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Breeding of the Hooded Robin *Melanodryas cucullata* in native and exotic woodlands near Armidale, New South Wales

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The breeding behaviour and habitat of three groups of Hooded Robins *Melanodryas cucullata* were studied near Armidale, on the Northern Tablelands of New South Wales, from winter 2006 to winter 2007, by quantifying nest sites, colour-banding nestlings, and observing Robin families until beyond independence of the banded juveniles. Egg-laying commenced in September, and continued until December for the last of five consecutive unsuccessful clutches (all C/2). Two broods (each B/2) fledged, after an incubation to fledging period of 27 days, including a nestling period of more than 11 days. Breeding productivity was 1.3 fledglings/group and 0.57 fledglings/attempt (nest success and fledging success were both 29%; n = 3 pairs or groups, 7 nests). Fledglings were dependent on their parents for eight weeks, with post-juvenile moult starting at 6–8 weeks and completed by 6–7 months post-fledging (in autumn); one offspring acquired adult-like male plumage by this time. Breeding groups consisted of 2–5 adults, in home ranges of 30+ hectares; nest sites were in eucalypt saplings and in an exotic pine plantation. Nest-building, breeding behaviour, and food and foraging are described.

INTRODUCTION

The south-eastern subspecies of the Hooded Robin *Melanodryas cucullata cucullata* is considered nationally *near-threatened* (Garnett *et al.* 2011), and is listed as *vulnerable* in New South Wales (*Threatened Species Conservation Act 1995*). It is one of the typically open-nesting, ground-foraging, insectivorous woodland passerines that are declining in the sheep–wheat belt (Ford *et al.* 2001; Ford 2011; Watson 2011). This subspecies prefers large patches of woodland (>100 ha) that are well connected to other woodland, have moderate to high tree and shrub cover, and have logs, fallen branches and litter (Watson *et al.* 2001, 2002; Antos and Bennett 2006; Antos *et al.* 2008). It also prefers a ground cover of native, perennial tussock grasses on deep (i.e. productive) soils, on the edge of woodland remnants (Maron and Lill 2005; Priday 2010).

The biology of the Hooded Robin is now reasonably well known (Higgins and Peter 2002; Fitri and Ford 2003a,b), and it has been studied in the New England region of New South Wales (Courtney and Marchant 1971; Bell 1984; Fitri and Ford 1997, 2003a,b). However, there are few data on nestling growth, the post-fledging period, and acquisition of adult-like plumage (Higgins and Peter 2002; Fitri and Ford 2003b). This paper reports on these hitherto little-documented aspects. It also presents data on habitat use, including breeding in exotic pine forest, and reports on an attempted translocation and reintroduction. The Hooded Robin metapopulation around Armidale is highly dispersed and declining (Ford *et al.* 2009), hence the value of further data despite small sample sizes. Furthermore, there is a need for natural-history information to supplement science (Herman 2002).

STUDY AREA AND METHODS

The study area was within a 50-kilometre radius of Armidale (30°30′S, 151°40′E) on the Northern Tablelands of New South Wales (altitude 1000 m, annual rainfall 800 mm: see Fitri and Ford 2003a,b; Debus *et al.* 2004; Debus 2006a,b; Ford *et al.* 2009), and included some of the Hooded Robin sites described by Fitri and Ford (1997). One of those territories (in Yina Nature Reserve; see Debus 2006b and Debus and Ford 2012) was visited repeatedly throughout 2001–02 while a Hooded Robin group persisted there. In 2005 the one remaining Gara Travelling Stock Reserve (TSR) group (see Fitri and Ford 1997) was observed repeatedly, and in 2006–07 Yina and Gara were searched repeatedly, but no Hooded Robins were found breeding.

In 2006 three previously unknown pairs/groups were found around Armidale: two in or on the edge of Armidale State Forest (the Pine Forest, a Monterey Pine *Pinus radiata* plantation) where it adjoined eucalypt grassy woodland and grassland, and one in partly cleared eucalypt grassy woodland north of the University of New England campus (Kirby Road) (Fig. 1). The Pine Forest (~250 ha, in three discrete blocks of approximately equal area separated by clearings) is described elsewhere (Debus 1983; Debus *et al.* 2004). It consists mostly of mature pines with a sapling regrowth midstorey, and some blocks of advanced saplings planted in the preceding decade or so (in some cases with logging debris persisting from the previous cutting cycle). One corner remnant (~5 ha) consists of mature eucalypt grassy woodland. The surrounding land use is mostly livestock grazing, in grassy paddocks with remnant eucalypt woodland or scattered trees.

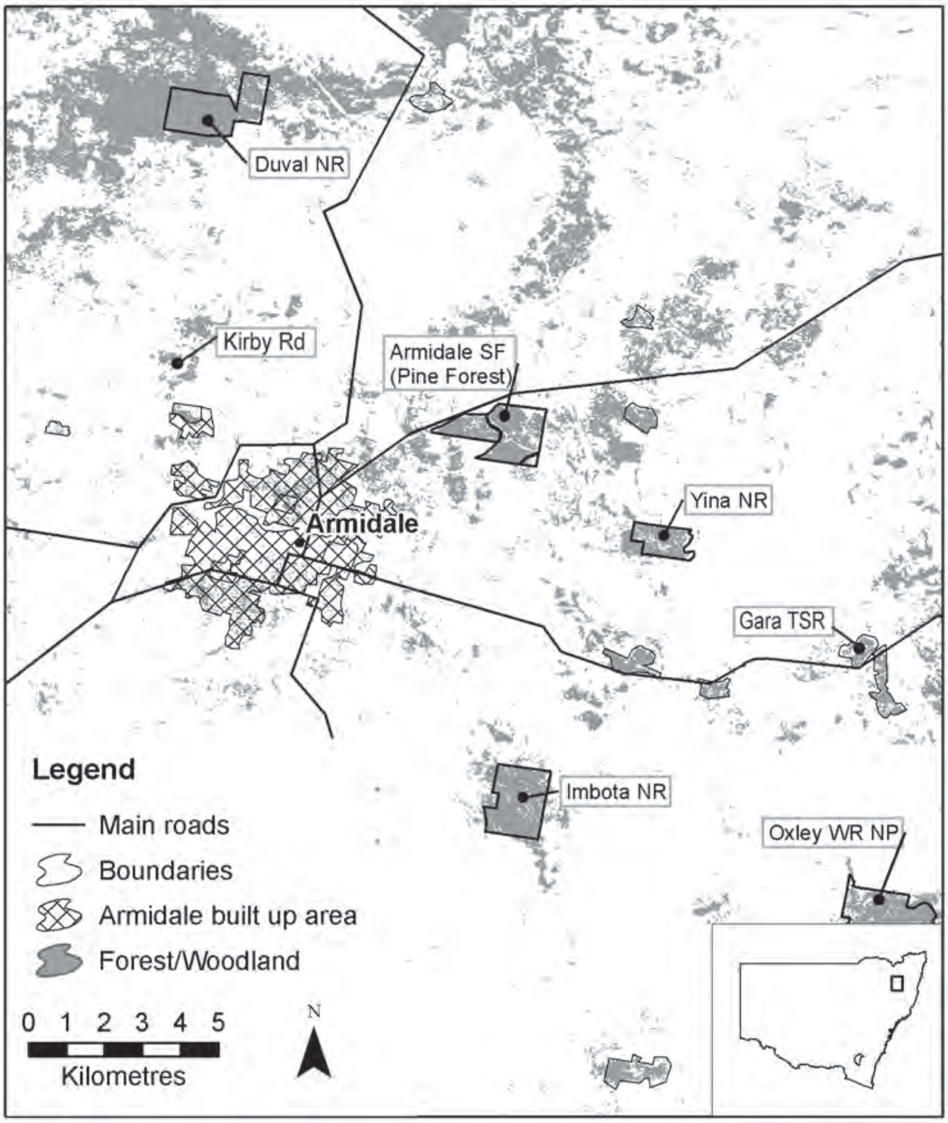

Figure 1. *Map of main study area, showing locations mentioned in text. Outlying locations in Table 1 (Torryburn, Yarrowyck) are ~40 km west of Armidale.*

The Kirby Road site was predominantly regrowth Yellow Box *Eucalyptus melliodora*–Blakely's Red Gum *E. blakelyi* grassy woodland, with some Manna Gum *E. viminalis* (in gullies) and Rough-barked Apple *Angophora floribunda* peripherally, and some grassland; the native grass cover included Kangaroo Grass *Themeda australis* tussocks.

In spring–summer 2006 all nesting attempts of the Kirby Road pair and the two Pine Forest pairs (herein designated North and South) were monitored. Nest sites and aspects of nest microhabitat of the Kirby Road pair were measured (habitat complexity within 20 m of each nest, and density of trees, shrubs, dead trees/shrubs and logs in 1 ha enclosing the nest sites: see Debus 2006a,b). In spring–summer 2006–07 the two Pine Forest families with fledglings were followed until independence of their juveniles, after colour-banding their chicks in the nest a few days before nest-leaving age (metal bands supplied by the ABBBS). Care was taken not to flush incubating or brooding females off nests. Vacated nests and their components were weighed on an electronic balance, and abandoned intact clutches (several days overdue to hatch) were examined for fertility. Terminology follows Higgins and Peter (2002) and Fitri and Ford (2003a,b), as applicable, and nest-site parameters (e.g. 'tree', 'sapling' and 'shrub' classes) were as defined elsewhere (Debus 2006b).

Resightings of colour-banded maturing juveniles, while still with their parents, were used to plot approximate home-range boundaries (on 1:25 000 topographic maps) where possible, although members of both groups sometimes could not be found, and the exact limits of their home ranges in some directions from the nest were undetermined. A basic polygon was drawn around all observations points, and areas and distances were estimated or measured from the maps. For the Pine Forest North group, the forest interior was frequently searched and netted for other robin species in 2006 (Debus and Ford 2012) without encountering Hooded Robins.

Table 1

Composition of Hooded Robin groups around Armidale. TSR = travelling stock reserve; NR = nature reserve; SF = state forest. N = north, S = south. M = male, F = female, imm. = immature.

Group	Site	Year	Comments
Gara	TSR; eucalypt grassy woodland	2005	Pair + imm. blotchy M (latter seen once on periphery of territory, in winter).
Yina	NR; eucalypt grassy woodland	2001	Pair + grey bird (sex?) in winter; pair + imm. blotchy M late next summer (+ fledgling)
Pine Forest N	SF; mature *Pinus* plantation	2006	Pair + two pied (adult-plumaged) M helpers and a grey helper (sex ?); after brood fledged, helpers dispersed, leaving pair + (by next autumn) first-year banded M offspring (acquiring pied plumage)
Pine Forest S	SF; young *Pinus* plantation	2006	Pair + one pied M helper; after brood fledged, one banded grey offspring (M? by size and behaviour) remained with adult trio through next winter.
Kirby Rd	Private land; eucalypt grassy woodland	2006	Adult pair only (raised no offspring during study)
Torryburn 1	Private land; eucalypt grassy woodland	2006	Adult pair only
Torryburn 2	Private land; eucalypt grassy woodland	2006	Four pied M, one imm. M (hooded, but dark grey-brown, not black); F not seen (could have been on nest, Aug.). Much chasing, but group seemed coherent.
Yarrowyck	Private land; eucalypt grassy woodland	2006	Pair + pied M

In spring 2006 an adult male and female of a trio (having a 'pied' male helper) were mist-netted approximately 10 kilometres north-west of Yarrowyck, west of Armidale (see Fitri and Ford 1997; Ford *et al.* 2009), fitted with radio transmitters (model BD-2, Holohil Systems Ltd), and translocated to Imbota Nature Reserve (see Debus 2006a,b), from which the species had disappeared by the 1980s. The transmitters weighed approximately one gram or five percent of the body weight of a Hooded Robin, attached as a backpack to a dissolving pelvic harness (Doerr and Doerr 2002). This procedure was part of an experiment investigating reintroduction, dispersal and use of corridors by Eastern Yellow Robins *Eopsaltria australis* (see Debus and Ford 2012). Over several days of trying to net adult Hooded Robins in two territories, observations were made on those and neighbouring pairs or groups of Hooded Robins: groups Torryburn 1 and 2, and Yarrowyck, in Table 1. The Yarrowyck territory was monitored occasionally for reoccupation, to assess the effect on the source population of the removal of a pair.

RESULTS

Social organisation

At the start of the breeding season, Hooded Robin groups ranged from simple pairs to up to three or possibly four helpers: commonly a trio of an adult pair plus an adult or maturing male, with most helpers being male (Table 1). In both Pine Forest groups, one fledgling (of two) disappeared around the time of independence. In both cases, the absent juvenile had moulted (from brown, streaked juvenile plumage) into a grey plumage, suggesting that both were females. The remaining (single) juveniles moulted into (a) pied plumage, i.e. male (Pine Forest North), and (b) grey plumage, but this bird was large and dominant, and appeared to be male (Pine Forest South). The latter chased its grey sibling repeatedly, and the pied juvenile male also behaved aggressively towards its mother, in both cases around the time the respective sibling disappeared. The three helpers in the Pine Forest North group also disappeared, leaving only the pair and two juveniles, around the time the juvenile male started acquiring adult-like plumage.

Home ranges

The home range of the Pine Forest North group was at least 25 hectares, and 500 metres across in one direction, with nest-building forays of up to approximately 300 metres. This group mostly ranged out from the edge of the mature pines (where the nest was) into adjoining pasture with remnant eucalypts, and onto an old sportsfield surrounded by a low wooden fence and scattered eucalypts. The pines (and then only the grassy edge zone of the mature pines) appeared to form a small proportion of this group's home range, perhaps 15 percent, but these birds could not always be located and their habitat use at such times was unknown (other than being absent from the forest interior: see above).

The home range of the Pine Forest South group was at least 30 hectares, approximately 700 × 500 metres, and included young pines of various ages with open areas, standing dead or dead-topped young pines, pine logs, tracks and a wide powerline easement, and extended (in the non-breeding season) to the eucalypt woodland remnant and adjoining pasture with scattered eucalypts. The immature pines and open areas within appeared to form a large proportion (~70%) of this group's home range, particularly in the breeding season where they spent all their observed time.

Table 2

Hooded Robin breeding success, Armidale, spring 2006 (see Table 1).

Robin pair/group	Clutch	Brood	Outcome
Kirby Rd pair	C/2	–	Fail (predation)
	C/2	–	Fail (overdue, infertile; abandoned)
	C/2	–	Fail (destroyed; predation/storm?)
	C/2	–	Fail (overdue, infertile; abandoned)
	C/2	–	Fail (overdue, infertile; abandoned)
Pine Forest N group	C/2?	B/2	Both fledged, independent
Pine Forest S trio	C/2?	B/2	Both fledged, independent

The Kirby Road pair was seen, in the following winter, approximately 600 metres west of the nesting area, and in the 2009 season the pair had a nest also approximately 600 metres west-north-west of the 2006 nesting area.

