

HOLMES, R.T., BONNEY, R.E. & PACALA, S.W. 1979. Guild structure of the Hubbard Brook bird community: a multivariate approach. *Ecology* 60: 512–520.

KARR, J.R. 1971. Structure of avian communities in selected Panama and Illinois habitats. *Ecological Monographs* 41: 207–233.

LEACH, G.J. 1988. Birds of Narayen Research Station, Mundubbera, south-east Queensland. *Sunbird* 18: 55–75.

LEACH, G.J. & HINES, H.B. 1987. Birds of the Marburg District, south-east Queensland. *Sunbird* 17: 65–95.

MACARTHUR, R.H., RECHER, H. & Cody, M. 1966. On the relation between habitat selection and species diversity. *American Naturalist* 100: 319–332.

MACNALLY, R., HORROCKS, G. & PETTIFER, L. 2002. Experimental evidence for potential beneficial effects of fallen timber in forests. *Ecological Applications* 12: 1588–1594.

MARON, M., MAIN, A., BOWEN, M., HOWES, A., KATH, J., PILLETTE, C. & MCALPINE, C.A. 2011. Relative influence of habitat modification and interspecific competition on woodland bird assemblages in eastern Australia. *Emu* 111: 40–51.

MONTAGUE-DRAKE, R.M., LINDENMAYER, D.B. & CUNNINGHAM, R.B. 2009. Factors affecting site occupancy by woodland bird species of conservation concern. *Biological Conservation* 142: 2896–2903.

SATTLER, P. & WILLIAMS, R. (eds) 1999. *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency: Brisbane.

SEARLE, J., MADEN, S., PRINCE, B. & DILLON, T. 2012. Bird surveys of Gold Coast City conservation areas. *Sunbird* 42: 24–38.

SMITH, G.C., MATHIESON, M. & HOGAN, L. 2007. Home range and habitat use of a low -density population of greater gliders, *Petauroides volans* (Pseudocheiridae: Marsupialia), in a hollow-limiting environment. *Wildlife Research* 34: 472–483.

TEMPLETON, M.T. 1992. Birds of Nanango, south-east Queensland. *Sunbird* 22: 87–110.

TOTTERMAN, S.L. 2012. Evaluation of bird survey methods and estimators for species inventory in dry sclerophyll forest. *Corella* 36: 81–89.

VESK, P.A., NOLAN, R., THOMSON, J.R., DORROUGH, J.W. & MAC NALLY, R.M. 2008. Time lags in provision of habitat resources through revegetation. *Biological Conservation* 141: 174–186.

WHITE, N.A. 1999. Ecology of the koala (*Phascolarctos cinereus*) in rural south-east Queensland, Australia. *Wildlife Research*, 26: 731–744.

WIENS, J.A. 1989. *The Ecology of Bird Communities. Part 1.* Cambridge University Press: Cambridge.

WOINARSKI, J.C.Z. & CATTERALL, C.P. 2004. Historical changes in the bird fauna at Coomooboolaroo, northeastern Australia, from the early years of pastoral settlement (1873) to 1999. *Biological Conservation* 116: 379–401.

WOINARSKI, J.C.Z., MCCOSKER, J.C., GORDON, G., LAWRIE, B., JAMES, C., AUGUSTEYN, J., SLATER, L. & DANVERS, T. 2006. Monitoring change in the vertebrate fauna of central Queensland, Australia, over a period of broad-scale vegetation clearance, 1973-2002. *Wildlife Research* 33: 263–274.

YOUNG, P.A.R. & DILLEWAARD, H.A. 1999. Southeast Queensland. Pp. 12/1-12/10 in *The Conservation Status of Queensland's Bioregional Ecosystems*, ed. by P.S. Sattler & R.D. Williams. Environmental Protection Agency: Brisbane.

YOUNG, P.A.R., WILSON, B.A., MCCOSKER, J.C., FENSHAM, R.J., MORGAN, G. & TAYLOR, P.M. 1999. Brigalow Belt. Pp. 11/1-11/14 in *The Conservation Status of Queensland's Bioregional Ecosystems*, ed. by P.S. Sattler & R.D. Williams. Environmental Protection Agency: Brisbane.

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APPENDIX 1

Counts of each species encountered both 'on and off' the 2-ha transects and 'on' the transects (in brackets). Sites are as follows: 1 – Rosedale (four survey periods), 2 – Bunyip Hole (two survey periods), 3 – Goomeri (three survey periods), 4 – Tarong SF (three survey periods), 5 – Imbil SF (one survey period), 6 – Dan Dan Scrub SF (one survey period). Guilds are shown as nesting guilds, predominant feeding guild. Codes for nesting guilds are: G = ground, LV = low vegetation, H = hollow, T = tree, P = parasitic; and codes for predominant feeding guilds are: N = nectivore, F = fruit/seed eater, V = vegetarian (mainly plant parts other than fruit and seed), C = carnivore (invertebrates and/or vertebrates), I = insectivore, O = omnivore (plant and animal food), P = piscivore/crustacean eater.

Taxon no.	Genus species	Common name	Guild	1	2	3	4	5	6	Total
20060	*Alectura lathami*	Australian Brush-turkey	G,O	-	-	-	1	-	-	1
20100	*Coturnix ypsilophora*	Brown Quail	G,O	2	-	1	-	-	-	3
20180	*Dendrocygna eytoni*	Plumed Whistling-duck	H,V	-	2	-	-	-	-	2
20300	*Chenonetta jubata*	Australian Wood Duck	H,V	-	2	4	-	-	-	6
20340	*Anas superciliosa*	Pacific Black Duck	LVH, V	1	2	4(3)	-	-	-	7(3)
20450	*Podiceps cristatus*	Great Crested Grebe	LV,P	1	-	-	-	-	-	1
21440	*Anhinga novae-hollandiae*	Australasian Darter	T,P	4	5	-	-	-	-	9
21450	*Microcarbo melano-leucos*	Little Pied Cormorant	T,P	2	-	-	-	-	-	2
21470	*Phalacrocorax varius*	Pied Cormorant	GT,P	1	-	-	-	-	-	1
21480	*Phalacrocorax sulci-rostris*	Little Black Cormorant	T,P	-	1(1)	-	-	-	-	1(1)
21550	*Egretta novaehollan-diae*	White-faced Heron	T,O	-	2	-	-	-	-	2
21580	*Ardea pacifica*	White-necked Heron	T,O	-	1(1)	-	-	-	-	1(1)
21630	*Ardea ibis*	Cattle Egret	T,O	-	-	3(3)	-	-	-	3(3)
21730	*Threskiornis molucca*	Australian White Ibis	T,O	-	-	1(1)	-	-	-	1(1)
21740	*Threskiornis spini-collis*	Straw-necked Ibis	T,O	-	-	25(22)	-	-	-	25(22)
21760	*Platalea flavipes*	Yellow-billed Spoonbill	T,P	1	-	-	-	-	-	1
21860	*Haliastur sphenurus*	Whistling Kite	T,C	1	1(1)	-	-	-	-	2(1)
21880	*Haliaeetus leuco-gaster*	White-bellied Sea-eagle	T,P	3	5	-	-	-	-	8
21930	*Accipiter cirrhoceph-alus*	Collared Sparrowhawk	T,C	1	-	-	-	-	-	1
21960	*Aquila audax*	Wedge-tailed Eagle	T,C	2	-	-	-	-	1(1)	3(1)
21980	*Falco berigora*	Brown Falcon	T,C	-	-	-	-	-	1	1

Taxon no.	Genus species	Common name	Guild	1	2	3	4	5	6	Total
21990	*Falco longipennis*	Australian Hobby	T,C	-	-	8(4)	-	-	-	8(4)
22220	*Gallinula tenebrosa*	Dusky Moorhen	LV,V	1	-	-	-	-	-	1
22250	*Fulica atra*	Eurasian Coot	LV,V	1	-	-	-	-	-	1
22320	*Turnix varius*	Painted Button-quail	G,I	-	-	-	1(1)	-	-	1(1)
23060	*Vanellus miles*	Masked Lapwing	G,I	-	-	2	-	-	-	2
23230	*Hydroprogne caspia*	Caspian Tern	G,P	1	-	-	-	-	-	1
23510	*Macropygia amboinensis*	Brown Cuckoo-dove	T,F	-	-	-	-	3	-	3
23530	*Phaps chalcoptera*	Common Bronzewing	T,F	-	-	-	3(1)	-	-	3(1)
23630	*Geopelia striata*	Peaceful Dove	T,F	12(5)	4	2	-	-	-	18(5)
23640	*Geopelia humeralis*	Bar-shouldered Dove	T,F	7(1)	1	4(3)	-	1(1)	4(3)	17(8)
23650	*Leucosarcia picata*	Wonga Pigeon	T,F	-	-	-	-	-	1	1
23760	*Calyptorhynchus banksii*	Red-tailed Black-cockatoo	H,O	5	4	9(9)	-	-	-	18(9)
23780	*Calyptorhynchus funereus*	Yellow-tailed Black-cockatoo	H,O	-	-	-	-	1	-	1
23820	*Eolophus roseicapillus*	Galah	H,F	-	13(2)	48(42)	2	2(2)	-	65(46)
23850	*Cacatua sanguinea*	Little Corella	H,F	-	-	9(9)	-	-	-	9(9)
23870	*Cacatua galerita*	Sulphur-crested Cockatoo	H,O	1	28(5)	44(42)	3	49(45)	-	125 (92)
23880	*Nymphicus hollandicus*	Cockatiel	H,F	-	4	2(2)	9	-	-	15(2)
23890	*Trichoglossus haematodus*	Rainbow Lorikeet	H,N	58(39)	48(21)	54(31)	48(31)	5(1)	16(16)	229 (139)
23900	*Trichoglossus chlorolepidotus*	Scaly-breasted Lorikeet	H,N	60(46)	21(13)	25(25)	11(11)	-	-	117 (95)
23930	*Glossopsitta pusilla*	Little Lorikeet	H,N	38(36)	17(2)	11(8)	4(3)	-	-	70(49)
23980	*Alisterus scapularis*	Australian King-parrot	H,NF	-	3(1)	5(5)	9(5)	-	1	18(11)
23990	*Aprosmictus erythropterus*	Red-winged Parrot	H,NF	-	-	3(1)	-	-	-	3(1)
24060	*Platycercus adscitus*	Pale-headed Rosella	H,NF	8(5)	2	7(4)	2(1)	-	-	19(10)
24320	*Cacomantis variolosus*	Brush Cuckoo	P,I	3	-	-	1(1)	-	-	4(1)
24340	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	P,I	1	-	-	2	1(1)	-	4(1)
24380	*Chalcites minutillus*	Little Bronze-cuckoo	P,I	1	-	-	2(2)	-	-	3(2)
24400	*Eudynamys orientalis*	Eastern Koel	P,F	1(1)	-	1	2	-	-	4(1)
24420	*Scythrops novaehollandiae*	Channel-billed Cuckoo	P,F	11(2)	-	4	1	-	2(2)	18(4)
24430	*Centropus phasianinus*	Pheasant Coucal	G,I	4	1	2	-	-	1(1)	8(1)
24460	*Ninox connivens*	Barking Owl	H,C	1(1)	-	-	-	-	-	1(1)
24470	*Ninox novaeseelandiae*	Southern Boobook	H,CI	1(1)	2	1	1(1)	-	1	6(2)
24530	*Tyto javanica*	Eastern Barn owl	H,CI	1	2(2)	4(3)	1(1)	-	1	9(6)
24550	*Podargus strigoides*	Tawny Frogmouth	T,I	1	-	1		-	1(1)	3(1)
24580	*Eurostopodus mystacalis*	White-throated Nightjar	G,I	-	-	-	3(3)	-		3(3)
24620	*Aegotheles cristatus*	Australian Owlet-nightjar	H,I	4(2)	-	-	2(1)	1(1)	5(1)	12(5)