Breeding season

At Armidale, one female Hooded Robin (Pine Forest North) had started nest-building by 1 September and laid around 10 September; two others (Pine Forest South, Kirby Road) were incubating first clutches by 6 and 21 September, respectively. One repeatedly unsuccessful female (Kirby Rd) laid her last clutch in the second week of December.

Nest-building

All seven nests examined were constructed of grasses and other fibres, bound with cobweb, and camouflaged externally with bark flakes (of native or exotic trees as available), much as described previously (see Higgins and Peter 2002; Fitri and Ford 2003b). Seven vacated nests weighed 7.6–14.2 grams (mean 10.0 g). Strands of nest fibre averaged 0.01 gram each, so there would have been approximately 1000 fibres and 10 or so bark flakes (~0.06 g per flake) per nest, representing approximately 100 collecting trips per nest if the female's beakful of material averaged 0.1 gram (10 fibres or two bark flakes). Females gathered beakfuls of multiple items, and flew sometimes more than 200 metres from source to nest. The male (of a simple pair) sometimes closely followed the female during the pre-laying phase and during her material-gathering forays, as if guarding. The Pine Forest North first (successful) nest was completed to the outer cup stage in three days from discovery of building behaviour, and took a further five days to egg-laying (i.e. >8 days from start to lay; lining, and latent time to laying, not recorded).

The Kirby Road pair started a second nest four days after the first was destroyed by an unknown predator (egg stage). On day 2 (after discovery) the base and sides were built; on day 3 the nest cup was formed and the inside walls lined; on day 4 the nest cup was complete (not fully lined?), no eggs; two days later (= day 6) the female laid the first of C/2. After that nest was abandoned (see Table 2), the female was suspected to be rebuilding four days later (= day 1); on day 3 she was building, and on day 7 she was already incubating the third clutch (i.e. laid the first of C/2 by day 6). After that nest was destroyed (egg stage), she was already rebuilding four days later and was incubating the fourth clutch another two days later (i.e. had laid the first of C/2 only five days after failure). When that nest in turn failed (egg stage), the time to rebuild and lay was not recorded, but she was found already incubating a fifth (final) C/2 clutch within nine days (probably less) of failure. Thus, new nests were built and repeat clutches laid within 5–9 days of failure at the egg stage, with four replacement clutches in the season. Repeat nesting and laying occurred more rapidly than for the initial nesting.

Breeding biology

Five clutches (from one female) were all C/2, and two other females had a brood each of two chicks with no sign of unhatched eggs. Thus, seven clutches were probably all C/2. One female had five successive failed clutches within the 2006 season: two nests with eggs were destroyed (one by a predator, one possibly by a storm), and three clutches were abandoned a few days after hatching was due (all infertile or dead, with no developing embryo; Table 2). Two other females had one successful brood (B/2) each. Thus, nest success was 29 percent for nests with eggs, with four young from an assumed 14 eggs (= 29% fledging success); four young fledged from three groups (= 1.3 young/group) or from seven attempts (= 0.57 young/attempt) in 2006 (Table 2).

For one nest, incubation to fledging took 27 ± 1 days, and at another, the nestling period lasted at least 11 days. At one nest, the female was always brooding the chicks, when checked, until seven days before fledging, and brooded intermittently until five days before fledging. At both, the chicks were feathering at seven days before fledging (Table 3).

One adult female started a second nest 31 days after her young fledged, when the juveniles were still being fed. The nest was apparently completed in three days (no eggs yet), and was abandoned, apparently without laying, three days later. Another female was carrying nest material 59 days after her young fledged (5 days after independence), but the attempt did not proceed to laying. Thus, four repeat clutches were laid after successive failures, but no repeat clutches were found after a successful brood was raised.

Parental behaviour

Males courtship-fed females in the pre-laying phase. Incubating females were fed on the nest by the male, and gave food-begging calls, but also foraged for themselves. At one nest, a male attended (fed?) the chicks on day 6 of the nestling period, and at another, a grey helper fed advanced nestlings. Food-bearing adult males gave soft contact calls or a soft version of the song when approaching the nest.

Table 3

Growth stages of nestling Hooded Robins (two broods, each of two young), Armidale, spring 2006. Day 1 = first day hatchlings seen (could have hatched on previous day).

Day	Description
1	Naked: dark skin, feather pins just emerging
2	As above
5	Covered in burst pin-feathers
6	Feathered; remiges ensheathed
7	Well feathered
8	Remiges ensheathed; no tail (visibly emerged by 7 d post-fledging; see Table 4)
11	Still in nest, fully feathered other than tail
12	Fledged (nest vacant, young invisible in cover)

Figure 2. *Female Hooded Robin incubating, on nest, Gara TSR (native eucalypt woodland), spring 2011. A pair reappeared at Gara in 2011 (see text), but also had five successive unsuccessful nests that year.*

Photo: Bob Shepherd

The adults of Pine Forest North defended the nest (the female also performed a distraction display, i.e. injury-feigning as described by Higgins and Peter 2002) when the near-fledged chicks were banded, but those of Pine Forest South did not. However, the adults of both groups (especially the male) defended the new fledglings hiding in low cover, and a male performed a distraction display. The North male vigorously defended the fledglings against two Grey Shrike-thrushes *Colluricincla harmonica* that were trying (unsuccessfully) to find them. Thus, there was some individual variation in the willingness of adult Hooded Robins to defend nestlings, but defence of fledglings was strong.

Post-fledging period

Fledglings at first hid in low cover of shrubs, logs or saplings, but within a week could fly well, within a month they were adult in proportion and starting to forage, within 6–8 weeks were in post-juvenile body moult (one male directly into adult-like body plumage), and were independent at 8 weeks (details in Table 4). One other dependent juvenile, at approximately six weeks post-fledging (begging, yellow gape) was also moulting directly into adult-like male (blotchy black) body plumage. Three others (apparently two females, one male from its size and dominant behaviour) moulted into grey plumage (see Tables 1 and 4). Juvenile begging calls were similar to those of the Eastern Yellow Robin (see Higgins *et al.* 2002), though a little faster at times.

The pied immature male was still slightly scruffy and mottled in early February, four months after fledging, but was fully in adult-like male body plumage in mid May (7 months after fledging). The grey immature (male?) was losing its ventral mottling in late December, three months after fledging (compare week 8, Table 4), but was still slightly scruffy and mottled in early February (over 4 months after fledging), by which time its mother was moulting heavily; it was in full grey plumage in early April, six months after fledging. Both these immatures were still with their respective natal group when last checked in mid-July.

In the post-fledging period, both males and the female of the Pine Forest South trio fed the juveniles. In week 8, a male (parent?) and the female had charge of one juvenile each. Of the Pine Forest North group (three helpers), the adults and the grey helper fed the juveniles then, after the helpers had all dispersed by about week 7, both parents continued to feed the maturing juveniles.

Nests and breeding habitat

The first nest at Pine Forest North was 3.5 metres above ground in the horizontal subterminal fork of the lowest limb of a mature Monterey Pine (85 cm dbh), on the edge of the forest. The second was approximately 1.5 metres above ground in a fork against the trunk of a pine sapling, also near the edge of the forest. The nest at Pine Forest South (~1.3 km away) was 1.1 metres above ground in a fork against the trunk of a pine sapling (5 m tall, 13.5 cm dbh), amid extensive pine sapling regrowth, but near a linear clearing formed by a vehicle track and high-voltage powerline easement. The nest tree was next to two fallen dead mature pines and a thicket of Briar Rose *Rosa rubiginosa* and Blackberry *Rubus* sp. Bark used for external camouflage was from pines (the two sapling nests) or exotic deciduous trees in a nearby, otherwise cleared creekline.

The five nests in the Kirby Road territory were all low (<3 m) in native trees in a patch of eucalypt woodland (Table 5): three in the main forks of Rough-barked Apple *Angophora floribunda* saplings, one on the lateral branch fork of a small *Angophora* tree, and one in a fork against the trunk of a Yellow

Table 4

Behaviour and growth stages of fledgling Hooded Robins, compiled from two broods of two young. Week = week post-fledging; day 1 = fledging day.

Week	Day	Comments
1	1	Brood 1: hiding low (~1 m) in thicket, ~2 m from nest. Brood 2: hiding in cover (not visible, defended by adults).
	7	Brood 2: stubby tail, flew ~50 m across open ground
2	8	Brood 1: hiding in log pile >100 m from nest
	13	Brood 2: flew well, tail half-length
4	23	Brood 2: tail less than full (3/4?), not foraging
5	30	Brood 1: adult proportions, juvenile plumage; foraging, but dependent (begging, fed by adult)
	31	Brood 1: dependent (fed by adult)
	32	Brood 2: adult proportions; dependent (fed by adults)
6	39	Brood 1: streaky; adult-like proportions and agility, foraging; dependent (fed by adults). Brood 2: dependent (fed by adult).
7	43	Brood 2: one sibling moulting into blotchy black hood, other moulting into grey; foraging, dependent (fed by adult)
	46	Brood 1: dependent (fed by adult)
8	50	Brood 1: fully mottled; foraging, dependent (fed by adult)
	55	Brood 1: moulting into grey ('female') plumage; dependent (fed by adult); one sibling chasing and displacing the other. Brood 2: blotchy adult-like colours (one male, one grey); dependent (begging).
9	60	Brood 1: only one sibling present hereafter; foraging, independent (not fed by adults over next month)
10	67	Brood 2: only one sibling present hereafter; blotchy adult-like male plumage
11	77	Brood 2: remaining sibling foraging, independent; blotchy black except wing coverts, scruffy mottled head; aggressive towards adult female

Table 5

Characteristics of five Hooded Robin nests in one territory at Kirby Road, Armidale (see text) in eucalypt woodland: range (mean) in 0.13-ha nest-centred plots. Habitat complexity = sum of above-ground contacts on a 2.4-m Levy pole at points 10 m and 20 m from the plot centre on four cardinal axes; cover = no. items in which a fledgling robin could shelter; distance = distance to nearest cover (see Debus 2006b).

Nest height (m)	Tree dbh (cm)	Complexity[A] score	Cover[B] (*n* items)	Distance (m)
1.1–2.5	6–17[C]	0–5	0–3	0.3–5
(1.7)	(11)	(2.8)	(1)	(1.8)

[A] Items scored: logs, coarse woody debris, shrubs, saplings, branches

[B] Live or dead shrubs, saplings, branches, brush-piles, stumps, logs, <3 m above ground

[C] Nest on side branch 7 cm in diameter.

Box sapling. External camouflage was of *Angophora* or Box bark flakes, according to nest-tree species. These nests were either on the edge of the woodland patch (two nests) or several metres into it (0–14 m, mean 5.8 m), and all fell within the one-hectare plot measured for breeding-habitat characteristics.

The five Kirby Road nests were all built in the one patch of young regrowth eucalypt woodland, dominated by rough-barked trees and saplings, with few shrubs, some standing dead trees and many logs (Appendix 1). Casual observations of groups west of Armidale (Yarrowyck and Torryburn, Table 1) revealed a high density of standing dead timber, amid grassland and open woodland, in occupied home ranges.

Food and feeding

Foraging Hooded Robins were observed opportunistically, ground-gleaning in the open, on bare ground, and perching on sticks in an open grassy paddock (winter); low ground-pouncing (spring); hawking, snatching and ground-pouncing (sometimes from high powerlines) for small aerial, foliage and ground insects around young pines and adjacent open ground (warm, humid summer morning); ground-pouncing around a small clearing in eucalypt woodland (autumn); pouncing from low sites (e.g. fences) onto freshly slashed grassland (autumn, where they had been absent in summer when the grass was tall); and pouncing and gleaning on open ground (subsequent winter). In the post-fledging period (late spring), one family frequented young pines and adjacent open areas with logs and standing dead timber, where they mostly pounced to the ground for prey. These observations were casual (non-systematic); the Hooded Robin's local foraging behaviour has been quantified elsewhere (Fitri and Ford 2003a).

Food items observed included a froglet *Crinia* sp. (taken from a creek bank), a moth (Lepidoptera), a larva/pupa, a spider (Araneae), and a small green moth or leafhopper. Insects seen hawked and snatched by Hooded Robins in summer were abundant (swarming?), and surprisingly small (<4 mm) for the size of the birds taking them. One male Robin in eucalypt woodland took a large sawfly larva (Hymenoptera: Pergidae), and beat it on a branch to eject the gut (which contains the noxious 'spitfire' defensive fluid), before feeding it to his incubating mate.

Predator avoidance

In the pre-nesting period, one pair of Hooded Robins was courtship-chasing and ground-hopping (foraging) in the open. When a Peregrine Falcon *Falco peregrinus* flew over, the male 'froze' crouching on a dead treetop (his song-post, where his plumage blended with his perch in that posture), and the female fled rapidly approximately 50 metres low across the paddock to the centre of a dense small tree (exotic fruit tree), where she effectively hid although it was leafless (deciduous) at the time. These two responses illustrate both the Robin's cryptic plumage (even the male, among dead timber), and the importance of shelter from avian predators.

Reintroduction

Of the two Hooded Robins translocated to Imbota, the male was killed by a predator (only his transmitter found, with blood-stained feathers attached), and the female was also found dead, both on the day following their release. After the pair had been captured (in August), the remaining pied male of the trio was singing 12 days later, and had a new mate in the following May. Thus, the territory was still occupied after two adults were removed, and a dispersing female was available in that population for pairing with a lone male. The depletion of the adult population in that area was therefore only temporary.

DISCUSSION

This study adds several pieces of new information on Hooded Robins. Higgins and Peter (2002) did not mention exotic pine plantations as a habitat for this species, nor the use of exotic nest materials. The two Pine Forest pairs were successful and productive breeders, compared with Fitri and Ford's (2003b) data for eucalypt woodland. Although the sample size is small, some pine forests may be valuable sites for Hooded Robins where the diversity of habitat structure (age-classes, shelter) and feeding substrate (e.g. open areas, logs, dead timber) is high. Also, there were few avian nest predators in the plantation (e.g. the few Pied Currawongs *Strepera graculina* were only in the mature pines; butcherbirds *Cracticus* spp. and shrike-thrushes were uncommon, and mostly in the mature pines). Hooded Robins have disappeared from many sites around Armidale (Ford *et al.* 2009), giving this remnant population in pine forest importance locally. The Pine Forest also retains a significant Eastern Yellow Robin population (Debus *et al.* 2004).

This study confirmed that multi-helper groups may disperse after a successful breeding event (leaving the pair and new pied son as a trio through the winter). It also showed that new offspring may disperse in autumn, in at least one case apparently encouraged by aggression from a male sibling (which stayed on through winter). In each group, the dispersing brood-mate was apparently female. In multi-helper groups, grey helpers occurred in those groups that already had one or more pied helpers, and perhaps acquisition of pied plumage is delayed (inhibited) in first-year male helpers in such groups.