Tax-on no.	Genus species	Common name	Guild	1	2	3	4	5	6	Total
24690	*Ceyx azurea*	Azure Kingfisher	H,P	-	1	-	-	-	-	1
24720	*Dacelo novaeguineae*	Laughing Kookaburra	H,CI	20(9)	5	14(7)	5	1	1(1)	46(17)
24730	*Dacelo leachii*	Blue-winged Kookaburra	H,CI	-	6	-	-	-	-	6
24750	*Todiramphus macleayii*	Forest Kingfisher	H,CI	10(7)	-	-	-	1(1)	1(1)	12(9)
24770	*Todiramphus sanctus*	Sacred Kingfisher	H,CI	1	-	1	2(2)	-	-	4(2)
24790	*Merops ornatus*	Rainbow Bee-eater	H,I	4(4)	-	-	6	1	2	13(4)
24800	*Eurystomus orientalis*	Dollarbird	H,I	6(4)	-	3	3(1)	-	-	12(5)
24890	*Cormobates leucophaea*	White-throated Treecreeper	H,I	-	-	-	4(2)	1(1)	-	5(3)
24980	*Malurus lamberti*	Variegated Fairy-wren	LV,I	-	-	-	6(6)	-	-	6(6)
25030	*Malurus melanocephalus*	Red-backed Fairy-wren	LV,I	20(20)	5(5)	-	-	5(5)	4(4)	34(34)
25170	*Pardalotus punctatus*	Spotted Pardalote	H,I	1	-	-	3	-	-	4
25200	*Pardalotus striatus*	Striated Pardalote	H,I	23(23)	10(9)	15(14)	3(2)	-	3(3)	54(51)
25280	*Sericornis frontalis*	White-browed Scrub-wren	LV,I	2	-	-	4(4)	-	-	6(4)
25390	*Chthonicola sagittata*	Speckled Warbler	LV,I	-	-	-	8(7)	-	-	8(7)
25400	*Smicrornis brevirostris*	Weebill	T,I	-	-	-	9(8)	2(2)	1(1)	12(11)
25500	*Gerygone albogularis*	White-throated Gerygone	T,I	-	2	2(1)	6(3)	3(2)	-	13(6)
25710	*Plectorhyncha lanceolata*	Striped Honeyeater	T,NI	-	2	-	5(1)	-	-	7(1)
25740	*Philemon corniculatus*	Noisy Friarbird	T,NI	4(1)	5	-	21(10)	-	-	30(11)
25750	*Philemon citreogularis*	Little Friarbird	T,NI	-	18(7)	8(6)	8(7)	2(2)	-	36(22)
25770	*Entomyzon cyanotis*	Blue-faced Honeyeater	T,NI	6(2)	6	3(3)	7(7)	-	1	23(12)
25780	*Manorina melanophrys*	Bell Miner	T,NI	-	-	-	-	11	-	11
25790	*Manorina melanocephala*	Noisy Miner	T,NI	-	4(3)	16(12)	46(37)	-	-	66(52)
25840	*Meliphaga lewinii*	Lewin's Honeyeater	T,NI	5(5)	1	-	23(16)	10(7)	3(2)	42(30)
25900	*Lichenostomus chrysops*	Yellow-faced Honeyeater	T,NI	-	-	-	19(18)	5(5)	-	24(23)
26060	*Melithreptus gularis*	Black-chinned Honeyeater	T,NI	3(2)	4	-	1	-	-	8(2)
26080	*Melithreptus brevirostris*	Brown-headed Honeyeater	T,NI	-	-	-	11(11)	-	-	11(11)
26090	*Melithreptus albogularis*	White-throated Honeyeater	T,NI	52(49)	10(5)	2(1)	11(10)	-	-	75(65)
26100	*Melithreptus lunatus*	White-naped Honeyeater	T,NI	-	-	-	-	-	7(7)	7(7)
26130	*Lichmera indistincta*	Brown Honeyeater	T,NI	5(3)	5	2	-	-	2(2)	14(5)
26180	*Phylidonyris nigra*	White-cheeked Honeyeater	T,NI	-	-	-	-	5(5)	-	5(5)
26330	*Myzomela sanguinolenta*	Scarlet Honeyeater	T,NI	12(8)	-	-	10(10)	1	-	23(18)
26390	*Microeca fascinans*	Jacky Winter	T,I	-	-	-	-	4(2)	-	4(2)
26510	*Eopsaltria australis*	Eastern Yellow Robin	T,I	-	-	-	4(4)	-	-	4(4)

Taxon no.	Genus species	Common name	Guild	1	2	3	4	5	6	Total
26610	*Pomatostomus temporalis*	Grey-crowned Babbler	T,I	-	-	1	2(2)	-	-	3(2)
26650	*Psophodes olivaceus*	Eastern Whipbird	G,I	-	-	-	3	2	-	5
26730	*Daphoenositta chrysoptera*	Varied Sittella	T,I	15(13)	10	-	-	-	2(2)	27(15)
26790	*Pachycephala pectoralis*	Golden Whistler	T,I	-	-	-	-	6(1)	-	6(1)
26820	*Pachycephala rufiventris*	Rufous Whistler	T,I	9(6)	2	-	8(5)	-	-	19(11)
26870	*Colluricincla harmonica*	Grey Shrike-thrush	T,I	5(2)	3	-	2(1)	-	-	10(3)
26960	*Myiagra rubecula*	Leaden Flycatcher	T,I	5(3)	1	-	7(7)	2(2)	1(1)	16(13)
26990	*Myiagra inquieta*	Restless Flycatcher	T,I	1	-	-	-	1	-	2
27000	*Grallina cyanoleuca*	Magpie-lark	T,I	3(2)	5	2	1	-	-	11(2)
27020	*Rhipidura fuliginosa*	Grey Fantail	T,I	5(5)	-	-	7(6)	2(2)	-	14(13)
27060	*Rhipidura leucophrys*	Willie Wagtail	T,I	2(2)	1	5(4)	5(5)	1(1)	-	14(12)
27070	*Dicrurus bracteatus*	Spangled Drongo	T,I	8(5)	-	-	6(5)	-	7(7)	21(17)
27080	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	T,I	3(3)	4	-	6(5)	-	1(1)	14(9)
27100	*Coracina papuensis*	White-bellied Cuckoo-shrike	T,I	-	1	-	3(3)	-	-	4(3)
27110	*Coracina tenuirostris*	Cicadabird	T,I	-	1	-	3(1)	-	1(1)	5(2)
27140	*Lalage leucomela*	Varied Triller	T,I	-	-	-	-	-	1	1
27170	*Oriolus sagittatus*	Olive-backed Oriole	T,F	1(1)	-	3(3)	7(7)	-	-	11(11)
27180	*Sphecotheres vieilloti*	Australasian Figbird	T,F	12(12)	-	-	-	-	10(2)	22(14)
27260	*Cracticus torquatus*	Grey Butcherbird	T,CI	-	2	-	8(3)	1	-	11(3)
27280	*Cracticus nigrogularis*	Pied Butcherbird	T,CI	7	8(5)	1	4(2)	-	2	22(7)
27291	*Gymnorhina tibicen*	Australian Magpie	T,CI	4	5(3)	19(16)	12(4)	4(3)	2(2)	46(28)
27300	*Strepera graculina*	Pied Currawong	T,CI	-	1	2	2	-	2(2)	7(2)
27410	*Corvus orru*	Torresian Crow	T,O	36(7)	15(5)	34(19)	12	1	2(2)	100 (33)
27420	*Corcorax melanorhamphos*	White-winged Chough	T,O	7	-	-	-	-	-	7
27430	*Struthidea cinerea*	Apostlebird	T,O	-	5	-	-	-	-	5
27670	*Taeniopygia bichenovii*	Double-barred Finch	LV,F	7(7)	-	-	2(2)	-	2	11(9)
27740	*Neochmia temporalis*	Red-browed Finch	LV,F	-	-	-	3	-	-	3
27810	*Lonchura castaneothorax*	Chestnut-breasted Mannikin	LV,F	12(2)	-	-	-	-	-	12(2)
27930	*Dicaeum hirundinaceum*	Mistletoebird	T,F	3(2)	1(1)	4(3)	6(6)	-	7(7)	21(19)
27970	*Hirundo neoxena*	Welcome Swallow	T,I	10(8)	-	-	-	-	-	10(8)
27990	*Petrochelidon nigricans*	Tree Martin	T,I	24(24)	-	-	-	1(1)	-	25(25)
28060	*Megalurus timoriensis*	Tawny Grassbird	LV,I	4(2)	-	-	-	-	-	4(2)
28070	*Megalurus gramineus*	Little Grassbird	LV,I	1	-	-	-	-	-	1
28120	*Cisticola exilis*	Golden-headed Cisticola	LV,I	3(2)	-	-	2	-	-	5(2)
28160	*Zosterops lateralis*	Silvereye	T,O	-	-	-	13(8)	-	-	13(8)

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WATERBIRD BREEDING COLONIES IN THE GULF PLAINS, 2009–2013

ROGER JAENSCH & PAUL RICHARDSON

ABSTRACT

We report the results of aerial surveys of breeding colonies of waterbirds (herons, ibises, cormorants and allies) in the central part of the Gulf Plains region, Queensland, conducted by the Carpentaria Land Council Aboriginal Corporation over five years (2009–2013). This was the first broad-scale, multi-year documentation of colonial waterbird breeding in the Gulf Plains; historically, about 10 colonies were known to science, all in estuaries. Coverage of the region was incomplete, but cumulatively 32 active colonies were recorded in our surveys, 28 of them described for the first time. Colonies were in tree or shrub habitats: 13 in estuarine mangrove and 19 in freshwater wetlands. Colonies were in each of the major river systems (up to five colonies per river) from the Leichhardt River to the Gilbert River, and up to 115 km from the coast. Eleven colonial-breeding species of waterbird were recorded, with some colonies including all, many colonies with most and a few colonies with just one or two of these species. Scale of waterbird breeding was mostly recorded in terms of colony dimensions, with informed estimates suggesting variations from in the order of hundreds to 10,000 breeding pairs. The most abundant species was the Intermediate Egret (*Ardea intermedia*), which was also among the most frequently detected breeding species, along with Australian White Ibis (*Threskiornis molucca*), Royal Spoonbill (*Platalea regia*), Nankeen Night Heron (*Nycticorax caledonicus*) and Little Black Cormorant (*Phalacrocorax sulcirostris*). At some sites, colonial breeding was not recorded in drier years; rainfall and river flow regimes are considered to be determinants of breeding activity. Threats presently recognisable include any process or development that reduces the flooding of colony sites or floodplain feeding areas or that threatens the health of nesting trees. Many of the individual colonies meet criteria for international importance. To sustain these assets perpetually, land managers will require further information on the numbers and ecological requirements of waterbirds that breed in colonies in the Gulf Plains region.

INTRODUCTION

Breeding colonies of waterbirds are dense aggregations at sites that meet the ecological requirements for breeding. In Australia, several species of herons, ibises, cormorants and their allies breed in colonies. They commonly require inundated shrubs or trees that can support nests, near extensive and shallowly inundated habitat that will provide sufficient food for adults and their rapidly growing nestlings (Marchant & Higgins 1990; RJ personal observations). Colonies tend to be few and occupy relatively small areas in the landscape, generally less than 100 ha (Marchant & Higgins 1990; RJ personal observations); consequently they are vulnerable to direct or indirect loss or disturbance from human activities. Conservation planners and land managers therefore require comprehensive knowledge of the locations and characteristics of waterbird breeding colonies.

Information on waterbird breeding colonies in the Gulf Plains biogeographic region of tropical Queensland reveals that before 2000 only 10 or 11 colony sites were known to science: one each on tidal reaches of the Flinders, Bynoe, Gilbert, Staaten and Nassau Rivers; three in the Mitchell River delta; and two or three other colonies in coastal mangrove (Marchant & Higgins 1990; Taplin 1991; Driscoll 2001). These estuaries tend to be visited often by commercial fishermen and local residents and sometimes by ornithologists. However, no systematic survey of waterbird breeding colonies had been conducted across all major wetland systems, estuarine and freshwater, of the Gulf Plains before 2009. A major impediment had been the inability to access most of the region's wetlands during the wet season, when most colonial breeding occurs (Marchant & Higgins 1990). In the Top End of the Northern Territory, this impediment had been overcome by aerial surveying, which had proved effective in the discovery of many colonies during the wet season and demonstrated that many occur in freshwater wetlands (Chatto 2000).

An opportunity to fill some gaps in the knowledge of Gulf Plain colonies arose in 2008, when the Queensland Government approached Wetlands International (RJ) for advice on a target for biodiversity surveys by indigenous rangers during the wet season, when rangers were otherwise unable to access much of the country. Following successful trials using helicopters, start-up funding for systematic, broad-scale aerial surveys of colonies was secured and a survey program was implemented by the Land and Sea Rangers of the Carpentaria Land Council Aboriginal Corporation (CLCAC), based in Normanton. Surveys targeted the major river systems within the Kurtijar, Gkuthaarn and Kukatj tribal boundaries, which collectively extend from the Leichhardt River to the Staaten River and up to 150 km inland. The present article summarises results of CLCAC surveys of waterbird breeding colonies within this study area during wet seasons in the period 2009–2013, as fully documented in an unpublished internal report of

CLCAC (Jaensch 2013). Smaller programs of similar surveys by rangers at Burketown and Kowanyama mentioned in the CLCAC report are not reported here.

METHODS

Study area and target species

Surveys were conducted in the central near-coastal part of the Gulf Plains biogeographic region (Sattler & Williams 1999), between the Leichhardt River in the west and the Staaten River in the east (Figure 1). This area is characterised by alluvial plains that are crossed by abundant river channels and distributaries, which transform into complex estuarine systems (Sattler & Williams 1999). Rivers tend to run in summer–autumn, in and following the monsoonal wet season, often with vast areas of over-bank flooding, but water may be confined to deeper waterholes and relatively few off-river 'lagoons' in the winter–spring dry season (personal observations of RJ, PA & rangers).

The CLCAC Land and Sea Rangers based at Normanton operate throughout the study area. Within the study area, nine river catchments were defined specifically for the purposes of the colony survey program, particularly to facilitate survey planning. From west to east these catchments were: Leichhardt River (includes Alexandra R.); catchments of M Creek, L Creek and Spring Creek (West); Flinders and Bynoe Rivers; Norman River; Walker Creek, Bayswater Creek and Brannigan Creek; Smithburne River and Fitzmaurice River; Duck Creek and Spring Creek (North); Gilbert River; and Staaten River (Figure 1).

Target species for the surveys were from four bird families: Ardeidae (herons and allies, including egrets); Threskiornithidae (ibises and spoonbills); Phalacrocoracidae (cormorants); and Anhingidae (darters) (taxonomy and names are based on Christidis & Boles 2008). Prior knowledge (Marchant & Higgins 1990; Chatto 2000; Jaensch 2009) indicated that many to most species would breed together and that breeding would often start and finish on different dates among species. Determining the optimal dates to conduct surveys – especially when only one survey per site was possible per season – and identifying all species and their breeding activity in a colony were thus substantial challenges for the survey program.

Timing of surveys

The timing of breeding by colonial waterbirds is influenced by availability of food for bringing the adults into condition for egg laying, sustaining adults sitting on nests and feeding of nestlings (Briggs & Thornton 1999). Food

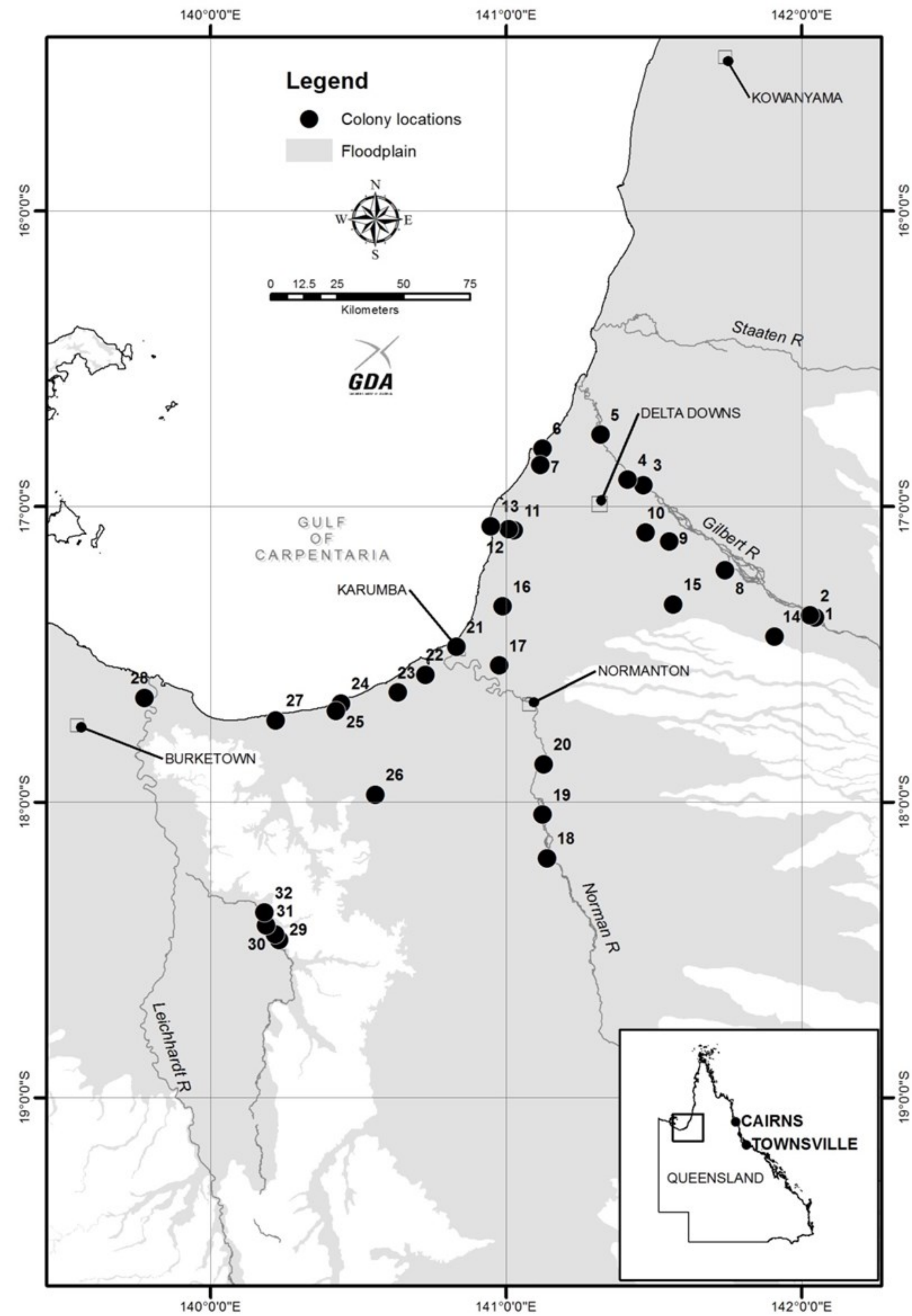

Figure 1. Location of waterbird breeding colonies recorded by the Normanton Land and Sea Rangers in the Gulf Plains region, 2009–2013.