This study also identified the age at which post-juvenile moult started, and found that some juvenile males moulted directly and completely (body feathers only) into adult-like male plumage in their first autumn. The post-fledging period was twice as long as previously reported (8 vs 4 weeks; Fitri and Ford 2003b). However, the latter referred to when juveniles left the nest area, whereas in the present study juveniles continued to be fed in the wider home range of 30+ hectares, for a total uninterrupted breeding cycle (nest-building to independence) of approximately 90 rather than approximately 70 days. Post-fledging dependence periods in Australian passerines are long (Russell 2000), and in this respect the Hooded Robin closely resembles the Eastern Yellow Robin (8 weeks: Debus 2006a). The Hooded Robin's juvenile begging (and some other) calls were similar to those of the Eastern Yellow Robin, which suggests that the Hooded Robin is more closely related to *Eospaltria* than to *Petroica*.

The findings of this study are consistent with, and supplement or confirm with further empirical data, those of prior compilations and studies (Bell 1984; Higgins and Peter 2002; Fitri and Ford 2003b) on most aspects of the Hooded Robin's biology, including: social organisation (group size and composition, roles of helpers); home-range size and dispersion of nests (within a season) in the breeding territory; nests (sites, materials) and nest-building; and breeding biology (e.g. season, clutch size, breeding behaviour, incubation and nestling periods, nest success). For instance, a combined incubation–nestling period of 27 days fits a mean of 15 and 12 days for each phase, respectively.

Hooded Robins around Armidale fed mostly by pouncing or gleaning on the ground, consistent with previous information (see Higgins and Peter 2002; Fitri and Ford 2003a). They also tended to forage higher in warm weather, as previously found. The froglet and sawfly larva ('spitfire') are novel prey items for the Hooded Robin, and the latter item illustrates an ability to deal with certain noxious prey, although other Australian robins variously take small skinks or potentially noxious insects (coccinellid beetles, pentatomid bugs), and beat large prey (Higgins and Peter 2002). Foraging substrates (e.g. logs, standing dead timber, open ground) and microhabitat components (e.g. woodland/grassland edges, saplings, native tussock grasses) are consistent with previous knowledge on the Hooded Robin's ecological requirements (e.g. Higgins and Peter 2002; Recher *et al.* 2002; Fitri and Ford 2003a,b; Maron and Lill 2005; Antos and Bennett 2006; Antos *et al.* 2008; Priday 2010).

This study provides further insights into the Hooded Robin's requirements, and suggests some possible management implications. Nest predation was apparently lower, and breeding productivity high, in exotic vegetation where avian nest predators were scarce and cover for nests and fledglings was plentiful. Exotic vegetation also provided nest materials. Therefore, care should be taken not to remove exotic vegetation without first checking for the presence of rare or locally declining species. This finding suggests that ecological control of avian nest predators in native woodland, by removal of the exotic, invasive berry-bearing plants that support currawong populations, may also lead to better breeding productivity of Hooded Robins. However, such removal should occur as a phased process where alternative native shrubs and habitat components are provided well before all exotic habitat is removed.

The failed translocation suggests that reintroductions of this species are not a useful management option, at least until aspects of habitat quality and nest predation are addressed in areas where Hooded Robins have disappeared (see also, e.g., Ford *et al.* 2009; Ford 2011; Debus and Ford 2012).

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Appendix 1

Habitat characteristics of 1-ha plot enclosing five successive Hooded Robin nesting attempts in one territory at Kirby Road, Armidale, spring 2006 (see text). 'Tree' and 'shrub' size classes as defined elsewhere (Debus 2006b).

Parameter		*n* items in nesting territory
Trees:	rough-barked	109
	gums	12
	total	*121*
Saplings:	rough-barked	338
	gums	29
	total	*367*
Shrubs[A]:		3
Standing dead[B]		31
Logs[C]		218

[A]More than 1 m high

[B]Trees, saplings, shrubs

[C]Includes rotting coarse woody debris more than 10 cm thick × 50 cm long

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Group size and composition in the Grey-crowned Babbler *Pomatostomus temporalis* in an urban environment

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The Grey-crowned Babbler *Pomatostomus temporalis*, a cooperatively breeding woodland bird, is declining in the southern parts of its range where its social dynamics and reproduction have been negatively affected by fragmentation and degradation of suitable habitat. We studied 12 groups of Grey-crowned Babblers in and around Dubbo, New South Wales, eight in altered habitat and four in the surrounding natural habitat of Ironbark/Cypress woodland. Individuals were captured and colour-banded and weighed. Feather samples were collected for DNA analysis to determine the sex of individuals. There were no significant differences between groups in natural and altered habitat in sex ratio, group size, or mean weight. Mean group size was 6.7 birds, with a mean of 3.3 young birds from the previous two breeding seasons, figures comparable with or better than those in groups from more natural habitats in Queensland and New South Wales. Mean weights were similar to those of birds in the Pilliga Nature Reserve 230 kilometres north of Dubbo, but heavier than those in Queensland. Generally, the population of Grey-crowned Babblers inhabiting areas in and around Dubbo seems to be healthy, although this may change as the city grows.

INTRODUCTION

Habitat fragmentation, degradation and loss are well-known drivers of species extinction. In association with modified interactions with other species, changes in behaviour and biology may cause populations to decline (Reed 1999; Haila 2002). Large tracts of open forests and woodlands in temperate southern Australia have been cleared for agriculture. As much as 90 per cent of the native vegetation has been lost in many districts (Hobbs and Yates 2000). Some woodland birds have suffered contraction of their geographical ranges (Priddel and Wheeler 2003; Ford *et al*. 2009), extinction from districts and regions (e.g. Saunders 1989; Bennett and Watson 2011) and population declines (Gardner 2004; Olsen *et al*. 2005). Many species are now listed as threatened in one or more states.

Species with complex avian breeding or social systems could be more negatively affected by disruptions to biological processes than those with simpler ones (Fischer and Lindenmayer 2007). Habitat fragmentation is believed to disrupt social interaction among groups, reducing group size, possibly leading to inbreeding and resulting in reduced breeding success (Garnett and Crowley 2000; Walters *et al*. 2004). Bird populations in fragmented habitat may have an imbalanced sex ratio, with an excess of males. This is because females, typically the dispersing sex, leave isolated populations at a greater rate than new females arrive (Dale 2001). This leaves many males unpaired and, in the case of cooperative breeders, may lead to groups containing only males (e.g. Walters *et al*. 1999). Individuals living in degraded environments may also show physiological stress, which may be indicated by low body weights (Cucco *et al*. 2002).

The Grey-crowned Babbler *Pomatostomus temporalis* occurs in woodland across northern and eastern Australia, and in New Guinea (Higgins and Peter 2002). *P. t. temporalis* inhabits eastern Australia, with *P. t. rubeculus* in northern, north-western and central Australia. In many parts of south-eastern Australia, Grey-crowned Babblers have declined, due to habitat loss and fragmentation (Olsen 2008). The species is extinct in southern South Australia (Higgins and Peter 2002), endangered in Victoria (Davidson and Robinson 1992) and vulnerable in New South Wales (NSW OEH 2012).

Numerous studies have been conducted on the Grey-crowned Babbler's life history, cooperative behaviour and social structure (Counsilman 1979; King 1980; Brown *et al*. 1982a, b; Brown *et al*. 1983; Dow and King 1984; Blackmore 2006; Blackmore and Heinsohn 2007, 2008; Eguchi *et al*. 2007). The species lives in groups, whose members defend a territory year-round and roost together (King 1980; Dow and King 1984). It breeds cooperatively and most helpers are offspring of the breeding pair from previous broods, genetically evidenced by Blackmore and Heinsohn (2008). Both sexes may become helpers (Brown *et al*. 1983) and can be admitted into the group from other groups (King 1980), but only male helpers improve the reproductive success of the groups (Blackmore and Heinsohn 2007). Groups of two or three have been found to produce few fledglings (Brown *et al*. 1982a; Eguchi *et al*. 2007) and in small fragments, groups eventually disappear (Lockwood and Robinson 1997).

Habitat quality is also important for the Grey-crowned Babbler, which requires specific habitat characteristics (Simondson 2001). Groups are less likely to be found on burnt

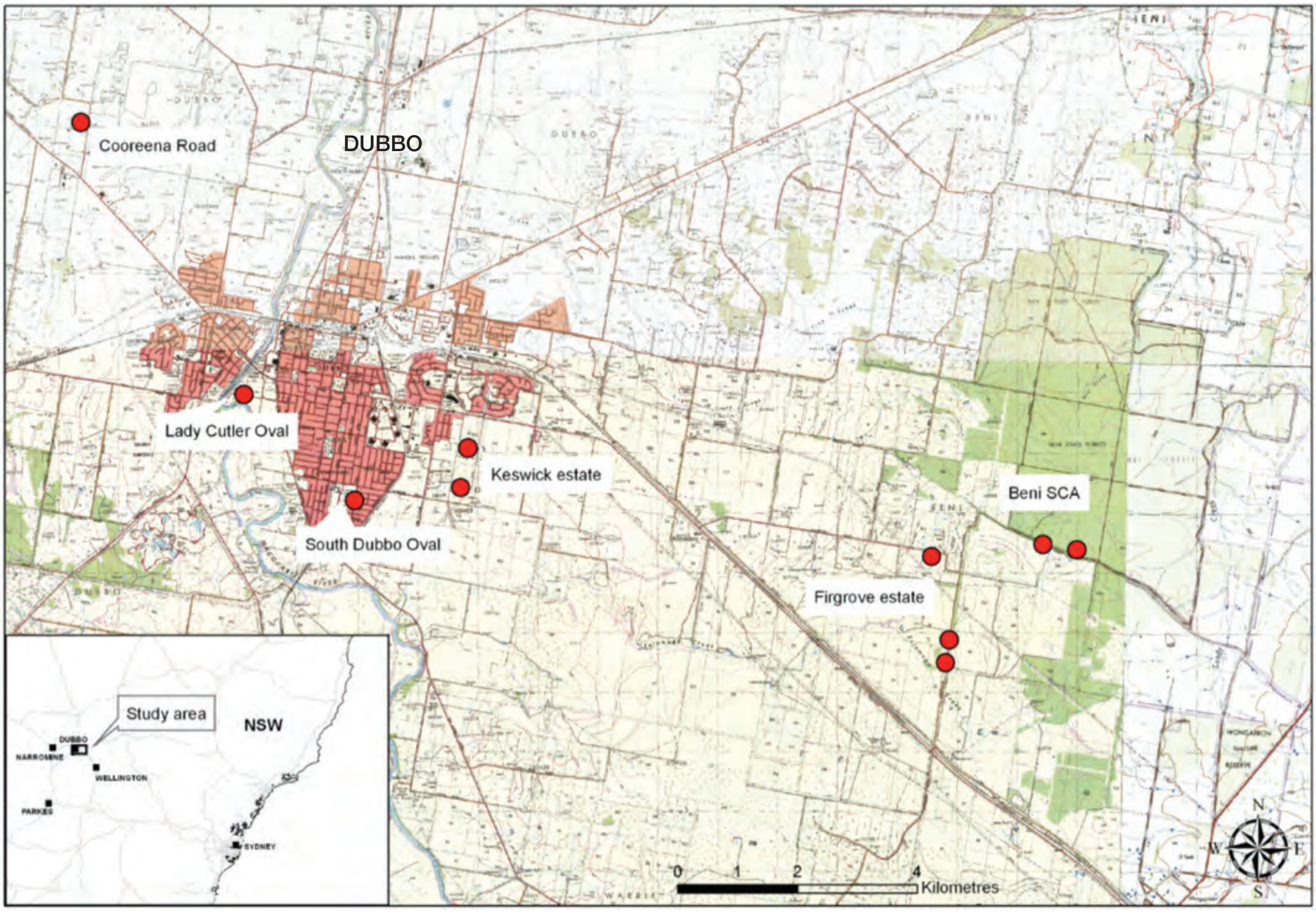

Figure 1. *Map of study area. Study groups are indicated in red.*

than on unburnt roadsides (Adam and Robinson 1996), and in sites with limited leaf litter and grass, and few large trees and clumps of small trees and shrubs (Robinson 1994). Grey-crowned Babblers in fragmented habitats may also suffer from food shortages in a similar way to the Eastern Yellow Robin, *Eopsaltria australis*, (Zanette *et al*. 2000; and as suggested by Blackmore 2006). They may also have to travel farther to find food (Recher *et al*. 1987). Thus habitat fragmentation and degradation may lead to reduced group sizes and poor reproductive success in babblers. This is supported by numbers of Grey-crowned Babblers increasing in response to revegetation in parts of Victoria (Robinson 2006; Thomas 2009).

Although Grey-crowned Babblers have been studied in fragmented rural landscapes, they have received little attention in urban environments. Urban areas often provide considerable habitat for some bird species, whereas other species do not cope well there (Grim *et al*. 2008; Fuller *et al*. 2009). Grey-crowned Babblers have been sighted on golf courses, in parks and recreational areas (Schulz 1991; Birds in Backyards 2011). They have also been observed near houses and farms (Templeton 1955; Blackmore 2006), but no detailed studies have been conducted on urban groups. We studied the group size and composition of a population of Grey-crowned Babblers in and around Dubbo, in altered remnants through to continuous habitat. If babblers are coping poorly with the altered environment and the population is declining we predict that, in comparison with populations in continuous environments, they will show: 1) an imbalanced sex ratio, with an excess of males, 2) small group sizes, 3) few young birds in groups, and 4) low average body weights, or the presence of some very light individuals.

METHODS

This study was conducted in and around the city of Dubbo on the border of the Central Tablelands and Western Plains of New South Wales (32°15'45"S, 148°44'25"E) from May to October 2009. Babbler groups were found in natural open forest in Beni State Conservation Area (SCA) (19 km east of the centre of Dubbo), on private, mostly cleared land outside the city (Firgrove Estate and Cooreena Road), in remnant vegetation near a suburban housing estate and vegetation within that estate (Keswick Estate) and in parks, gardens and sporting grounds in the city (Lady Cutler and South Dubbo Oval) (Figure 1). The major vegetation in Beni SCA, referred to as continuous habitat, is Ironbark/Cypress woodland dominated by *Eucalyptus nubila*, *E. crebra* and *Callitris glaucophylla*, with a dense leaf litter and scattered small herbs, forbs and grasses on sandy infertile soil. The private land outside the city had remnant patches and roadside strips of modified native vegetation. The sites in the city contained small patches of natural or replanted vegetation, parkland, private gardens, roads, houses and other buildings. Both of these areas are referred to as altered habitat. Disturbances included traffic, grazing cattle and sheep, motor-cycle riding and housing development outside the city and pedestrians, cyclists, mowing, domestic animals, recreational activities such as fishing, swimming and sporting events within the city.