items for herons, ibises, cormorants and allies and their nestlings are mainly small aquatic animals, notably fish, frogs and crustaceans (Marchant & Higgins 1990). Whereas these food items may be found in permanent waterholes, lagoons and rivers and/or in intertidal habitats, local and regional flooding in the wet season causes a huge increase in abundance and availability of these foods; temporary (seasonal) wetlands are especially productive (Briggs *et al.* 1997; DPIPWE 2013). As the Intermediate Egret (*Ardea intermedia*) tends to be one of the most abundant of the target species in the Gulf Plains and northern Australia generally (Wetlands International 2013; Kingsford *et al.* 2012; RJ personal observations), its breeding activity may be a trigger for breeding by co-locating colonial waterbird species. Intermediate Egrets feed exclusively in shallow freshwater wetlands (Marchant & Higgins 1990; RJ personal observation) and thus can be expected to time their breeding in accordance with rainfall and flood events. Accordingly, major waterbird colonies in northern Australia are most likely to be supporting large numbers of nesting pairs and species in the mid-to-late wet season (March to May). Another timing consideration was, wherever possible, to avoid disturbance to large young in the nest and to avoid dates when many near-fledged young were present in colonies, as that would confuse our counting of the number of nesting pairs. Consequently, the optimal date for a single survey effort was considered to be mid-season (March), when all species were expected to be nesting, but with nests of most species still containing eggs or small young. In practice, surveys were conducted during March and/or April.

Transportation and routes for surveys

Helicopters were used for surveying for the following reasons. In March, the expected extent of floodwaters would create large areas to search for colonies and access to most known or likely colony sites was anticipated to be difficult or impossible on foot. Boat access was often impractical due to strong floodwater currents, vast areas of floodplain to navigate and the presence of saltwater crocodiles underneath colonies. Also, high aerial manoeuvrability was important to enable optimal viewing of colonies and minimise the duration of disturbance.

Based on the literature (Marchant & Higgins 1990; Taplin 1991; Chatto 2000; Driscoll 2001) and prior experience (RJ, PR and rangers), searching for colonies focussed on estuaries with mangroves and river reaches with wooded waterholes and associated wooded swamps. Surveys involved helicopter travel along river systems to locate waterbird colonies, and rapid collection of data (described below) when colonies were found. The number of observers on any one survey varied from one to three depending on the type of helicopter. The usual route involved helicopter travel along a river from its mouth to about the upper limit of its floodplain, crossover to the next river system and following that downstream to the coast. Some efforts were confined to two rivers per survey date, owing to constraints of helicopter fuel range and observer fatigue. Known colony sites were included as first priority; the number of these increased year by year. In coastal areas, the major blocks of mangrove were checked, initially from at least 500 feet (150 m) altitude because white egrets tend to be highly conspicuous against green mangrove forest; based on RJ's experience of preferred colony sites, less attention was given to narrow fringing strips of mangrove. In freshwater riverine country, the tall and dense tree/shrub vegetation of major waterholes was checked wherever possible, accepting that it was not practical to cover all such waterholes on every flight. Off-channel habitats such as wooded swamps and inundated floodplain woodland were checked opportunistically, mainly where egrets were seen congregating. Some information on colony locations was provided to the CLCAC ranger coordinator by helicopter pilots, property managers and others in the community and was factored into planning of survey routes. Overall, the survey program was implemented according to available budget and rangers' other work commitments.

Type and constraints of data obtained

Data recorded were geographic position (coordinates), habitat type and impression of overall number of birds in the colony. During a second pass over the colony, species composition, improved assessment of scale of the colony (usually length, sometimes estimated numbers) and stages of breeding were recorded. In view of the inherent difficulties in counting birds and nests from a moving aircraft over just a few minutes and considering the fact that most colonies are linear, we recorded length of colony as an alternative measure of the size of breeding effort. Photographs and videos were obtained at some colonies; in several cases these enabled further refinement of size estimates and species composition. Overall, safety and other operational considerations greatly limited the time available to record data on breeding at any one colony.

Several assumptions, constraints and caveats apply to the survey data. As verification of nest contents was often impossible, a colony was considered as being active if at least several individuals of a target waterbird species were seen attending nests in suitable breeding habitat. This result also included situations where waterbirds seemed to be preparing to nest, or were acting as if breeding, or appeared to have recently finished nesting at the site. For example, breeding activity could be assumed with some confidence where groups of Pied Heron (*Ardea picata*) were flushed from inside the lower parts of an area of mangroves, because they are known to breed in mangroves but otherwise spend most of their time in freshwater or dryland habitats (RJ personal observations). We also assumed that the total number of active nests (scale of breeding activity) in the colony matched the number of birds seen – whether estimated or counted accurately – in the colony. This assumption was reasonable where most of the birds in a colony were attending nests with eggs or small young, one adult per nest, while the other adult was elsewhere seeking food. Despite careful choice of survey date (see above), such conditions were not always applicable but it was beyond the scope of the survey program to address this limitation. An additional constraint was detectability. For example, Pied Herons tend to nest out of sight, in lower layers of the vegetation (RJ personal observation); with their dark steel-grey plumage they are far less conspicuous than the masses of eye-catching white waterbirds. Australasian Darters (*Anhinga novaehollandiae*) and sometimes other species often nest on the edges of colonies and so may have been missed because observers tended to focus on the core part of the colony. Egrets were moderately difficult to identify to species level in aerial surveys. There are no data for the early years, in regard to status of colonies that were found only in later years of the program, and some colonies found early on were not surveyed in every subsequent year.

Wetland conditions and survey coverage

Accumulated rainfall is an indicator of wetland condition; the intensity of rainfall is an additional indicator of the occurrence and size of floods. During the four Northern Wet Seasons (1 October of preceding year to 30 April of focus year) from 2009 to 2012, total rainfall across the Gulf Plains region was generally above average, whereas for the corresponding period in 2013, rainfall was below to well below average (Bureau of Meteorology 2013a). This is also reflected in the annual rainfall for Normanton Airport, near the centre of the study area, for the five calendar years 2009 to 2013: respectively 1338, 1183, 1292, 867 and (for nine months including the three that are typically the wettest) 470 mm, compared to the annual mean of 838 mm; results were similar for Miranda Downs station to the north-east, which has a much longer record of data (Bureau of Meteorology 2013b). Conditions for colonial breeding by waterbirds therefore are assumed to have been highly favourable in many parts of the Gulf Plains in 2009, 2010 and 2011, less favourable in 2012 and relatively poor in 2013. Wettest conditions were in 2009 and 2011 but the most severe floods (e.g. Norman River) were observed to be in 2009. Over such a large region, spanning more than 250 km of coastline and extending over 100 km inland, local and sub-regional variations within the overall annual pattern are to be expected.

Depending on funds available for helicopter charter and on rangers' commitments, survey coverage varied markedly as follows:

2009 (mid-March): extensive in the western and central catchments but nil in the northern catchments of the study area;
2010 (mid-April): limited, in central and northern catchments only;
2011 (mid-March to mid-April): extensive in all catchments except Duck and Spring Creeks;
2012: no surveys were conducted; and
2013 (mid-March): very limited, confined to the central catchments.

Collectively, over the five year period extensive coverage was achieved at least once in each of the nine catchments, including substantial parts of each river's estuary system. However, due to the complexity of the wetland systems and to operational constraints, there remained some unsurveyed areas, even within the well-surveyed freshwater channels and tidal estuaries.

RESULTS AND DISCUSSION

Location, distribution and habitats of colonies

Thirty-two waterbird breeding colonies were recorded by CLCAC during our Gulf Plains surveys from 2009 to 2013. Locations of the colonies are mapped in Figure 1. Tables 1 and 2 give the colony working (unofficial) names, river systems (catchments), coordinates, habitats and years in which colonies were recorded as active.

At least one colony was recorded in each catchment, except for Staaten River. Five catchments (the Gilbert, Smithburne, Walker, Norman, and Leichhardt catchments) each supported four to five colonies. At least one colony was recorded in each of the surveyed coastal estuaries, except for the Fitzmaurice estuary and Van Diemen Inlet. One colony was in mangroves on an island close to the mainland.

Many colonies (13) were in mangrove (intertidal) habitat, but the majority (19) were in freshwater wetlands in channels with riverine woodland/forest (especially *Melaleuca* trees and shrubs: Figure 2) (15) or in off-channel situations (on flat floodplain or in depression swamps; some colonies included riverine and off-channel habitats) (4).

Previous extensive surveys of waterbirds in the wider Gulf Plains region by Driscoll (2001), Taplin (1991) and others (Marchant & Higgins 1990) recorded some colonial breeding. Colonies of 100–200 Pied Cormorant (*Phalacrocorax varius*) along the coastline, one between Karumba and Pelican Island and another near Morning Inlet (Taplin 1991: undated records), were

Table 1. Names, catchments and coordinates of each colony recorded by the Normanton Land and Sea Rangers, 2009–2013.