We found 45 groups of Grey-crowned Babblers in the area, of which, due to time constraints, only 12 were studied in detail. Four groups were located in continuous habitat, while eight were found in altered habitat (Figure 1). Two Beni groups were not observed after banding. These were: Beni 3 – located on the eastern side of Beni SCA where Sandy Creek meets the forest; and, Beni 4 – located in the middle of Beni SCA. We chose more groups of Grey-crowned Babblers in altered landscapes because previous studies focused on groups in continuous habitat. Grey-crowned Babblers start breeding in July and fledge the last broods in March in temperate climates of New South Wales (Blackmore and Heinsohn 2007). Our study groups bred between October and February (per. obs), so were observed in the non-breeding season, when they use a larger home range than when breeding (Counsilman 1979; King 1980; Dow and King 1984).

Banding

Of the 12 target groups, we successfully captured 68 out of 80 individuals with seven groups completely banded during May 2009 using mist nets and playback of territorial calls. Each bird was banded using a stainless steel band supplied by the Australian Bird and Bat Banding Scheme, plus a unique combination of coloured plastic bands.

Age determination

The colour of the iris of Grey-crowned Babblers changes with age (King 1980). Fledglings and juveniles up to about one year old have a dark brown iris, 1–2 year old birds have a light brown iris, which becomes yellowish-brown in adults 2–3 years old, whereas birds older than three years have a pale yellow iris. We placed each trapped individual into one of these four categories, but we could not determine the age of 11 birds that we failed to catch. We did not classify any individuals as having dark brown irides. As we observed babblers in the non-breeding season we were unable to determine which were the breeders in each group. Sexual maturity is reached at two years in both sexes (King 1980).

Sex determination

We collected seven breast feathers from each individual using the method by Griffiths *et al.* (1998) and sent them to Genetic Technologies Limited in Fitzroy. Sex was determined using the sex-linked chromo-helicase-DNA-binding (CHD) gene, which was used by Blackmore *et al*. (2006) to sex Grey-crowned Babblers.

Statistical Analyses

All data were analysed with χ^2 tests, t tests or ANOVA itilising the MiniTab program.

RESULTS

Group size and composition

Mean group size of Grey-crowned Babblers in Dubbo was 6.67 (standard error = 0.916, *n* = 12), with a range of two to 12 birds. Other than a pair in Beni SCA and a group of three at the Lady Cutler Oval, all groups had five or more individuals. There was no difference in the size of groups between altered (mean = 7, *n* = 8) and natural (mean = 6, *n* = 4) environments (t = 0.25, p = 0.630).

The proportion of known male and female Grey-crowned Babblers, based on molecular analysis, did not differ significantly from unity (32 males and 34 females; $\chi^2 = 0.06$, $p > 0.05$). Group size did not affect the ratio of males to females (F = 0.968, p = 0.538). The proportions of known males and females did not differ between altered (23 males, 28 females) and natural environments (9 males, 6 females; $\chi^2 = 0.99$, $p > 0.05$).

Groups contained from one to four pale yellow-eyed adults (more than 3 years old). Two groups at Beni SCA were recorded as having only one pale yellow-eyed individual, although not all individuals in these groups were captured and aged. The group at Cooreena Road on the outskirts of Dubbo contained two pale yellow-eyed birds, both females, but it did contain one brownish pale yellow-eyed individual that could have reached sexual maturity. We found no dark brown-eyed individuals in any group. We assessed 32 birds as having light brown eyes, a mean of 2.67 per group, with up to seven in a group of 11 in Keswick Estate in Dubbo. Birds with a light brown iris hatched in the previous (2008) breeding season and those with yellowish-brown irides from the 2007 breeding seasons. Birds with yellow irides would have hatched in or before 2006. This suggests that the 2008 breeding season had been productive.

All except one group at Beni SCA had individuals with light brown eyes (1–2 years old). Only nine birds in five groups had yellowish brown eyes, with four of these in a group of 11 in the Keswick Estate. This suggests that fewer young were produced in 2007, although some would have died or dispersed. There was no significant difference between the numbers of birds of each age group between altered and natural environments (Figure 2 – $\chi^2 = 1.55$, $p > 0.05$, df = 2). In particular we found that the groups in urban sites were as productive as those in natural ones.

Weights

Based on molecular sexing, males were significantly heavier (mean = 83.30g ± 0.642 SE) than females (mean = 79.63g ± 0.998 SE) (t = 9.65, *n* = 23 males, 24 females, p = 0.004), although there was considerable overlap in weight between the sexes (males ranged from 79g – 92g; females ranged from 68g – 88g). Weight showed no difference across age classes (F = 0.14, p = 0.937). Also, there was no difference in mean weight between birds of either sex between natural (females = 75.3 ± 2.75 SE; males = 83.2 ± 1.3 SE) and altered (females = 80.5 ± 0.99 SE; males = 83.3 ± 0.75 SE) environments (F = 0.80, p = 0.375).

DISCUSSION

Although the sample size is small, overall, we found no evidence of imbalanced sex ratios, smaller groups, or fewer young birds in our groups of Grey-crowned Babblers in altered compared with continuous sites. Furthermore, there was no indication that groups in and around Dubbo were smaller than those in any other studies in a range of habitats (Table 1). Our mean group size was similar to that in groups in southern Queensland (King 1980; Moffatt 1982; Brown *et al*. 1983) and of *P. t. rubecula* in central Queensland (Edwards and Kot 1995), but were larger than groups of *P. t. temporalis* in north Queensland (Edwards and Kot 1995), and of *P. t. rubecula* in Northern Territory (Eguchi *et al*. 2007) (Table 1). Groups in Dubbo were also larger than those in the natural woodlands in the Pilliga Scrub (Blackmore and Heinsohn 2007), and, than those in fragmented landscapes in central Victoria (Robinson 2006; Wilson *et al*. 2009). It is possible that some of our groups were counted before dispersal of young birds and those groups at the start of breeding would have been smaller.

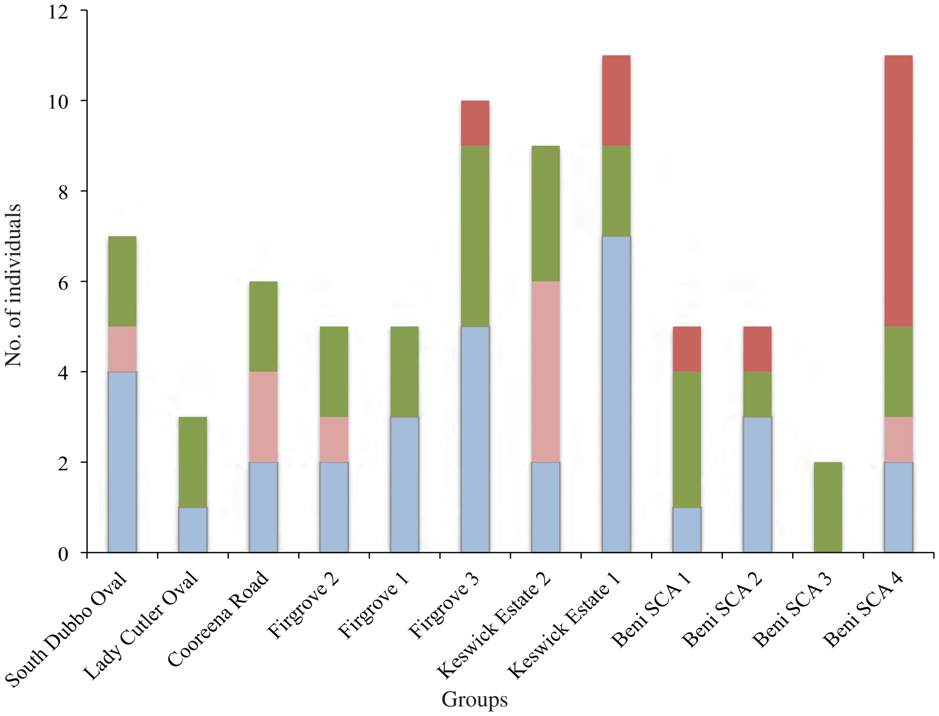

Figure 2. *The age composition of each group of Grey-crowned Babblers. Light brown-eyed birds (1-2 years) are blue, yellowish brown-eyed birds (2-3 years) are pink, pale yellow-eyed birds (3 years or older) are green and unknown are red.*

Only two of our 12 groups had fewer than four birds in the non-breeding season, the size at which breeding productivity becomes low. Even if some groups were reduced before breeding, the presence of young birds, with light brown or yellowish-brown eyes, in all groups suggests that previously they had been large enough to breed successfully. The area experienced average rainfall for the two years prior to this study but below average rainfall for the two years before that (Bureau of Meteorology 2011). However, we do not know whether groups in altered habitat performed more poorly than those in continuous habitat during the drought. Whereas group size partly reflects previous breeding success, it may also be influenced by groups splitting and by movement of individuals among groups. New group formation may be more common under better conditions, resulting in smaller group sizes in better years (e.g. Counsilman 1977), whereas harsh conditions encourage philopatry (Emlen 1982).

Grey-crowned Babbler group composition around Dubbo was similar to that found elsewhere (Table 2). The other populations, except for that in the Pilliga, had no birds with dark brown eyes, as we found, or very few such birds. Probably the number of birds with dark brown eyes is very dependent on the time of year, as the eyes of young birds become lighter before the next breeding season. The number of birds with light brown or yellowish-brown eyes in our population was similar to or more than that found in other populations.

Although not all individuals in all groups were captured and sexed, the sex ratio of those that were captured was close to unity (32 males, 34 females). Furthermore, all groups had at least one bird of each sex. Hence, there was little indication of an imbalanced sex ratio as often seen in isolated populations (e.g. Dale 2001), or of groups lacking females, as occurs in other cooperative breeders, e. g. Brown Treecreepers, in highly fragmented landscapes (e. g. Walters *et al.* 1999). It is possible that one sex is easier to capture than the other, though we would expect playback to attract both sexes, or possibly males more than females. It is possible also that one sex may be more likely to disperse before the breeding season, though Blackmore *et al.* (2011) found that both sexes of Grey-crowned Babblers disperse equally. Groups of Grey-crowned Babblers in remnants near the Pilliga Scrub showed a deficiency of females (Blackmore 2006).

In our population, males are heavier than females, as found elsewhere (Counsilman and King 1977; Brown *et al.* 1982b; Blackmore 2006). There was no indication that Babblers in our urban sites were lighter than those in more natural sites. Similarly, Blackmore (2006) found little difference in weights of birds from natural and fragmented habitats in the Pilliga Nature Reserve.

Our results are very similar to those on another cooperative breeder, the White-winged Chough (*Corcorax melanorhamphos)* in Canberra. Beck and Heinsohn (2006) found that urban groups were a similar size, had a similar sex ratio, and produced a similar number of fledglings annually to groups in a nearby nature reserve. Birds in Canberra were a similar weight to those outside the city. There were some differences though, urban groups had fewer adults, started breeding earlier, and had lower nesting success than groups in the natural site.

CONCLUSIONS

The population of Grey-crowned Babblers living in and around Dubbo appears to be healthy. Average group size and numbers of young birds were as high as in any other populations

Table 1

Group sizes of Grey-crowned Babblers from various studies (a: Moffatt 1982; b: this study; c: Edwards and Kot 1995; d: Brown *et al.* 1983; e: King 1980; f: Counsilman 1977; g: Blackmore and Heinsohn 2007; h: Eguchi *et al*. 2007; i: Wilson *et al.* 2009).

Location	Vegetation/Landscape	Sub-species	*n*	Mean	SE
The Dell QLD[a]	Vegetation remnants	*P. t. temporalis*	15	7.3	
Dubbo NSW[b]	Vegetation remnants and nature reserve	*P. t. temporalis*	12	6.67	0.916
Australia and New Guinea[c]	Vegetation remnants	*P. t. rubecula*	74	6	2.84
Meandarra QLD[d]	Vegetation remnants	*P. t. temporalis*	46	5.76	
Australia and New Guinea[c]	Vegetation remnants	*P. t. temporalis*	46	4.5	1.67
Bonningar QLD[e,f]	Vegetation remnants	*P. t. temporalis*	79	4.45	
Pilliga Nature Reserve[g]	Nature reserve and vegetation remnants	*P. t. temporalis*	47	4.28	0.22
Coomalie Farm NT[h]	Vegetation remnants	*P. t. rubecula*	19	4.26	8.064
Violet Town, Moglonemby and Molka VIC[i]	Vegetation remnants	*P. t. temporalis*	42	3.6	24.42

Table 2

The age structure of groups of Grey-crowned Babblers from various studies (a: this study; b: King 1980; c: Counsilman 1977; d: Blackmore 2006; e: Eguchi *et al.* 2007).

Location	Group size (mean)	Dark brown	Light brown	Yellowish brown	Pale Yellow	Unknown
Dubbo NSW[a] (*n*=12)	6.67	0	2.67	0.75	2.25	1
Boningar QLD[b] (*n*=7)	6	1.1	0.16	0.95	3.16	0.63
Dyer's Lagoon QLD[c] (*n*=21)	5.6	1.4	1.4	0	2.4	0.4
Pilliga Nature Reserve NSW[d] (*n*=47)	4.28	0	1.03	0.61	2.64	0
Coomalie Farm NT[e] (*n*=19)	4.26	0	0.75	0.98	2.53	0
Fernvale QLD[b] (*n*=5)	3.8	0.6	1.2	0	2	0

studied and are certainly higher than in the endangered Victorian population (Robinson 2006). There was no evidence of a male-biased sex ratio, and all groups had adult females. Breeding and recruitment in recent years had obviously been successful, despite the recent drought, with all but one group having immature birds or young adults. Finally, individual birds were not especially light, providing no evidence of food shortage or other stresses.

Although the Dubbo Grey-crowned Babbler population appears healthy, this could change. For instance, new housing developments could lead to the loss of vegetation remnants and hence of Babbler groups. We recommend that this population continues to be monitored and recommend studies on the species in other towns or cities. We also suggest that the breeding behaviour and success of the urban groups be compared with a larger sample of groups from continuous native vegetation.

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The season, frequency, parental care and success of breeding Black-necked Storks *Ephippiorhynchus asiaticus australis* in northern New South Wales

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The Black-necked Stork *Ephippiorhynchus asiaticus* is a large waterbird native to Australasia whose breeding biology is poorly known. They are known to breed as solitary pairs within large home ranges making detailed breeding studies difficult. We investigate the breeding biology of eleven regularly monitored pairs over a four-year period (2003–2006) in northern New South Wales. They were found to breed from May to January, with incubation from May to October, nestlings from July to January and fledging from September onwards. Individual pairs bred approximately twice over the four-year period. There was no tendency for successful years to be followed by a non-breeding year and pairs were capable of rearing young in successive years. Both parents shared nesting duties, with males spending more time than females brooding the nestlings (68%).The first three years had average or below average rainfall, but 2006 had good rain in summer and autumn. More Storks bred in that year and produced more fledglings per active nest (1.7) than in the previous three years (mean of 1.3 fledglings/active nest). Juveniles remained with their parents for at least two months, though they started foraging by themselves soon after leaving the nest. One young bird was found dead 400 kilometres NNE of its nest, within four months of fledging. The production of at least 64 young in four years suggests that the recruitment rate is likely to be adequate to maintain the state's population of this presumably long-lived species.

INTRODUCTION

The Black-necked Stork (*Ephippiorhynchus asiaticus*) is native to south and south-east Asia, where it is threatened and declining, and has its core populations in New Guinea and northern Australia (*E. a. australis*). A small population is also established in New South Wales (NSW), where it is regarded as *endangered* (Marchant and Higgins 1990). Although there have been studies in India (Sundar 2003; Maheswaran and Rahmani 2005; Sundar *et al*. 2007), the breeding biology of the species in Australia is poorly known and based mostly on anecdotal or unconfirmed reports (Marchant and Higgins 1990). Black-necked Storks nest high in tall trees, close to water on coastal and riverine plains, but far from human activity (Clancy and Ford 2011). Unlike most large Australian waterbirds which breed colonially in response to heavy rain (Kingsford and Norman 2002), the Black-necked Stork is a solitary breeder within a large home range (Clancy and Andren 2010). Hence, it is difficult to collect substantial information on its breeding season, frequency, parental care and productivity.

Black-necked Storks have been recorded breeding from May to November in NSW (Gosper 1981, Gosper and Holmes 2002), and from March to August in Queensland and the Northern Territory (Frith and Davies 1961; Boekel 1980; Marchant and Higgins 1990; Chatto 2006). The timing corresponds to the end of the wet season in northern Australia, and follows summer and autumn in coastal NSW, which tends to be the period of highest rainfall. Breeding in India also follows the wet season (monsoon – Sundar 2003).

Black-necked Storks produce from one to three, occasionally four, nestlings in India (Sundar *et al*. 2007) and Queensland (Richards 2005). The incubation period is at least 32 days (Clancy and Ford 2011), and the nestling period is approximately 80 days (Crompton 2001, 2002). Thus, the breeding season is long, and hence, pairs may not breed every year. There is apparently no information on breeding frequency from Australia, but in India pairs may not nest in years when food is scarce (Maheswaran and Rahmani 2005).

In this paper we present details of the breeding season, frequency of breeding, development of nestlings, division of parental care, nest productivity and post-fledging dependency of the Black-necked Stork in northern New South Wales. We examine whether there are differences between years in breeding effort and success and whether this relates to previous rainfall.

METHODS

The study was based in the Clarence Valley, north-eastern New South Wales, with more limited observations on nest sites elsewhere in New South Wales south to Bulahdelah, north of Newcastle. Thirteen nest sites (breeding territories) were visited each year from 2003 to 2006, inclusive. Four sites were visited in three of these years, one in two years and five in a single year. The territories are listed in Table 1, and a map of their locations is shown in Fig. 2 of Clancy and Andren (2010).

We calculated the mean annual rainfall from three Clarence Valley sites (Tullymorgan, South Grafton and Levenstrath) for each year of the study and long-term average (1966–2006) from historical records. Both 2003 (1034 mm) and 2004 (1039 mm) had rainfall close to the long-term average (1091 mm), whereas 2005 was dry (849 mm) and 2006 was a wet year (1179 mm). The average monthly rainfall for each year, and long-

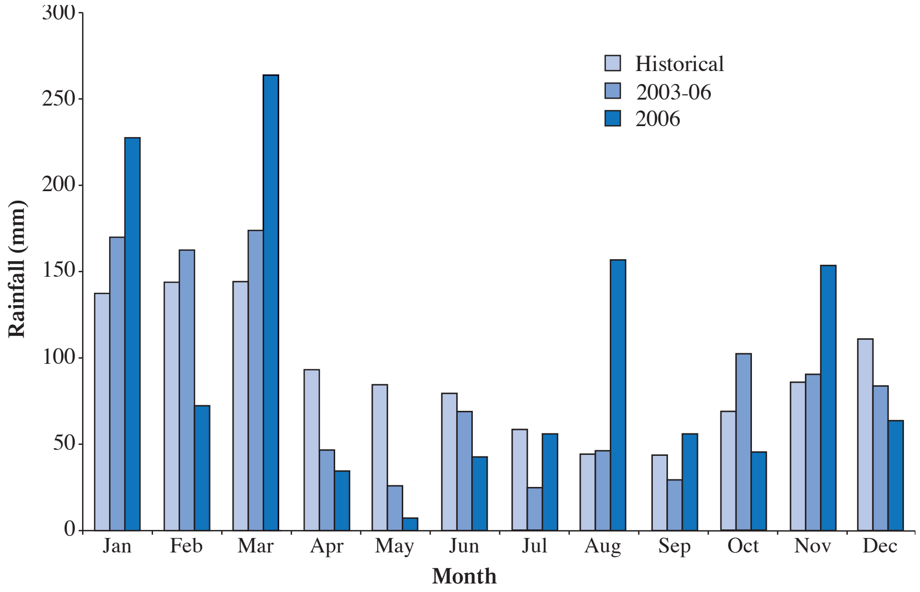

Figure 1. *Average monthly rainfall from various Clarence Valley sites, averages of three sites from 2003 to 2006 and rainfall for 2006.*

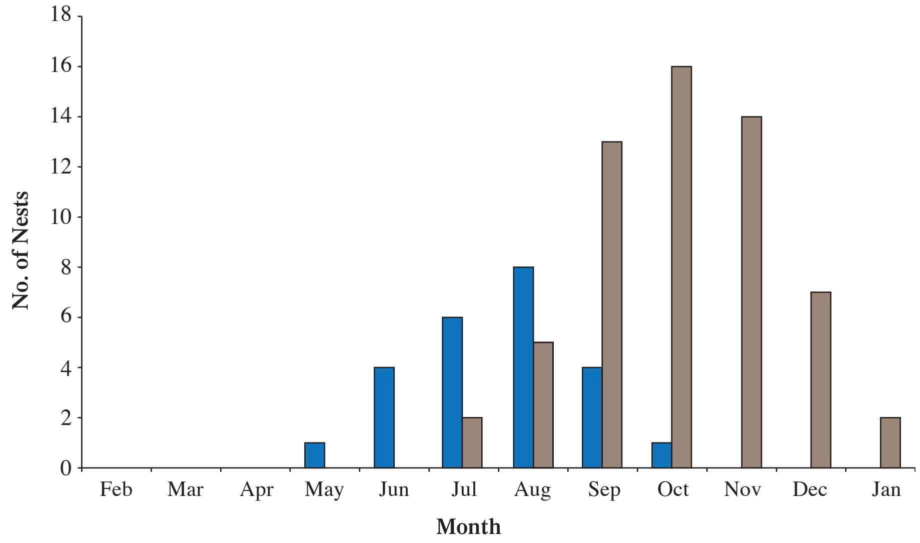

Figure 2. *Monthly distributions of nests with eggs or young 2003-2007 (blue = eggs grey = young).*

term average, is shown in Fig. 1. Monthly rainfall in 2006 was higher than the long-term averages in January, March, August, September and November, leading to increased water levels in most wetlands but not widespread flooding (Fig. 1).

Nests were checked fortnightly for activity by GPC during the predicted breeding season. The presence or absence of Storks was recorded as was any evidence of breeding. At any subsequent visit to an active nest we recorded how many storks were present and what they were doing. We assumed that birds were incubating if they sat on the nest for a long period. We recorded the behaviour of the breeding birds and calculated the contributions to parental care made by each sex at each stage of nesting. The sexes were differentiated based on iris colour (females have a yellow iris, males a dark brown iris) (Kahl 1972). Active nests were visited close to the expected time of fledging to record the number of fledglings. Nestlings in five nests were colour-banded using bands supplied by the Australian Bird and Bat Banding Scheme. Opportunistic observations were also made on some recently fledged birds.

RESULTS AND DISCUSSION

Breeding season

Breeding activity, including nest construction or repair, egg laying and incubation, nestlings and fledging of young, was recorded between May and January, but mostly between June and December at the regularly watched nests (Clancy 2008). This is somewhat later than previously recorded in the Richmond River Valley, NSW where breeding was noted from March to October (Gosper 1981; Gosper and Holmes 2002). Nest construction, repair, and rearranging of nest material, commenced as early as May and continued throughout the period when eggs and nestlings were present, but ceased in November. Mating, which occurred on nests, was recorded from May to August. Eggs (inferred from incubating behaviour and egg rolling) were recorded in nests from May to October, peaking in August, and nestlings were present from July to January, peaking in October (Fig. 2). Young fledged from September to January.

Stork breeding in New South Wales occurred when wetlands were more likely to be full following summer and/or autumn rain and food more plentiful. Storks in the Northern Territory and Queensland appear to breed earlier than those in New South Wales. In the Northern Territory, Storks had eggs or small young from March to May, with most nesting being finished by July/August although some birds were still incubating in July (Frith and Davies 1961; Boekel 1980; Chatto 2006). In Queensland, egg-laying occurs mostly from March to May with a nest on Stradbroke Island containing eggs in May 1972 (Beruldsen 1972). Interestingly, the Birds Australia Nest Record Scheme reported occupied nests in all months in Queensland (Marchant and Higgins 1990). The earlier breeding in northern Australia probably reflects the more marked wet and dry seasons compared with New South Wales. In northern India, egg-laying begins in early September, following the monsoon (July to September), with most chicks hatching by mid-January and fledging by mid-March, before the hottest and driest part of the year (Sundar 2003). Therefore, there is a tendency for Black-necked Storks to breed after rain. Breeding dates of the Jabiru *Jabiru mycteria* in Belize are also influenced by seasonal rainfall patterns in the transition from the wet to the dry season (Barnhill *et al.* 2005).

Breeding frequency

Only one stork pair attempted to breed in every year out of the 13 nests that were monitored every year (Table 1). Six pairs attempted to nest in three out of four years. Of these, three did not nest in 2003, two in 2004 and one in 2005. Two pairs nested in two years and three pairs in only one year. One pair did not nest at all. So pairs nested in 56 percent of years in which nests were checked. For pairs checked in only some years, active nests were found in 15 out of 19 potential nesting opportunities (79%). More pairs nested in 2006 than in each of the earlier years, ($\chi^2_{(1)} = 4.79$, $P < 0.05$, comparing 2006 with 2003–2005 combined for all nest sites).

The long period of breeding activity in the species (up to 12 months from egg-laying to juveniles reaching independence) leaves little time for the adults to recover and breed again in successive years but there was no tendency for successful pairs to forgo breeding the year following a successful breeding event ($\chi^2_{(1)} = 1.30$, $P > 0.05$). Ten out of 25 pairs that bred successfully in one year did so in the following year. Similarly in the Jabiru *Jabiru mycteria* in Venezuela, fewer than half of the active pairs in one season bred in the following one and only 25 percent of successful pairs bred successfully in a second consecutive season due to the demands of breeding (Gonzalez 1996).

Rainfall was higher in 2006 than in other years, including heavy rain in January and March, and thus more Storks nested. This suggests that good rainfall before the breeding season encourages a nesting attempt. Although 2005 was the driest year, 2004, with average rainfall, had the fewest active nests among those observed regularly. It is likely that factors other than rainfall, such as those that affect food supply, may influence the likelihood of breeding. In India Maheswaran and Rahmani (2005) thought that limited food resources, leading to competition for food between the members of a pair, influenced whether a pair nested in any year. We have no data to test this hypothesis in New South Wales. The related Saddlebill Stork *Ephippiorhynchus senegalensis* in Zimbabwe also bred more in wet years than dry years (Ewbank 2003).

Table 1

Activity and nest productivity at regular and additional sites from 2003 to 2006. NC = not checked. DNN = did not nest. *n* is number of fledglings, a fraction indicates some nestlings did not fledge, e.g. 1/2 means that one chick fledged from two nestlings.

Nest site	2003	2004	2005	2006
Regular nest sites – visited all years				
Mongogarie	DNN	DNN	DNN	1/1+
Coraki	2	0/1	1	1/1+
Bungawalbin Creek	2	DNN	1	1
Arndilly North	DNN	0/1+	1	2
Arndilly South	1	DNN	2	2
Woodford Island	2	2	DNN	2
Tyndale	DNN	DNN	0	2/3
Bunyip Creek	1/2	DNN	DNN	3
Swan Creek	DNN	0	1	1
Chaffin Creek	1	DNN	DNN	2/2+
Waterview	DNN	DNN	DNN	DNN
Coutts Crossing	DNN	1	1	3
Bulahdelah	2	DNN	DNN	DNN
Nest sites only visited some years				
Main Camp 2	DNN	1/2	DNN	NC
Crowsnest	1/1+	1/1+	NC	DNN
Urunga	1/1+	NC	1	1
Maria River	NC	2	DNN	1
Gumma	NC	NC	2	2
Stratheden	NC	2/2+	NC	NC
Main Camp 3	NC	1/1+	NC	NC
Barretts Creek	NC	NC	3	NC
Belmore River	NC	NC	NC	2
Harrington	NC	NC	2/2+	NC
No. Regular nests active	7	5	7	11
No. All nests active	9	10	11	15
No Fledglings/Regular nests	11	3	7	20
No. Fledglings/All nests	13	10	15	26
No Fledged/Active nest	1.4	1	1.4	1.7

Parental care at nests

Nestlings were observed on nests for up to 87 days (Fig. 3). Males and females spent similar amounts of time on the nest during the *incubation* and *nestling* stages (Table 2), incubating, guarding and feeding the young (19 times by female, 21 by male: all $t < 1.55$, $P > 0.05$). When both adults were on the nest and one was incubating, the other collected nesting material, repaired the nest, transported water to the nest or rested. Males did significantly more brooding than females (Table 2; $t = 4.16$, $P < 0.001$).

Adult Storks regurgitated food onto the nest throughout the day, often re-eating most of it shortly afterwards. They did not usually feed young directly, but nestlings picked up small food items. An adult male regurgitated eight eels onto a nest, which it methodically picked up and swallowed again. A small nestling attempted to eat a large eel, but did not manage to swallow it,

Figure 3. *Nestlings in nest at Tullymorgan.*

Table 2

Percentage of time spent by male versus female Black-necked Storks on ten nests at various stages of nesting behaviour. P = pre-laying; E = eggs in nest; I = incubation; N = nestling/s in nest; B = brooding of nestling/s.