Site code	Site name: (official, or created for the project)	River system (name of catchment)	Longitude (dec. deg. E)	Latitude (dec. deg. S)
GPWC-01	UPPER GILBERT - 1 (UPRIVER)	Gilbert River	142.0456	-17.3758
GPWC-02	UPPER GILBERT - 2	Gilbert River	142.0297	-17.3685
GPWC-03	MIDDLE GILBERT - 1 (UPRIVER)	Gilbert River	141.4647	-16.9279
GPWC-04	MIDDLE GILBERT - 2 (NEAR GRAHAM'S YARD)	Gilbert River	141.4125	-16.9092
GPWC-05	LOWER GILBERT	Gilbert River	141.3197	-16.7573
GPWC-06	KELSO POCKET (NORTH SPRING CK ESTUARY)	Spring Creek (North)	141.1237	-16.8041
GPWC-07	DUCK CREEK ESTUARY	Spring Creek (North)	141.1172	-16.8591
GPWC-08	UPPER SMITHBURNE	Smithburne River	141.7420	-17.2166
GPWC-09	BIRD WATERHOLE	Smithburne River	141.5520	-17.1185
GPWC-10	SMITHBURNE CENTRAL	Smithburne River	141.4730	-17.0888
GPWC-11	SMITHBURNE ESTUARY - 1 (UPRIVER)	Smithburne River	141.0269	-17.0813
GPWC-12	SMITHBURNE ESTUARY - 2 (DOWNRIVER)	Smithburne River	141.0107	-17.0760
GPWC-13	PELICAN ISLAND	coast	140.9495	-17.0666
GPWC-14	UPPER WALKER CREEK	Walker Creek	141.9084	-17.4398
GPWC-15	MAID'S LAGOON	Walker Creek (Bayswater Ck)	141.5669	-17.3317
GPWC-16	BRANNIGAN CREEK	Walker Creek (Brannigan Ck)	140.9892	-17.3379
GPWC-17	WILLS-WALKER SALTFLAT	Walker Creek	140.9769	-17.5381
GPWC-18	NORMAN 40 MILE	Norman River	141.1385	-18.1908
GPWC-19	CROCODILE WATERHOLE	Norman River	141.1239	-18.0429
GPWC-20	NORMAN WEIR	Norman River	141.1271	-17.8721
GPWC-21	KARUMBA (MOUTH)	Norman River	140.8320	-17.4750
GPWC-22	BYNOE (ESTUARY)	Flinders (Bynoe)	140.7270	-17.5693
GPWC-23	FLINDERS ESTUARY	Flinders (Bynoe)	140.6340	-17.6297
GPWC-24	WEST SPRING CREEK ESTUARY	Spring Creek (West)	140.4417	-17.6669
GPWC-25	LARGE SALTFLAT ISLAND (RUBBERVINE)	Spring Creek (West)	140.4249	-17.6922
GPWC-26	L CREEK	L Creek	140.5586	-17.9750
GPWC-27	MORNING INLET	M Creek	140.2207	-17.7239
GPWC-28	LEICHHARDT ESTUARY	Leichhardt River	139.7763	-17.6476
GPWC-29	ALEXANDRA - 1 (UPRIVER)	Alexandra River	140.2323	-18.4681
GPWC-30	ALEXANDRA - 2 (ORIGINAL COLONY)	Alexandra River	140.2200	-18.4490
GPWC-31	ALEXANDRA - 3	Alexandra River	140.1891	-18.4187
GPWC-32	ALEXANDRA - 4 (FLOODOUT, 12 MILE)	Alexandra River	140.1834	-18.3745

not noted in our surveys, probably because our focus was on river systems rather than coastline. Precise locations of historical colonies are not available in all cases but it seems that our surveys missed only one of the other historical colonies in our study area (Staaten estuary: Marchant & Higgins 1990) and discovered 28 new colonies. New colonies can be attributed to our wider coverage of freshwater wetlands, favourable dates of surveys and/or the overall level of colonial breeding activity in the year of survey.

Table 2. Principal habitat and scale of breeding recorded at each colony, 2009–2013. Blank cells mainly indicate that a colony was not surveyed in that year and do not necessarily mean that breeding did not occur.

Colony site code	Habitat at colony*	Scale in 2009 (birds)	Scale in 2010 (km)	Scale in 2011 (km)	Scale in 2013 (km)
GPWC-01	R			< 0.5 km	
GPWC-02	F			< 0.5 km	
GPWC-03	F		< 0.5 km		
GPWC-04	RF		3.5 - 4 km	4.5 - 5 km	
GPWC-05	S		< 0.5 km	< 0.5 km	
GPWC-06	M				< 0.5 km
GPWC-07	M				< 0.5 km
GPWC-08	RF			< 0.5 km	
GPWC-09	R	hundreds	< 0.5 km	0.5 - 1 km	
GPWC-10	R	thousands	1.5 - 2 km	2 - 2.5 km	0.5 - 1 km
GPWC-11	M		0.5 - 1 km	0.5 - 1 km	
GPWC-12	M			< 0.5 km	
GPWC-13	M		0.5 - 1 km	0.5 - 1 km	
GPWC-14	R			< 0.5 km	
GPWC-15	R	< 100	1 - 1.5 km	4.5 - 5 km	
GPWC-16	M			< 0.5 km	
GPWC-17	M			4.5 - 5 km	
GPWC-18	R	thousands		1 - 2 km	
GPWC-19	R			< 0.5 km	
GPWC-20	R	< 100			
GPWC-21	M	hundreds		1 - 1.5 km	
GPWC-22	M	< 100		0.5 - 1 km	
GPWC-23	M			1 - 1.5 km	
GPWC-24	M			0.5 - 1 km	
GPWC-25	S			< 0.5 km	
GPWC-26	R	hundreds		1 - 1.5 km	
GPWC-27	M			1 - 1.5 km	
GPWC-28	M			1.5 - 2 km	
GPWC-29	R			3.5 - 4 km	
GPWC-30	R	hundreds		< 0.5 km	
GPWC-31	R			1 - 1.5 km	
GPWC-32	R			< 0.5 km	

*Habitat at colony:
R = Riverine trees and/or shrubs (e.g. in or fringing waterholes)
S = Swamp trees and/or shrubs (in a basin or depression, not in a channel)
F = Floodplain trees and/or shrubs (on a flat subject to inundation)
M = Mangrove trees.

Timing and regularity of breeding effort

Systematic documentation of the stage of breeding occurred only in 2010 and 2011. In April 2010, eggs were recorded in some nests in most of the active colonies, and young were recorded at three colonies; in March-April 2011, eggs were recorded at all 28 surveyed colonies and young at 23 colonies. This confirms that March and/or April is a suitable time for

Figure 2. A riverine breeding colony of egrets in freshwater trees and shrubs, Gulf Plains. Photo: Normanton Land & Sea Rangers, CLCAC.

surveys, as it is not too late for nests to have eggs (see Methods), but caution is nevertheless required because it is not too early for nests to have young.

The inconsistent coverage of sites from year to year (see Methods) and sparseness of information on sites surveyed but found to be inactive, preclude drawing strong conclusions on regularity of colonial breeding in the Gulf Plains from the results of our surveys. We consider that some active colonies may have been missed in 2009 and 2010 due to gaps in coverage of catchments. However, we are aware that some sites were first detected as supporting active colonies in 2011, a year with conditions that were wetter than average, and that some colonies were inactive in the relatively dry year 2013. Twelve particular colonies were active in at least two years and it seems that at least some colonies (e.g. Smithburne Central, Maid's Lagoon) may be active in most years (Table 2). In drier years, rainfall may be sufficient to generate small floods that inundate some floodplain in some of the middle reaches of the river systems, but floods probably do not reach the saline coastal zone, other than as in-channel flow. We therefore expect that some of the mangrove colonies will be inactive in drier years because saline flats and marshes will not have been inundated by rain and/or floods. At such times, some waterbirds – notably the Intermediate Egret – may not have enough optimal feeding habitat close to the colony sites.

Scale of breeding effort (colony size)

Table 2 illustrates the scale of breeding recorded in the various survey years, at each colony that was surveyed and found to be active. Some colonies were less than 500 m long and/or held fewer than 100 birds; others were several kilometres long and/or held thousands of birds. Without documentation of the density of birds (high, low, continuous, or patchy), it is not possible to assign an estimate of bird or nest numbers to colonies, based on colony length. However, from prior field experience and examination of photos and videos taken of some colonies, we estimate that most of the colonies that were at least 1 km long contained thousands of birds. This scale was recorded in at least one year at each of 12 colonies, and in two or more years at four colonies: Middle Gilbert 2, Smithburne Central, Maid's Lagoon and Norman 40 Mile. The largest colonies, each 4.5–5 km long in at least one year, were Middle Gilbert 2, Maid's Lagoon and Wills-Walker Saltflat. From prior field experience we estimate that each of these held several thousand birds, if not in the order of 10,000 birds in some years. We think these numbers, albeit coarse estimates, probably reflect the number of breeding pairs. As the surveys were only snapshots, it is possible that there were also undetected late or early breeders and some repeat nests at some colonies over the course of the breeding season.

With the exception of Wills-Walker Saltflat, the largest colonies were all in freshwater/inland locations, although the mangrove-based Leichhardt Estuary and Karumba colonies were moderately large. This result is not necessarily typical in northern Queensland: a colony in mangroves on the South Mitchell River estuary, north of the study area, near Kowanyama is sometimes very large, supporting in the order of 10,000 breeding pairs (RJ personal observations).

Data were inadequate for comprehensive inter-annual comparisons of scale of breeding effort but they showed variation at some colonies, such as the colony in mangroves opposite Karumba (probably an order of magnitude larger in 2011 than in 2009), whereas the size of some other colonies was consistent through time (Table 2). Rangers postulated that some increases may have been due to return of the previous year's young to breed in their birthplace colony, while in other cases, newly detected colonies may have been due to previous year's young needing to find alternative places to breed. As these waterbirds are highly mobile it is also possible that in wetter years, some – originating in other regions of northern Australia – visit the Gulf Plains to breed, whereas they may not visit in drier years.