Nest/sex	P	E	I	E+I	N	B	N+B
Male %	54.5	59	43	45.7	41.5	68	53.5
Female %	45.5	41	57	54.3	58.5	32	46.5
t test	t = 0.91	t = 0.07	t = 0.67		t = 1.55	t = 4.16***	
Total time (minutes)	745	1276	6576	7852	2786	2290	5076

*** significant at $p < 0.001$

so the adult took it from the nestling and swallowed it. Possibly, large food items need to be well digested before small chicks can consume them. Two small nestlings attempted to swallow the same eel from different ends, resulting in a tug-of-war. One eventually wrestled the eel from the other and swallowed it. Eels, mostly greater than 300 millimetres in length, constituted the only identified food delivered to nests. There may have been smaller prey regurgitated but observers were too far from the nests to sight these. Nestlings were observed to drink water from the bill of adult birds on four occasions.

In India, both sexes spent similar amounts of time feeding the young (Maheswaran and Rahmani 2005). The regurgitation of large quantities of food at the nest after the young hatched, was also recorded (Maheswaran and Rahmani 2005). Black Storks *Ciconia nigra* in the Czech Republic brought larger prey as the chicks became older (Hampl *et al.* 2005), but we have no evidence of this in Black-necked Storks.

Regurgitation of water over a nest with nestlings, and dribbling water from the bill for nestlings have also been recorded in India, especially on hot days (Maheswaran and Rahmani 2005).

Marchant and Higgins (1990) stated that young are left unattended at 30 days of age, but we regularly observed adults at nests until young were about 2 months old. At one nest a juvenile died of starvation shortly after fledging, although it was still being attended by adults. Therefore, early desertion of young may only occur occasionally, for instance when food is scarce. White Storks *Ciconia ciconia* in Switzerland constantly guarded their young for the first 20 days, after which adults spent progressively more time foraging (Moritzi *et al.* 2001).

We had insufficient data to determine nestling period, but it is at least 87 days, compared with 78 and 80 days at Urunga, NSW (Crompton 2001, 2002) and 87–100 days in captivity (Terry Carmichael pers. comm.).

Post-fledging

Not all families were followed after fledging of young, but ten fledglings stayed with their parents for at least three months, with two still with adults seven and eight months after fledging. Eight nestlings were colour-banded during the study (2 in 2003, 3 in 2005 and 3 in 2006). These young remained close to nest sites shortly after fledging. Three juveniles remained within 300 to 400 metres of the nest for the first month and then moved up to 3.5 kilometres by two months and 5.5 kilometres by just over four months. They also moved back towards the nest during this period. Juveniles were often left alone on wetlands but adults regularly returned to feed them. Another juvenile moved two kilometres within the first 11 days and was 3.75 kilometres from the nest 22 days post-fledging. Its sibling was 3.8 kilometres from its nest 14 days after fledging, where it joined an adult pair and their two, slightly older and larger, juveniles and was also fed by the foster mother. It was still 4.4 kilometres from

Table 3

Average number of young fledged from active nests for various species.

Species	Mean	Range	No. of nests#	No. of Years	Source
Black-necked Stork *Ephippiorhynchus asiaticus*					
NSW	1.42	1.0-1.7	45	4	this study
India	2.1	1.6-2.5	25	3	Sundar (2003)
Wood Stork *Mycteria americana*					
Georgia USA	1.37	0.09-2.65	243	6	Coulter and Bryan (1995)
Venezuela	1.67	1.0-3.0	180	1	Gonzalez (1999)
Painted Stork *M. leucocephala*					
India	2.2	2.0-2.6	370	3	Urfi (1993)
Jabiru *Jabiru mycteria*					
Belize	2.0*	1.3-3.0	69	7	Barnhill et al. (2005)
Venezuela	0.97	0.94-1.00	38	2	Gonzalez (1996)
Marabou *Leptoptilos crumeniferus*					
Uganda	0.9	0.74-1.80		7	Monadjem (2005)
Swaziland	0.41		27	1	Monadjem (2005)
White Stork *Ciconia ciconia*					
Normandy	3		167		Chartier (2001)

includes repeated nesting at same nests in subsequent years * reported as 1.53 in paper

its nest at one month and seven days. Both of these related birds were together over three months after fledging and both associated with the two other juveniles. Two other juveniles at Tullymorgan were observed within 1.75 kilometres of their nest for up to five months. A juvenile colour-banded as a nestling at Bulahdelah in November 2003 was found dead near Casino (400 km NNE) in April 2004, over five months after banding and an estimated 3.5 months after fledging.

Immature birds (1-2 years old) were recorded within the natal territory up to 18 months post-fledging but the possibility that they were birds from other territories could not be ruled out. Aggressive interactions between adults and juveniles were recorded twice, the earliest at just over eight months post-fledging.

We never observed fledglings returning to the nest, in contrast with observations at a nest at Urunga, NSW, where the young returned to the nest at dusk to be fed by their parents (Crompton 2002). Juveniles attempted to forage for themselves within days of fledging, and appeared proficient within two weeks, although they may have lacked the skills to be independent for some time. Juvenile Storks appeared to be dependent on their parents for about seven months, and were tolerated by them for about eight months although some young appeared to leave their natal area about four months after fledging. In India, adults were aggressive towards juveniles five months after fledging, but the young remained in the natal territory until seven to 10 months post-fledging (Sundar 2003). Juvenile Jabirus in Venezuela were dependent on their parents for up to two months (Gonzalez 1996).

Breeding success

The size of broods ranged from one to three birds, with a mean of 1.6 ± 0.8 (Table 1). Broods of three were more common in 2006 than in 2003-2005, but this was not significant for either nestlings ($\chi^2_{(2)} = 3.439$; $P > 0.05$) or fledglings ($\chi^2_{(2)} = 4.00$; $P > 0.05$). Brood size may have been underestimated because small nestlings that died shortly after hatching would not have been detected.

At least 64 storks fledged in New South Wales during the four breeding seasons 2003 -2006, 41 from nests that were observed in every year. Three died shortly after fledging in 2003 and one died after fledging in 2005. Annual productivity varied between 1.0 and 1.7 (average 1.4 ± 0.75 for four years) young per active nest or 1.4 to 1.7 young (average 1.6 ± 0.63 for four years) per successful nest. The regularly observed pairs produced 0.8 fledglings per year, including years in which they did not attempt to breed, four nesting attempts failed to produce any fledglings, three of them in 2004. A large nestling died, presumably of starvation, at the Coraki nest in 2004 and one of two nestlings from that nest died shortly after fledging in 2003.

Breeding productivity differed between years ($\chi^2 = 15.50$, $P < 0.01$, using numbers of nests producing zero, 1, 2 or 3 young in each year). Significantly more young were produced per nest and overall in 2006, the wettest year and fewer young in 2004, a year of average rainfall. Hence, as for many other large waterbirds in Australia, rainfall appears to stimulate breeding of Black-necked Storks and improve their breeding success (Kingsford and Norman 2002). Breeding success in the White Stork in Normandy was also affected by the weather, but for this species heavy rain killed nestlings (Chartier 2001).

Most Black-necked Stork broods range from one to three (this study, Sundar 2003), though four chicks have been recorded in India (Sundar *et al.* 2007) and Queensland (Richards 2005). The Marabou Stork *Leptoptilos crumeniferus* in Swaziland usually produces one or two fledglings from a typical clutch of three eggs (Monadjem 2005), Wood Storks *Mycteria americana* in Georgia had an average of 2.7 ± 0.74 nestlings (Coulter and Bryan 1995) and White Storks in Tunisia had broods of two to four chicks (Azafzaf 2002).

We recorded several cases of loss of nestlings, though we never saw dead nestlings being thrown from the nest by parents or cannibalism, as has been recorded in India (Maheswaran 2003). Infanticide has been recorded in both the White Stork and Black Stork (Zielinski 2002).

Breeding success in this study was slightly lower than for Black-necked Storks in India (Table 3). However, the birds in India foraged in an artificially managed wetland where water levels were maintained throughout the breeding season. Other stork species produce an average of 1.6 young per active nest, ranging from below one in the Marabou Stork to 3.0 in the White Stork (Table 4). The White Stork is more productive than other storks, because it has a larger clutch size of one to seven eggs (average 4), and a very different ecology, being more terrestrial and insectivorous.

Nest site variables and breeding success

Higher nests tended to be re-used more frequently than low nests were ($F_{1, 19} = 11.06$, $P = 0.004$, $\%r^2 = 28.2\%$). There have been no previous studies on the relationship between nest height and nesting frequency of success in Black-necked Storks.

CONCLUSIONS

This study showed that Black-necked Storks may breed annually in New South Wales, from late autumn to early summer. However, individual pairs do not always breed every year. Although the breeding season, including the period of dependency of young, is long, Storks are capable of breeding successfully in successive years. High rainfall before the breeding season appears to encourage breeding and lead to higher productivity, as found in numerous other Australian waterbirds (Kingsford and Norman 2002). At least 64 young storks fledged during the study (mean of 16 young per year), despite three of the four years having below average rainfall. Over all four years, the pairs studied produced 0.9 young per year. Although little is known about the survival rate of Storks, this productivity is probably adequate to sustain the breeding population of the species in New South Wales, which is about 80 pairs (Clancy and Andren 2010).

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SEABIRD ISLANDS

No. 255

Gandja-baa, Broughton Group, New South Wales

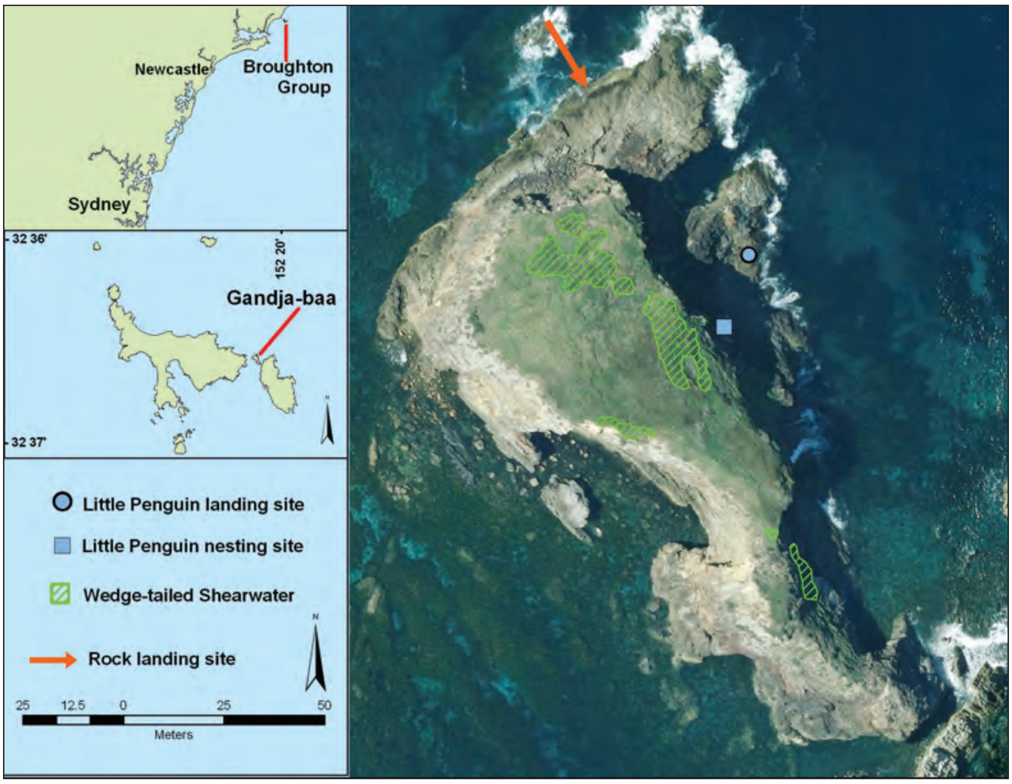
Location: 32°37'S, 152°20'E. Located approximately 16 kilometres north-east of the entrance to Port Stephens, New South Wales (NSW). It is part of the Broughton Island Group, situated 90 metres east of Broughton Island and 25 metres west of Little Broughton Island.

Status: Crown land.

Description: Gandja-baa (Gathang language for 'place of nesting birds') is a recently named islet[1]. It is an irregular-shaped island measuring approximately 175 metres by 100 metres at its widest point, with its longest axis aligned north-west to south-east. The rocky shoreline encompasses an area of 1.0 hectare with a vegetated area of 0.4 hectare rising to 31 metres. It is geologically similar to the surrounding larger islands, being composed of Carboniferous volcanic rhyolite. Cliffs of 10 to 30 metres occur on all but the north-east side, the steep slope here providing access to the plateau. Vegetation on the plateau is dominated by low stands of *Myoporum boninense* var. *australe* and White Correa *Correa alba* on the deeper soils and Blady Grass *Imperata cylindrica* var. *major* and other herbaceous plants on the shallower soils. Other species, including exotics (*) are: *Cheilanthes austrotenuifolia, Carpobrotus glaucescens, Tetragonia tetragonioides, Senecio pinnatifolius* var. *pinnatifolius, Enchylaena tomentose, Crassula sieberiana, Commelina cyanea, Dichondra repens, Isolepis nodosa, Histiopteris incisa, Monotoca elliptica, Kennedia rubicunda, Scaevola calendulacea, Lepidium pseudohyssopifolium, Lobelia gracilis, Oxalis perennans, Poa poiformis* var. *poiformis, Sporobolus virgincus, Dianella caerulea, Wikstroemia indica,* * *Opuntia stricta* var. *stricta,* **Conyza* sp. and * *Sonchus oleraceus.*

Landing: Onto rocks at the north end, depending on prevailing conditions.

Ornithological History: No previous ornithological visits have been recorded. Carlile and Callaghan visited for one hour on 2 September 2011 to search for signs of penguins and to document vegetation. The authors, with others, visited for 1.5 hours on 16 December 2011 to survey seabirds.



• *Gandja-baa, Broughton Group, New South Wales*

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[1] Gathang is a First Nations language group spoken by the Worimi Aboriginal people whose traditional territory takes in the Port Stephens area and extends south to Maitland and the Hunter River, to Forster–Tuncurry in the north, and as far west as Gloucester, New South Wales.

• *Gandja-baa from the north. The landing site is a wave-washed platform on the right of the islet in this image.*

• *Gandja-baa from the south. Viewed from Little Broughton Island.*

Breeding Seabirds and Status

Eudyptula minor Little Penguin—In September 2011, a single nesting penguin was located in a deep rock overhang on the eastern side of the island. The contents of the nest could not be determined. However, breeding was confirmed in December 2011 when downy feathers and excrement were found, indicating the presence of young that, presumably, had recently fledged.