Results by waterbird species (distribution and scale of breeding)

Table 3 shows the distribution of the 11 waterbird species recorded breeding in Gulf Plains colonies, among the 32 colonies surveyed from 2009 to 2013, based on aggregated data across all surveys. The highest number of species (11) was at Norman 40 Mile colony, followed by Maid's Lagoon (10) and five other sites each with 9 species. Ten colonies each had fewer than three species recorded breeding. The most widespread breeding species was the Australian White Ibis (*Threskiornis molucca*) (26 colonies), followed by the Royal Spoonbill (*Platalea regia*) (20) and the Nankeen Night-Heron (*Nycticorax caledonicus*), Intermediate Egret and Little Black Cormorant (*Phalacrocorax sulcirostris*) (18 each). No Cattle Egrets (*Ardea ibis*) were detected in the colonies in our surveys or in earlier coastal surveys by Taplin (1991) despite increasing range and numbers in Australia and small numbers on Karumba Plain (Marchant & Higgins 1990; Wetlands International 2013; RJ personal observations). Some egrets and black and white cormorants may not have been correctly identified in a few instances due to the short time available for surveying at each colony. Direct comparison between historical records and our data is possible for the combined Flinders and Bynoe estuarine colonies: species composition was similar (*cf.* Taplin 1991 citing earlier data from S. Garnett).

The scale of breeding effort by each species cannot be described adequately at present. However, the general impression, reinforced by RJ's observations elsewhere (e.g. South Mitchell River) and some other reports (Top End: Chatto 2000) is that the Intermediate Egret is the most abundant breeding species in the largest Gulf Plain colonies. Taplin (1991) concluded that the Little Egret (*Egretta garzetta*) was the most abundant breeding egret in a 1990 survey that focussed on estuarine parts of the study area (favoured habitat for Little Egret more so than Intermediate Egret: RJ personal observations) but the 1990 wet season was a failure and was compounded by ongoing drought (Taplin 1991); this may have inhibited breeding at inland sites (favoured by Intermediate Egret). The Australian White Ibis, Little Black Cormorant and Royal Spoonbill each also seem to comprise a substantial proportion of the overall total breeding effort in the region, based on our observations and on the number of colonies at which they occur.

Gaps in coverage

There are significant gaps in our survey coverage, which could be targets for future surveys in order to obtain a comprehensive understanding of colonial

Table 3. Occurrence of waterbird species among the surveyed colonies, 2009–2013.

Colony	Australasian Darter	Australian White Ibis	Eastern Great Egret*	Intermediate Egret	Little Black Cormorant	Little Egret	Little Pied Cormorant**	Nankeen Night -Heron	Pied Cormorant	Pied Heron	Royal Spoonbill	Totals
GPWC-01		X							X			**2**
GPWC-02		X			X							**2**
GPWC-03												**0**
GPWC-04		X	X	X	X	X		X			X	**7**
GPWC-05		X			X						X	**3**
GPWC-06										X		**1**
GPWC-07										X		**1**
GPWC-08											X	**1**
GPWC-09		X	X	X	X	X	X	X	X		X	**9**
GPWC-10		X	X	X	X	X	X	X		X	X	**9**
GPWC-11		X	X	X		X	X	X			X	**7**
GPWC-12		X										**1**
GPWC-13		X		X	X	X		X			X	**6**
GPWC-14		X			X						X	**3**
GPWC-15	X	X	X	X	X	X	X	X	X		X	**10**
GPWC-16		X										**1**
GPWC-17		X						X		X	X	**4**
GPWC-18	X	X	X	X	X	X	X	X	X	X	X	**11**
GPWC-19		X	X	X	X	X						**5**
GPWC-20	X			X								**2**
GPWC-21		X	X	X	X	X		X	X	X	X	**9**
GPWC-22		X	X	X	X	X		X		X	X	**8**
GPWC-23		X	X	X	X	X		X	X		X	**8**
GPWC-24		X	X	X		X		X		X	X	**7**
GPWC-25		X										**1**
GPWC-26		X	X	X	X	X		X	X	X	X	**9**
GPWC-27			X	X		X		X		X		**5**
GPWC-28		X	X	X		X		X		X	X	**7**
GPWC-29		X	X	X	X	X			X		X	**7**
GPWC-30		X	X	X	X	X		X	X	X	X	**9**
GPWC-31		X			X			X				**3**
GPWC-32		X			X			X			X	**4**
Totals	**3**	**26**	**16**	**18**	**18**	**17**	**5**	**18**	**9**	**12**	**20**	

* Eastern Great Egret *Ardea modesta*
** Little Pied Cormorant *Microcarbo melanoleucos*

breeding in the Gulf Plains. Within the study area, geographical gaps include Van Diemen Inlet, Fitzmaurice River and the lower-middle reaches of the Flinders-Bynoe and Leichhardt Rivers. Observers should be alert to possible additional colonies in channels or bends outside the paths previously flown. Elsewhere in the Gulf Plains, and especially in years of average to above-average rainfall, surveys to find colonies should be conducted outside the study area to the west, between the Leichhardt River and Northern Territory border, and to the north, in western Cape York. Furthermore, additional species may be detected breeding in specific colonies, other than those recorded in our 2009–2013 surveys, including species that are less abundant or less conspicuous (e.g. Pied Heron), or that nest underneath the upper canopy layers (e.g. Nankeen Night-Heron). The Normanton Land and Sea Rangers hope to fill gaps in coverage wherever possible; surveys over at least 10 years would be desirable in order to fully document the diversity and variability of colonies.

MANAGEMENT AND CONSERVATION

Ecological requirements of colonial waterbirds

A comprehensive understanding of the ecological components and processes that trigger and sustain waterbird breeding within colonies should be developed to inform surveillance/monitoring and the management of these natural assets. These ecological requirements remain poorly known and many will be specific to the geography and habitats of the Gulf Plains region. It is recommended that a program of ground-level surveys be undertaken by the CLCAC rangers at several accessible colonies on several dates over at least one complete breeding season. Data to procure at each colony should include: vegetation used for supporting nests; changes in water depth and extent; a full list of species breeding; estimates of relative abundance and total numbers of species; dates of laying, eggs hatching and young departing; and measures of breeding success. Aerial surveys of these sites should be conducted using previous methods, so that ground-to-aerial extrapolations can be attempted on the data, thereby enabling greater use of existing and future information from aerial surveys. Information on diets of the colonial nesting waterbirds would also be instructive for management, but would require highly sophisticated research.

Site management and conservation issues

During the 2009–2013 surveys, no immediate major threats to the viability of waterbird breeding colonies in the Gulf Plains were identified. In some riverine colonies, rubber vine (*Cryptostegia grandiflora*) may destroy trees in which the birds nest but it is conceivable that, although rubber vine is a widespread weed, in some cases the birds could relocate and successfully breed at other sites. Fishing and other boat activity in estuaries, even at Karumba port, is most likely not a present threat because colonies tend to be well inside the dense mangrove forest. Commercial grazing of cattle is conducted over most of the Gulf Plains landscape and on present evidence this does not seem to pose an obvious direct threat to colonies. However, severe soil erosion in catchments of northern Australia does cause waterholes to be filled with waterborne sand/silt (Brooks *et al.* 2011), affecting the health of waterhole shrubs/trees; we consider this impact thereby may potentially alter the suitability of such waterholes for colonial breeding.

The greatest potential threat to long-term sustainability of colonies may be any process or development that reduces the flooding of colony sites or floodplain feeding areas, or threatens the health of essential nesting trees. Changes to river flow and flooding in the region (through construction upriver of large reservoirs or irrigation schemes), such as in the Flinders and Gilbert River catchments therefore pose possible future threats to colonies. Such changes may make conditions for widespread breeding by waterbirds far less favourable, especially in years of average to below-average rainfall. Dams may stop small flows that are common early in the wet season; even in wetter years, downstream wetland habitats and floodplains are primed by small early flows and this increases the spread and environmental benefits of later flood pulses (Kingsford 2000).

Importance of the Gulf Plains region for colonial breeding waterbirds

Criteria adopted by the Ramsar Convention on Wetlands, to which Australia is a signatory, are the most widely used indicators of international importance of a wetland. Several of these criteria relate to waterbirds (Ramsar Convention 2013):

> Criterion 4: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
>
> Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.
>
> Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

In our opinion, each colony identified in our surveys meets Ramsar Criterion 4 because breeding, especially colonial breeding, may be considered a critical stage in the life cycle of a waterbird. We also consider that several of the larger colonies probably meet Criterion 5 because the number of breeding pairs likely exceeds 10,000 and thus the site supports at least 20,000 waterbirds. Furthermore, it is our view that Criterion 6 is probably met at some colonies. An estimate of total population size, endorsed by the Ramsar Convention (Wetlands International 2013), exists for each of the waterbirds breeding in the Gulf Plains colonies that we documented. Accordingly, for the Little Black Cormorant, Intermediate Egret, Nankeen Night-Heron and Australian White Ibis the 1% threshold is 10,000 birds and for each of the other seven species (e.g. Royal Spoonbill), the 1% threshold is 1000 birds (Wetlands International 2013). Despite the absence of comprehensive counts of species from all of the colonies that we surveyed, we consider that larger colonies, such as Smithburne Central and Maid's Waterhole, would each meet Criterion 6 for more than one species and that some smaller colonies may also meet Criterion 6 for at least one species. As only one criterion needs to be met, we conclude that most, if not all, of the Gulf Plains colonies are internationally important in terms of globally accepted criteria.

In northern Australia, the only other known aggregation of colonies of similar scale and species composition is in coastal floodplains of the Northern Territory, east and west of Darwin (Chatto 2000). These Top End colonies lie along about 450 km of coastal and sub-coastal wetlands, whereas those in the Gulf Plains region span about 250 km. Direct comparisons between the two regions may be possible in the future if we succeed in obtaining comprehensive details on numbers of birds breeding in the Gulf Plains. Furthermore, whereas our surveys have provided a major addition to the knowledge of where colonies are located in northern Queensland, more colonies will possibly be detected in less well known or unsurveyed reaches of rivers draining to the Gulf of Carpentaria in coming years. We are aware of suitable habitat in other catchments and several colonies have been identified in western Cape York (Marchant & Higgins 1990; Taplin 1991; RJ personal observations) but the scale, composition and timing of all colonies remain inadequately documented.