Ardenna pacifica Wedge-tailed Shearwater—Burrows are patchily distributed across the plateau, occurring only where the soil is of sufficient depth for burrowing. An hour-long search of all potential nesting areas by five persons counted 34 burrows. Of the 10 birds extracted, eight were incubating an egg. A further single burrow contained a cold egg. We estimate fewer than 20 breeding pairs.

Factors Affecting Status

Black Rats *Rattus rattus* were eradicated from the Broughton Island Group in 2009[2]; their removal allowing the White-faced Storm-petrel *Pelagodroma marina* that nests on nearby North and Inner rocks[3,4] to potentially colonise (or recolonise) areas of shallow soil on Gandja-baa.

Shearwater remains on the ridges provide evidence of predation on seabirds by birds of prey, most likely the White-bellied Sea-eagle *Haliaeetus leucogaster* and Swamp Harrier *Circus approximans*, both of which were observed flying over the island.

Prickly Pear occurs in a single dense stand near the penguin nest site and should be eradicated before it spreads.

Other Seabirds Recorded

A pair of Sooty Oystercatchers *Haematopus fuliginosus* with a nestling, and an Eastern Reef Egret *Egretta sacra* were present in December 2011.

Other Vertebrates Recorded

Despite intensive although brief searches, no other vertebrates were recorded.

Banding

No banding has been undertaken on Gandja-baa.

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Birds of Tropical and Subtropical Queensland

Conservation Conference
Griffith University, Nathan Campus

23 MARCH 2013

ABSTRACTS

This year the Australian Bird Study Association joined forces with Birdlife Southern Queensland in presenting a conference highlighting some recent studies on tropical and sub-tropical birds. The abstracts of those presentations are published below.

Compiled by: Robert Clemens

What do birds do for rainforest decline or recovery, and vice versa?

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Rainforests are the habitat of a high diversity of bird species, and in Australia these include a significant number of regional endemics. It has consequently been widely recognised that the extensive clearing of these forests by European colonisers during the past two centuries has resulted in many species' declines. These birds are indicators of human-induced environmental impacts and also of the extent of biodiversity recovery that may be achieved by reforestation in formerly-cleared rainforest regions. However, the extent to which increasing these areas of 'new forest' can rescue the diverse fauna of native rainforests from further decline is a topic of substantial current debate. Moreover, birds are more than passive recipients of human-induced impact; they are also important components of ecosystems, and thereby act as agents of both degradation and restoration. In particular, fruit-eating birds are important dispersal agents of many plant species. This is especially the case in rainforests, where most plant species bear fleshy fruits and are bird-dispersed. Consequently, frugivorous birds have been significantly impacted by past rainforest clearing. However, they also benefit from feeding on the fruits of an increasing number of invasive non-native plant species. Birds are thus of crucial importance in enabling rainforests to regenerate, in altering their regeneration pathways in disturbed landscapes, and as key agents causing invasive plants to spread. This talk will review these issues, using case studies from the Australian tropics and subtropics, and considering some of the contemporary dilemmas which they create.

Avifaunal disarray from a single despotic species

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The Noisy Miner *Manorina melanocephala* is a native bird, but it markedly depresses the abundance of almost all smaller bird species within its territory. It is a Key Threatening Process (KTP) in Victoria, with nominations currently being considered in NSW and nationally. Despite three decades of research establishing the species' impact on entire assemblages at a level unparalleled by a native species, there is no large-scale synthesis of the causes of and solutions to the problem. To address these information gaps, the Australian Centre for Ecological Analysis and Synthesis (ACEAS) supported formation of a working group. The group developed conceptual models of Noisy Miner site occupancy and impact, and pooled bird survey data from over 2,500 sites in four states to test the postulated relationships. It also tested for increases in abundance of the species across eastern Australia and compared the cost-effectiveness of alternative management approaches. This presentation will outline the findings of the working group's research. Despite the very large distribution of the Noisy Miner and apparently conflicting results from past research, a cohesive understanding of the factors leading to increased risk of negative effects from Noisy Miners was developed. The species has increased in recent years in at least nine bioregions. Direct culling of Noisy Miners was considered to be cost-effective in some circumstances, and would be most desirable where threatened species are affected and where development of a dense woodland structure is inappropriate. Management experiments are needed to test these ideas.

Altitudinal migration around Brisbane and the problem of historical survey data

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In 1991–92 a bird survey was conducted at 20 sites along an altitudinal gradient in South D'Aguilar National Park, formerly known as Brisbane Forest Park. The aims of that survey were to determine how census duration and repetition of the Area Search Method affected the number of species recorded (Slater 1994), and to what extent habitat, vegetation characteristics and seasons explained variation in species composition and abundance (Slater 1995). Although altitude was found to have a significant effect on the abundance of most guilds, its influence on species abundance, or interaction with seasons was never examined. Twenty years later, in 2012, I began a survey that essentially replicates this study, except that the emphasis was on variation in species abundance with altitude. In the previous study, species richness and abundance were significantly higher in the second summer (1992–3) than in the first (1991–2), which followed 18 consecutive months of below-average rainfall.

A comparison of the two studies reveals some surprising differences. For instance, Slater recorded 85 species over 21 months, the present study 123 species in just 12 months. Of the 45 species that were not recorded by Slater, many are common summer migrants or locally nomadic nectarivores. One astounding absentee from the previous study was the Large-billed Scrubwren *Sericornis magnirostra*, which is currently resident at almost every site. Seven species reported by Slater have not been recorded during the present study; two are characteristic of drier regions. These disparities are discussed, and possible cases of altitudinal migration described.

Slater, P.J. (1994). Factors affecting the efficiency of the area search method of censusing birds in open forests and woodlands. Emu **94**: 9–16.

Slater, P.J. (1995). The interaction of bird communities with vegetation and season in Brisbane Forest Park. Emu **95**: 194–207.

Making the most of investment in citizen science: what makes a twitcher tick?

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Citizen science is on the rise. For citizens the motivation is to contribute to 'real' science and conservation. For scientists, citizen science collects information that would otherwise not be affordable. The longest-running and largest citizen science programs are broad-scale bird monitoring projects that include cross-sectional monitoring (e.g. Atlases) and longitudinal monitoring (e.g. Breeding Bird Surveys, BBS). We review recent applications of these programs, and a return-on-investment analysis indicates that compared with Atlases, BBS are more cost-effective and have higher impact in the scientific literature. This is most likely because BBS focus on measuring change, allowing management and policy impacts to be quantified. However, Atlases with a less-structured design are ideal for answering high-impact questions about the volunteers themselves, due to the untargeted nature of sampling. We demonstrate a social research application informed by data from the New Atlas of Australian Birds, investigating relationships between volunteer bird survey effort and motivations, to prioritise investment in future surveys. Using models describing volunteer behaviour, we identify areas unlikely to be surveyed. If these areas are important to achieve program objectives, we can either provide volunteer incentives or invest in professional surveying. Our approach saves up to 75 percent of the investment required for a professional surveying strategy that ignores volunteer efforts. To ensure citizen science data are used to their full potential we recommend the following: elements of BBS protocols (fixed sites, long-term monitoring) are incorporated into Atlases; communication between researchers and organisations coordinating volunteer monitoring is enhanced, with monitoring targeted to meet specific objectives; and under-explored objectives such as social research are encouraged.

Synergies between carbon farming and bird conservation in Queensland

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There is great potential in Queensland to accumulate carbon via the restoration of native vegetation. This is because large areas have been cleared, and many vegetation types will readily regrow if grazing and other threats are appropriately managed. Restoration of vegetation benefits birds by increasing the amount of habitat available, and this is particularly important for birds associated with heavily cleared vegetation types, e.g. brigalow. In addition, many management actions which will maximize the carbon in a forest are also good for birds. These include the retention of large trees, standing dead trees, litter and coarse woody debris; and the management of fire, weeds and grazing.

A new revenue stream for projects that have both carbon and biodiversity benefits has been provided by the Australian Government via the Carbon Farming Initiative. Both community groups and landholders are eligible for this funding. To support the restoration of native vegetation for carbon and wildlife, the Queensland Government is developing the Regrowth Benefits website which will include an interactive map and management guidelines for Queensland vegetation types. The interactive map will allow the user to determine the pre-clearing vegetation type at their site, and also whether the site is potential habitat for threatened species. Links are provided to web pages on vegetation ecology, condition states, and management actions for carbon and wildlife. This talk will provide an overview of the many synergies and some conflicts between managing native vegetation for carbon and birds, and a sneak peek at the Regrowth Benefits website.

Guided by the light: what is going on with those huge urban lorikeet roosts?

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Although most species are unable to cope with the process of urbanisation, a notable few are able to take advantage of the opportunities provided by anthropogenic environments. Some species such as Rainbow Lorikeets *Trichoglossus haematodus* are now among the most abundant birds found in many cities throughout Australia, a growth in populations fuelled largely by the popularity of nectar-bearing trees. During the evening, the species forms massive communal roosts, often in remarkably disturbed locations. We explored the potential influences on roost site choice among rainbow lorikeets in suburban Brisbane. The trees found in a series of 14 roosts ranging in size from a few thousand to over 100 000 birds were investigated with respect to size, canopy condition, species, proximity to natural and urban features, as well as the level of lighting reaching each tree. Trees at the roost site were classed as either roost tree, pre-roost trees or none-roosts; in addition, a large number of sites this apparent suitable conditions but not used were measures as controls. Lorikeets were found to use a wide variety of trees as roosts, but the level of light appeared to be the most important variable. One functional explanation for this may be predator detection.

Conserving nomadic birds

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Many Queensland birds are nomadic, moving around the landscape to follow resources which are often irregular and unpredictable. The isolation and extreme conditions of many parts of Queensland mean we still know very little about the way that most birds move around the landscape. I used BirdLife Australia Atlas data to map the changing distribution of outback birds over different seasons. I'll discuss critical issues in the conservation of nomadic birds and outline new ways to measure threats for nomadic and dispersive species.

Effect of observers on calling behaviour of birds during surveys.

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Observer bias in bird surveys is well documented, particularly when making estimates of abundance, however the effect of observers on the calling behaviour of birds is less well understood. Many species are known to modify their calling behaviour in response to the presence of threats either increasing or decreasing calling behaviour. This has not been accurately quantified in terms of bird surveys however. Given that bird detections based on calls can constitute over 50 percent of observations, either change can lead to under or overestimations.

We conducted simultaneous dawn, noon and dusk point count and acoustic sensor surveys at four sites over a five day period in the Samford Valley to determine if there was a change is bird calling behaviour during surveys. Recordings corresponding to the 20-minute periods prior to the arrival of surveyors on site, while the surveyors were on site, and after surveyors departed were analysed. In total, 16 253 calls were annotated, and 83 unique species identified in the one-minute segments analysed. The difference in mean calling frequency for each species, for the before, during and after periods were compared using a one-way ANOVA. None of the 83 species compared showed a significant difference in mean calling rates for the 20-minute periods corresponding to before, during and after periods. This result warrants further investigation in different habitat types to determine if these findings are consistent across different species assemblages, and to identify what factors influence calling behaviour during bird surveys.

Do Black-faced Cormorants *Phalacrocorax fuscescens* play favourites? An experimental test of the parent-offspring conflict in a brood reducing seabird

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This paper describes the parent-offspring interactions that occur in three-nestling clutches of Black-faced Cormorants *Phalacrocorax fuscescens*, an Australian brood reducing seabird. Studies of parent-offspring conflict show that parents 'play favourites' by preferentially feeding larger dominant nestlings over marginalized nestlings, thereby maximizing their inclusive fitness. We tested this hypothesis by experimentally manipulating brood size in Black-faced Cormorants and measuring (a) levels of parental provisioning, (b) nestling begging dynamics, and (c) aggression between nestlings. We found that: (a) nestling engage in a random begging strategy to parents without demonstrating a begging preference to a particular sex; (b) nestlings use aggression and begging as a competitive strategy to out-compete other nest mates; and (c) parents share the food delivery workload but have subtle differences in their feeding strategy. Males control the distribution of food between nestlings by selectively responding to nestling begging behaviour, while females do not show a preference towards nestling begging behaviours and equally distribute food between nestlings. This study suggests that differences in the feeding behaviour of adult male and female Black-faced Cormorants influences competitive begging interactions between nestlings.

Movement and home range of the Black-throated Finch southern subspecies *Poephila cincta cincta* – preliminary results

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The Black-throated Finch southern subspecies *Poephila cincta cincta*, previously found in woodlands from NSW to northern Queensland, has contracted in range by 80 percent since the 1970s. However, little is known about habitat use and movement of this species. Here, we present preliminary results of our study of black-throated finch southern subspecies' (BTF) movement and home range.

This study, focused mainly on the Townsville coastal plain, involves observing known BTF flocks, searching for new populations, and targeted mist netting. Captured BTFs were metal and colour-banded and selected birds were fitted with a 0.3 gram radio transmitter. Location data were analysed using a variety of spatial analysis methods.

To date, 63 BTFs have been colour banded (5 sites) and one has been radio tracked. Thirty-three re-sightings have been recorded to date, most within a few metres of the banding site but one bird was re-sighted six kilometres away after three months. Site-fidelity is strong, with three birds re-sighted in the same locale 238 days after banding. Over 11 days, the tagged BTF had regular daily activities, travelling 700 metres from a specific roosting site to a particular foraging area. Kernel density analyses indicated a foraging range of 3.55 hectares (D50%), while the overall home range was 3.78 hectares.

BTFs have been found to move farther than previously thought over seasonal time-scales, but over shorter scales, they maintain small home ranges. Further results will yield valuable information on habitat and landscape use at a variety of spatial and temporal scales, thus assisting management and conservation efforts.

Foraging behaviour of the Peaceful Dove *Geopelia striata* in relation to predation risk: group size and predator cues in a natural environment*

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Foraging behaviour is directly influenced by the risk of predation, which is in turn influenced by distance to cover, height of vegetation and, predator cues. In this study, we used giving-up density (GUD) to investigate the foraging behaviour of the Peaceful Dove *Geopelia striata* in relation to predation risk. We simulated predation risk by placing feeding patches in grass of various heights, and visual and auditory predator cues were also simulated. GUD was higher near tall grass and minimum GUD of individuals remained similar among different group sizes. Both visual cues and the combination of visual and acoustic cues altered the patterns of GUD significantly, but the effects of the two treatments did not differ from each other. We conclude that changes in vegetation structure and visual predator cues can strongly increase the assessment of predation risk by ground-feeding birds. Grouping behaviour in this species was not entirely a result of clumped food resources in their natural environment but was influenced by anti-predator strategies and birds could maintain higher food intake in more dangerous places when in groups. Our study used a rare, but important, field experimental approach to determine factors that affect foraging behaviour in a bird.