We consider several environmental factors to be important for understanding why so many colonies and waterbirds occur in the Gulf Plains region and to plan for their conservation. Firstly, the landscape is relatively flat and has many river and estuary systems, with multiple and complex networks of channels, associated floodplains and off-river depressions. In many years, relatively high and often intense seasonal rainfall and over-bank flooding fills these wetlands, producing abundant food resources for feeding by waterbirds. Additionally, the landscape presently has high integrity because the rivers and associated land systems are mostly unaffected by water regulation, disconnection of flows, removal of tree cover by clearing and development for cropping or industry. However, changes to any of these factors may impact the viability of the colonies.

Connections to other waterbird regions

Management of habitats, sites and species is more complex where substantial numbers of the key species move, annually or irregularly, to sites outside the region of interest. There is some evidence (Marchant & Higgins 1990) that some waterbird species, including many of those that have been recorded in the Gulf Plains colonies, migrate between northern Australia and southern New Guinea, and/or eastern Indonesia, during the dry season. For example, large numbers of egrets have been recorded in southern New Guinea (Halse *et al*. 1996) when they seem less abundant in drier parts of northern Australia; however, some egrets and Pied Herons apparently travel north only as far as northern Cape York (Taplin 1991; Driscoll 2001). Movements seem to reflect regional differences in seasonal dryness and thus availability of wetland feeding habitat. These likely connections between waterbird breeding colonies in the Gulf Plains region and other regions of Australia or overseas, indicate interdependence of wetland sites by showing that one cannot function without the ecosystem services provided by the other.

ACKNOWLEDGMENTS

We acknowledge the Carpentaria Land Council Aboriginal Corporation for making the survey program, data analysis and reporting of results possible; also the components of this funding which were supplied originally by the Queensland and Australian Governments. Mark Hogno coordinated the survey program for CLCAC; rangers PR, Lance Rapson, Phillip George, Alfred Pascoe and Derek George, also RJ, participated in one or more surveys. Special thanks are due to the helicopter pilot Des Butler of Cloncurry Mustering, who safely and expertly transported us around the region. Pilots, landholders and other community members supplied information that directed us to some of the colonies. Technical support and mentoring was provided by Wetlands International. Peter Barker and Melanie Dulfer-Hyams of CLCAC provided administration support and Mike Digby of Northern Gulf Resource Management Group produced the map for this article. Advice and comments on the draft article were provided by Julian Reid, Dane Panetta and Denise Elias.

Some places along the Norman River where waterbird breeding colonies were recorded, have been identified as Culturally Significant sites to the Kukatj people. These places were used for trading and ceremonies and burial sites are situated in the area. Similar values are likely to exist in regard to other rivers and their colonies.

REFERENCES

BRIGGS, S.V. & THORNTON, S.A. 1999. Management of water regimes in river red gum *Eucalyptus camaldulensis* wetlands for waterbird breeding. *Australian Zoologist* 31: 187–197.

BRIGGS, S.V., THORNTON, S.A. & LAWLER, W.G. 1997. Relationships between hydrological control of river red gum wetlands and waterbird breeding. *Emu* 97: 31–42.

BROOKS, A., SHELLBERG, J., SPENCER, J., KNIGHT, J. & PIETSCH, T. 2011. Erosion and sedimentation issues in the Mitchell & Gulf Rivers. Seminar of Tropical Rivers and Coastal Knowledge, June 2011. http://www.nailsma.org.au/sites/default/files/event/Andrew%20Brooks%20TRACK%20CLCAC%20June%2011.pdf Accessed 22 October 2013.

BUREAU OF METEOROLOGY 2013a. Archive – Northern wet season rainfall deciles for Australia. www.bom.gov.au Accessed 19 August 2013.

BUREAU OF METEOROLOGY 2013b. Climate Data Online. http://www.bom.gov.au/climate/data/ Accessed 19 August 2013.

CHATTO, R. 2000. Waterbird breeding colonies in the Top End of the Northern Territory. Technical Report 69, Parks & Wildlife Commission of the Northern Territory. http://lrm.nt.gov.au/__data/assets/pdf_file/0004/17518/2000_waterbirds_rpt69.pdf Accessed 19 August 2013.

CHRISTIDIS, L. & BOLES, W.E. 2008. *Systematics and Taxonomy of Australian Birds*. CSIRO Publishing: Melbourne.

DEPARTMENT OF PRIMARY INDUSTRIES, PARKS, WATER AND ENVIRONMENT (DPIPWE) 2013. Wise use of wetlands: Seasonal changes. Department of Primary Industries, Parks, Water and Environment, Tasmania. http://www.dpiw.tas.gov.au/inter-nsf/WebPages/RPIO-4YS94B?open Accessed 19 August 2013.

DRISCOLL, P.V. 2001. Gulf of Carpentaria wader surveys, 1998-9. Report to Queensland Environmental Protection Agency, 84 pp. plus appendices.

HALSE, S.A., PEARSON, G.B., JAENSCH, R.P., KULMOI, P., GREGORY, P.S., KAY, W.R. & STOREY, A.W. 1996. Waterbird surveys of the Middle Fly River floodplain, Papua New Guinea. *Wildlife Research* 23: 557–569.

JAENSCH, R. 2009. Floodplain wetlands and waterbirds of the Channel Country. South Australian Arid Lands Natural Resources Management Board. http://www.saalnrm.sa.gov.au/Portals/8/Publications_Resources/Project_Reports/SAAL-Report_Water_Floodplain_Wetlands_And_Waterbirds_Of_The_Channel_Country-022009.pdf Accessed 19 August 2013.

JAENSCH, R. 2013. Waterbird breeding colonies in the Gulf Plains region, 2009–2013. Report to Carpentaria Land Council Aboriginal Corporation, 32 pp.

KINGSFORD, R.T. 2000. Ecological impacts of dams, water diversions and river management on floodplain wetlands in Australia. *Austral Ecology*, 25: 109–127.

KINGSFORD, R.T., PORTER, J.L. & HALSE, S.A. 2012. National waterbird assessment. Waterlines report, National Water Commission, Canberra. http://www.nwc.gov.au/__data/assets/pdf_file/0012/21720/Waterlines-74-National-waterbird-assessment.pdf Accessed 19 August 2013.

MARCHANT, S. & HIGGINS, P.J. 1990. *The Handbook of Australian, New Zealand and Antarctic Birds*, Vol. 1: *Ratites to Ducks*. Oxford University Press: Melbourne.

RAMSAR CONVENTION 2013. Criteria for Identifying Wetlands of International Importance. Ramsar Convention on Wetlands. http://www.ramsar.org/cda/en/ramsar-documents-guidelines-strategic-framework-and/main/ramsar/1-31-105%5E20823_4000_0__#C Accessed 21 October 2013.

SATTLER, P.S. & WILLIAMS, R.D. (eds.) 1999. *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency: Brisbane.

TAPLIN, A. 1991. Distribution and abundance of selected waterbird species in the Gulf Plains and western Cape York during 1990. Report to Queensland National Parks & Wildlife Service, 68 pp.

WETLANDS INTERNATIONAL 2013. Waterbird Population Estimates. http://wpe.wetlands.org/ Accessed 19 August 2013.

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RAINBOW BEE-EATERS (*MEROPS ORNATUS*) TAKING FISH

LLOYD NIELSEN

Large numbers of Rainbow Bee-eaters (*Merops ornatus*) winter throughout the Wet Tropics of north-east Queensland. Wintering occurs at most altitudes, from sea level to high in the Great Dividing Range. Many birds winter along rivers and about swamps and lagoons.

In 1992, not long after I moved to north-east Queensland, I had a job taking tourists on day trips from Cape Tribulation north of the Daintree River to the Bloomfield River. One of the activities was a crocodile-spotting tour on the river, where there was also a wintering population of bee-eaters. Many times, I saw Rainbow Bee-eaters plunging into the water. I initially thought this was a bathing activity and took little notice until on one occasion, a bird came close to the boat, splashed onto the surface of the water and emerged with a small fish, which it took back to a perch and thrashed before consuming. From then, I watched other bee-eaters and realised they were all engaged in the same activity – catching small fish from the surface. Several Spangled Drongos (*Dicrurus bracteatus*) were also joining in and taking fish.

On following occasions when taking tours on the river, I watched birds more intently and realised bee-eaters splashing into the water were always taking fish. None were bathing.

Soon afterwards, I moved to Mt Molloy on the Northern (Atherton) Tablelands. Beside my residence, there is a permanent lagoon fringed with young weeping paperbarks (*Melaleuca leucadendra*). Up to 12 Rainbow Bee-eaters, but sometimes fewer, winter around the lagoon each year. I found these birds also to be catching small fish from the surface, using the branches of the paperbark trees as perches, flying out and diving onto the water to take a fish from the surface and then flying back to the same branch to beat the catch before swallowing it. The bee-eaters do this day after day, so much so that fish must form a considerable part of their diet at this time of the year. Occasionally a Spangled Drongo joins in to take the fish. Smaller species of fish in this lagoon have been identified as Chequered Rainbowfish (*Melanotaena splendida*) and Purple-spotted Gudgeon (*Mogurnda mogurnda*).

Piscivory in bee-eaters is rare. Of the 25 species worldwide, only three have been recorded taking fish and then only rarely (del Hoyo 2001). There appear to be no published records of Rainbow Bee-eaters taking fish. However, the taking of "food" from the water surface has been recorded at least twice. Wheeler (1973) describes an incident at Redesdale, 40 km south-east of Bendigo in Victoria, where birds took prey from a dam in a manner similar to that which I have observed. The prey was later identified as tadpoles. Wheeler also discusses an observation made by T. Guthrie, where birds took prey from the surface of the Mulgrave River near Gordonvale, north-east Queensland. Guthrie did not identify the prey, but supposed it to be a species of crustacean or a mollusc in the early stages of development. However, given that the Mulgrave River is a major coastal freshwater stream (approximately 75 km from Mt Molloy) and taking my observations into account, it seems likely that the prey may have been either a small species of fish or fingerlings of a larger species.

REFERENCES

del HOYO, J., ELLIOTT, A. & SARGATAL, J. 2001. *Handbook of the Birds of the World – Mousebirds to Hornbills.* 6: 286–341. Lynx Edicions: Barcelona, Spain.

HIGGINS, P.J. (Ed.) 1999. *Handbook of Australian, New Zealand and Antarctic Birds,* Vol. 4: *Parrots to Dollarbirds.* Oxford University Press: Melbourne.

WHEELER, R. 1973. Rainbowbirds taking tadpoles. *Australian Bird Watcher* 5 (2): 48.

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YELLOW WHITE-EYE (*ZOSTEROPS LUTEUS*) ON LITTLE WOODY ISLAND, NORTH QUEENSLAND – EXTENSION OF RANGE

LLOYD NIELSEN

The northern boundary of the range of the Yellow White-eye (*Zosterops luteus*) on the western side of Cape York Peninsula is given as "Christmas Creek, 115 km north of Edward River" (Higgins *et al.* 2006). (Note that Christmas Creek is in fact only 32 km north of Edward River.)

Since 2000 an annual visit has been made to Little Woody (Meggi Yalubi) Island (10°42'54" S; 142°.20'38.4" E), as an excursion from Klaus Uhlenhut's annual Bird Week to Bamaga. Little Woody Island is located on the western side of Cape York Peninsula, 17 km north-west of Seisia and 21 km south-west of the tip of the Peninsula. The annual visit takes place during the first full week of January or a few days later.

The island, approximately 450 m long and 270 m wide, is covered with closed, scrubby, monsoon-type forest and vine thicket. There is a large population of Pale White-eyes (*Zosterops citrinella*) on the island as well as Red-headed Honeyeaters (*Myzomela erythrocephala*), Mangrove Robins (*Peneonanthe pulverulenta*), Mangrove Golden Whistlers (*Pachycephala melanura*), Rose-crowned Fruit-Doves (*Ptilinopus regina*) and a very large breeding population of Pied Imperial-Pigeons (*Ducula bicolor*).

The main purpose of the excursion is to see the Pale White-eye, an island species that inhabits only the denser vegetated islands in the southern and south-western Torres Strait. (There are no authentic mainland records of Pale White-eyes on the immediate coast, even where islands are close to the mainland coast). We usually spend one to two hours on the island.

Up until 2002, the only white-eye we had recorded from the island was the Pale White-eye. In that year, a single very yellow bird was also seen. It was suspected as being either a Yellow White-eye (*Zosterops luteus*) or a luteous individual of the Pale White-eye. In 2003, another single yellow bird was seen, which we were able to identify definitely as a Yellow White-eye. Gregory (2003) also recorded two Yellow White-eyes on a later visit to Little Woody Island in early 2003. Since then one or more yellow birds have been seen in most years, all of which have been Yellow White-eyes.

Sightings of out-of-known-range Yellow White-eyes have been made previously on and off the eastern side of Cape York Peninsula and off the north-east coast of Queensland, e.g. Iron Range (Johnson & Hooper 1973); Lakefield NP, Bathurst Head and Cardwell (Higgins *et al.* 2006); Edge Hill, Cairns (Seaton 1956); North Barnard Islands (Le Souf 1891); Brook Islands (J. Young personal communication). However, despite there being a large isolated permanent population centred on the mouth of the Burdekin River –Barratta Creeks further south in central eastern Queensland, no permanent populations have established in either of these other localities.

There is an unusual record of a bird from Sawtell, NSW, February 2009, that has been accepted by the Birds Australia Rarities Committee (Case 594). The possibility that long-distance movement of this bird may have been assisted should not be ruled out. It is locally known that Olive-backed Sunbirds (*Nectarinia jugularis*) are occasionally transported south in truckloads of bananas from the extensive growing area in the Wet Tropics.

The area we visit on Little Woody Island consists of beachside vegetation 150 m long and up to 25 m wide. Considering the small size of the area visited, the short time we spend on the island, that the entire island is covered with similar vegetation and that we have seen one or more birds on most visits since 2002, it seems likely that a small permanent population has established here.

The presence of Yellow White-eyes on Little Woody Island extends the distribution of this species by approximately 420 km northward from Christmas Creek. Most of the intervening coastal area between these two localities is inaccessible.

This also represents the first record of sympatry between the two species. Higgins *et al.* (2006; p. 1734) state "Range [of Pale White-eye] unlikely to overlap that of Yellow White-eye;" and "...which [Pale White-eye] in HANZAB region is confined to islands of Torres Strait...". Draffan *et al.* (1983) did not record Yellow White-eyes in their extensive study of Torres Strait islands. These statements support my own observations: I have no records of Pale White-eyes south of Little Woody Island.

REFERENCES

DRAFFAN, R.D.W., GARNETT, S.T. & MALONE, G.J. 1983. Birds of the Torres Strait: an annotated list and biogeographical analysis. *Emu* 83: 208–234.

GREGORY, P. 2003. *Far North Queensland sightings.* Birding-aus newsgroup. 28.3.03.

HIGGINS, P.J., PETER, J.M. & COWLING, S.J. (Eds) 2006. *The Handbook of Australian, New Zealand and Antarctic Birds,* Vol. 7: *Boatbill to Starlings.* Oxford University Press: Melbourne.

JOHNSON, H.R. & HOOPER, N. 1973. The Birds of the Iron Range Area of Cape York Peninsula. *The Australian Bird Watcher* 5: 80–95.

LE SOUF, D. 1891. Trip to Queensland. *Victorian Naturalist* 8: 148–164.

SEATON, C. 1956. Birds at Edge Hill. *North Queensland Naturalist.* 114: 21–23.

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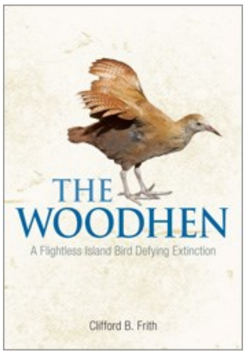
BOOK REVIEW

The Woodhen: A Flightless Island Bird Defying Extinction

By Clifford B. Frith



Published by CSIRO Publishing, 2013
Hardback, 240 pages
AU $59.95
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Frith presents a wonderfully complete history of the discovery and ecology of Lord Howe Island, focusing particularly on the flightless Woodhen. His historical, scientific and comprehensive literature research has produced a work of great general and scientific interest and value. Appendices include a comprehensive bibliography; the results of the Woodhen Captive Breeding programme (based on a first draft text by John Disney and Peter Fullagar); a comprehensive bird list for the Lord Howe Island Group; and a list titled: 'Some bird species saved from extinction'.

Woodhen origins, breeding biology, ecology, behaviour, and management are each considered in great detail. The planned recovery of the Woodhen population through the removal of feral predators and a successful captive breeding programme is an exciting model for recovery projects for island species.

In a chapter considering the future of the Woodhen, Frith stresses the importance of the ongoing Recovery Plan which involves tasks in management action, research and community awareness. He notes that research to assess the impact on the Woodhen of food competition from Buff-banded Rails, Purple Swamphens, Blackbirds and Song thrushes would make ideal PhD and Masters topics.

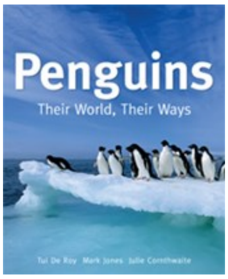
This is a most valuable resource for general ecological study of island species, for the development of recovery and management plans for those species and for the detailed history of the impact of human settlement on island species.

D. Muir

BOOK REVIEW

Penguins: Their World, Their Ways

By Tui De Roy, Mark Jones and Julie Cornthwaite



Published by CSIRO Publishing, 2013
Hardback, 240 pages
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This absorbing book takes the reader on a journey into (mostly) Antarctic, southern island and southern continental realms to observe the biology, ecology and behaviour of penguins, whose amphibious way of life is in fascinating contrast to the ways of other birds. The text is highly engaging and the photographs superb – on land, on ice, at sea and undersea, these capture action, moods, curious moments and stunning habitat.

Authoritative and detailed, the book makes a useful reference, alongside its design for the general reader. Its three parts are preceded by a double-page spread on global penguin distribution, where an informative map of the southern hemisphere provides a refreshingly uncommon perspective of the Earth.

Part 1, 'Life Between Two Worlds', presented by Tui De Roy, introduces the cyclic land–sea transitions that penguins make, and adaptations to each environment. Anecdote-filled accounts of the way of life of each species follow, written with an intimacy derived from a lifetime of observation, research and clear admiration.

Part 2, 'Science and Conservation', presented by Mark Jones, commences with an informative review of human discovery of, and relationships with penguins, including discourse on evolution, etymology and taxonomy, exploitation, attitudes, commercialisation, current threats and conservation. Vignettes contributed by scientists then describe a range of penguin research topics and discoveries, such as evolutionary shifts and ancient species, colouration, colony mapping, undersea observation, population dynamics, and climate change and other human impacts upon populations.

Part 3, 'Species Natural History', presented by Julie Cornthwaite, provides a pictorial line-up of the 18 penguin species, an array of penguin facts and a table summarising species' status, population estimates, ranges and threats. Species profiles follow, including information on identification, life history and threats, before concluding with a guide to best penguin-viewing locations.

If you are not yet enamoured by penguins, you will be after reading this book.

Denise Elias

SUNBIRD INDEX TO VOLUME 43

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The Sunbird is published periodically by the Queensland Ornithological Society Incorporated to further the knowledge of birds in Queensland and adjacent northern regions of Australia.

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Submission of a paper implies that the results reported have not been published and are not being considered for publication elsewhere. The editor reserves the right to submit records of rare birds to the Records Appraisal Committee of the Queensland Ornithological Society as part of the refereeing process.

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References should be listed in alphabetical order at the end of papers in the following styles:

FLEAY, D.H. 1973. Nesting habits of the brush turkey. *Emu* 36: 153–163.

FRITH, H.J. (Ed.) 1976. Mallee fowl. In *Complete Book of Australian Birds,* pp. 136–137. Reader's Digest: Sydney.

IUCN 2006. *2006 IUCN Red List of Threatened Species.* www.iucnredlist.org Accessed 14 October 2006.

SERVENTY, D., SERVENTY, V.N., & WARHAM, J. 1971. *The Handbook of Australian Sea-birds.* Reed: Sydney.

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