The full paper will be published in Emu:

Tang, L., and Schwarzkopf, L. (in press). Foraging behaviour of the Peaceful Dove *(Geopelia striata)* in relation to predation risk: group size and predator cues in a natural environment. *Emu: Austral Ornithology*. **113:** 1-7. Available at: http://dx.doi.org/10.1071/MU12023

The social dimensions of feeding birds in Australia and the United Kingdom

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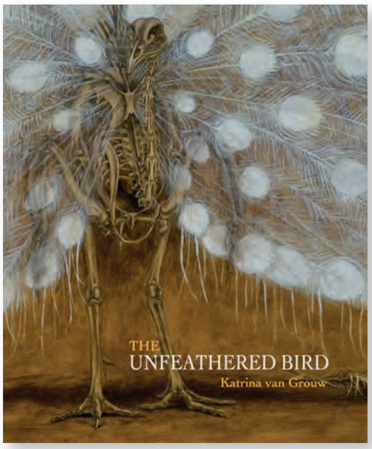
Bird feeding is very common and widespread throughout the world. Despite this fact there has been very little research into this phenomenon. The feeding of birds has raised many negative assumptions for both the birds and people involved. Studies have concentrated on the impacts of dependency, malnutrition, behavioural changes and disease for the species involved. Initial research has shown that the feeding public is conscious of these negative assumptions and the opposition to the practice and despite this still desire to engage in the activity. A survey has been distributed to investigate the attitudes and motivation behind bird feeding in Australia and the United Kingdom and what it means for those involved. This research will also examine the implications of this interaction for an individual's personal connection with nature and the subsequent environmental values that may be associated with it. An international comparison is made with the United Kingdom as there is an extensive history of bird feeding (it is encouraged particularly during winter) and an opposing view to the practice when compared to Australia.

Book Review



The Unfeathered Bird

Katrina van Grouw. 2013. Princeton University Press. Hardback, xiv+287 pp. ISBN 9780691151342. RRP $49.95

Everyone is acquainted with large format books of bird illustrations. Almost without exception such books are full of portraits of living birds, fully feathered—in other words, from the outside. *The Unfeathered Bird*, while filled with over 385 lovely drawings of birds, is quite unlike any book you've seen before. As the title indicates, in these images the feathers have been removed from the body to show what lies beneath. Few people regularly have such a view (other than for a cooked chook), but by looking at a plucked bird first showing the size and placement of the muscles and then with everything removed leaving only the skeleton reveals so much that is normally obscured from the observer by feathers. The figures in *The Unfeathered Bird* do exactly that—exposing what most people never see.

Short introductory sections on the structure of the skull, trunk and limbs of birds in general set the scene for the remainder of the book. The skeleton of birds is, on one hand, remarkably uniform across this class of animals because the physical constraints of flight limit the diversification that is possible. On the other hand, within these restrictions, there is a wide range of variation possible. This is demonstrated by a survey of the major groups of birds, encompassing 200 species, ranging from ostriches to hummingbirds, flamingos to eagles, and even some extinct species, like the Great Auk. These comparisons quickly reveal the marked divergence within birds, particularly in relative proportions in different parts of the body. The muscles can similarly be compared and contrasted between various kinds of birds. In a number of examples, images of the muscles and the skeleton are shown side by side for the same bird, giving an excellent depiction of the internal avian architecture at several levels.

Rather than being laid out like specimens on a museum slab, most of the subjects are shown in a lifelike position, engaged in characteristic behaviours, such as flight, perching or other activity. Among the most intriguing, and appealing, are an albatross soaring over the ocean, penguins swimming, grebes and cormorants diving, raptors and swamphens holding objects in a foot while feeding, a macaw chewing on a pencil and a whimsical Budgerigar skeleton admiring itself in a mirror. A bird of prey in flight with the head and body feathers removed, but retaining the wings and tail, is an excellent demonstration of how the flight feathers are placed on the body.

In addition to the pictures of entire bodies, there are numerous close up vignettes of skulls and feet, with a scattering of other features of interest. Often the feature is also shown *in situ*, for example, the woodpecker's tongue, which wraps around the skull, or the manucode's elongated and convoluted trachea, which curls in front of the chest. These and other special aspects are not presented as detached novelties, but in position on the fleshed out but defeathered body.

An interesting theme is what is possible through selective breeding within a single species. The artist presents an assortment of domestic chooks, waterfowl and pigeons, each group exhibiting striking diversity among individuals. These comparisons testify to the major restructuring of the body plan that has been possible in a rather short time through human intervention, especially when compared to the accompanying picture of the wild ancestor.

The text is engagingly written. It presents some general biology of each group of birds, but focuses on the characteristic features these exhibit and explains how their morphology and lifestyle are interrelated. Thus features that are critical for feeding, such as the 'kinked' neck of darters and herons, and locomotion, for example, the contrasting styles of grebes and auks, are explained in a manner to complement the pictures. While not attempting to be comprehensive, the informative text successfully provides the necessary information to add greater appreciation of the illustrations. And it manages to do so while avoiding excessive detail and boring technicalities. There are additional snippets on such aspects as history, relationships and, behaviour. The style is informative and appealing, even quirky in places.

The author/artist is uniquely situated to produce a book like this. Katrina van Grouw has a strong artistic background, having graduated from the Royal College of Art. What has given her the vast experience needed for this project, however, is her time spent as a taxidermist and curator in the bird collections of the Natural History Museum, United Kingdom. In her acknowledgements, she stresses that all drawings were from real specimens but none of the birds was deliberately killed for the purpose, instead relying on those found dead or donated. Most of the specimens were prepared at home, stored in personal freezers before being boiled up and cleaned.

This is not a dry detailed anatomical text and it will not replace such a volume for research purposes. But it does not try to be. The author states that she "attempted to make T*he Unfeathered Bird* a convergence of art and science". In this she has been successful. Who is the audience for such a book? It is directed towards those readers interested in knowing more about birds, particularly bird anatomy, without wading through overly technical, jargon-filled prose. It will also attract people who like books of pleasurable, albeit out of the ordinary, artwork. Because of this combination of art and accessible science, *The Unfeathered Bird* should appeal to professionals through amateurs, including those who do not have a strong interest in ornithology. I like this book a lot and recommend it highly.

Walter Boles
Primbee, NSW

RECOVERY ROUND-UP

This section is prepared with the co-operation of the Secretary, Australian Bird and Bat Banding Schemes, Australian Nature Conservation Agency. The recoveries are only a selection of the thousands received each year; they are not a complete list and should not be analysed in full or part without prior consent of the banders concerned. Longevity and distance records refer to the ABBBS unless otherwise stated. The distance is the shortest distance in kilometres along the direct line joining the place of banding and recovery; the compass direction refers to the same direct line. (There is no implication regarding the distance flown or the route followed by the bird). Where available ABBBS age codes have been included in the banding data.

Recovery or longevity items may be submitted directly to me whereupon their merits for inclusion will be considered.

Hon. Editor

The following abbreviations appear in this issue:

SSG -BOAT – Shorebird Study Group – BOAT (Tas.)

VWSG - Victorian Wader Study Group.

Red-tailed Tropicbird *Phaethon rubricauda*

091-44032. Nestling banded by N.J. Cornelius on Raine Island, North Great Barrier Reef, Qld. on 28 Jun. 2002. Recaptured, released alive with band on Ashmore Reef, West Island, Timor Sea, WA on 13 Apr. 2013. 2292 km W.

Shy Albatross *Thalassarche cauta*

(a) 131-90524. Nestling banded by N.P. Brothers on Albatross Island, Tas. on 2 Apr. 1997. Recovered dead at Fisherman's Beach, Torquay, Vic. on 19 Nov. 2012, over 15 years, 7 months after banding. 232 km N.

(b) 280-00512. Nestling banded by N.P. Brothers on the Mewstone, Tas. on 15 Mar. 1982. Recovered dead at Inverloch Beach, Vic. by J. Berry on 12 Feb. 2013, over 30 years, 10 months after banding. 570 km N.

(This is the oldest recorded for the species.)

(c) 280-01508. Nestling banded by N.P. Brothers on Albatross Island, Tas. on 31 Mar. 1982. Recovered dead at Burrill Beach, NSW on 17 Jan. 2013, over 30 years, 9 months after banding. 753 km NE.

(d) 280-07436. Nestling banded by N.P. Brothers on the Mewstone, Tas. on 24 Apr. 1985. Recovered dead at Mooreheads Beach, Bermagui, NSW on 11 Jan. 2013, over 27 years, 8 months after banding. 871 km NNE.

Lesser Frigatebird *Fregata ariel*

210-07172. Nestling banded by R.H. Clarke on Middle Island, Ashmore Reef, Timor Sea, WA on 10 Jul. 1989. Recaptured, released alive with band at banding place on 14 Apr. 2013, over 23 years 9 months after banding.

(This is the oldest recorded for the species.)

Australian Pied Oystercatcher *Haematopus longirostris*

100-84291. Adult (3+) male banded by SSG-BOAT at South Arm Neck, Tas. on 1 Aug. 1982. Recovered dead, found beachwashed, by A. McLachlan at Mortimer Bay, Tas. on 24 Sep. 2012, over 30 years 1 month after banding. 8km NNE.

(This is the oldest recorded for the species.)

Red-necked Avocet *Recurvirostra novaehollandiae*

083-22877 (plus engraved leg flag orange ABW). Juvenile banded by VWSG at Yallock Creek, Westernport, Vic. on 2 Jan. 2012. Leg flag recorded in a flock of 150 birds by A. Boyle at Roebuck Bay, Broome WA on 20 Jun. 2013, *c*. 3000 km NNW.

(This is a most unusual recovery and certainly the longest movement for the species)

Kelp Gull *Larus dominicanus*

111-12744. Nestling banded by W.C. Wakefield on Green Island, D'Entrecasteaux Channel, Tas. on 22 Dec. 1991. Band number read in field (bird not trapped) by J. Mure at the Old Pilot Station, Tinderbox, Tas. on 8 May 2013, over 21 years 4 months after banding. 17 km N.

Fuscous Honeyeater *Lichenostomus fuscus*

026-20626. Adult (2+) banded by W. Greenlees at South Grafton Water Reserve, NSW on 5 Jul 2004. Recaptured, released alive with band at banding place twice by G. P. Clancy the later occasion on 26 May 2013, over 8 years 10 months after banding.

(The bird was also banded with band no. 026-94933.)

White-plumed Honeyeater *Lichenostomus penicillatus*

(a) 023-47819 Adult (2+) male banded by J. Hardy at Burrendong Arboretum, near Wellington, NSW on 1 May 1999. Recaptured, released alive with band at banding place six times, last occasion by D. McKay on 15 Jun. 2013, over 14 years, 1 month after banding.

(b) 026-10498. Adult (1+) banded by C. Kinross at Burrendong Arboretum, near Wellington, NSW on 5 Jun. 2005. Recaptured, released alive with band at banding place seven times, last occasion by P. Hanke on 16 Mar. 2013, over 7 years, 9 months after banding.

Noisy Miner *Manorina melanocephala*

62-52436. Adult (1+) banded by D. McKay at Burrendong Arboretum, near Wellington, NSW on 3 Sep. 2005. Recaptured, released alive with band at banding place on 16 Mar. 2013, over 7 years, 6 months after banding.

Spiny-cheeked Honeyeater *Acanthagenys rufogularis*

051-23347. Immature (1) male banded by J. Hardy at Burrendong Arboretum, near Wellington, NSW on 21 Aug. 1999. Recaptured, released alive with band at banding place twice, last occasion by D. McKay on 16 Mar. 2013, over 13 years, 7 months after banding.

(This is the oldest recorded for the species.)

Golden Whistler *Pachycephala pectoralis*

034-37353. Immature (1) banded by A.J. Leishman at the Australian Native Botanic Gardens, Mount Annan, NSW on 14 May 2005. Recaptured, released live with band six times the last occasion by L. Palmer on 2 Jul. 2013, over 8 years, 1 month after banding.

Jacky Winter *Microeca fascinans*

019-85401. Adult (1+) banded by P.J. Milbourn at Mulligans Flat, ACT on 25 Jul. 2010. Band number read in field (bird not trapped) by R. Eckermann at Campbell Park, near Triangular Dam, ACT on 6 Jul. 2013. 11 km S.

(This is the longest movement recorded for the species.)

Red-browed Finch *Neochmia temporalis*

019-63153 Adult (1+) banded by D. McKay at Burrendong Arboretum, near Wellington, NSW on. 1 Mar. 2008. Recaptured, released alive with band at banding place three times, the last occasion by D. McKay on 15 Jun. 2013, over 5 years, 3 months after banding.

Notice to Contributors

Manuscripts relating to any form of avian research will be considered for publication. Field studies are preferred particularly where identification of individual birds, as by banding, has formed an integral part of the study. Some broad areas of research which do not necessarily require individual identification include morphometric analyses, techniques, species diversity and density studies as well as behavioural investigations. Behavioural, plumage and breeding studies can be conducted in captivity but must provide basic ornithological knowledge rather than avicultural interest.

Manuscripts are classified as either major articles (more than 1,500 words) or minor articles (500 to 1,500 words). Minorarticles need no summary. Shorter notes relating to almost any aspect of ornithology are welcomed but must adhere to the aims of the Association. Species lists or sightings which are not discussed in relation to historical evidence or scientific parameters are not suitable for publication in *Corella.* Authors proposing to prepare Seabird Island items should contact the Assistant Editor,Seabird Islands, and obtain a copy of the guidelines.

The copyright of material published in *Corella* is assigned to the Australian Bird Study Association.

Contributors are requested to observe the following points when submitting articles and notes for publication in *Corella*.

Manuscripts:

A guide to the format required for tables, figures and manuscripts can be attained by reference to a recent edition of the journal and more specifically to the Publication Style found on the ABSA website.

Articles or notes should be sent via email to the editor as a .doc or .rtf file or typewritten and submitted in triplicate via post. Double spacing is required with typing on one side of the paper only. Margins of not less than 25 mm width at the left hand side and top, with similar or slightly smaller at the right hand side of the page are required.

All pages of the manuscript must be numbered consecutively, including those containing references, tables and captions to illustrations, the latter placed in after the text. No underlining and no abbreviations should be used within the text.

The *Style Manual for Authors,Editors and Printers* (6th edition 2002; John Wiley & Sons Australia, Ltd.) is the guide for this journal. Spelling generally follows the Macquarie Dictionary.

Nomenclature and Classifications follow:

Christidis, L. and Boles, W. E. (2008). 'Systematics and Taxonomy of Australian Birds'. (CSIRO: Collingwood, Victoria).

Proper nouns, particularly place and bird names must commence with a capital letter.

Headings are as follows: **HEADING – capitals and bold** (e.g. **RESULTS**)
Sub Heading – lower case and italics (e.g. *Ecology*)

Referencing:

References to other articles should be shown in the text – '. . . Bell and Ferrier (1985) stated that . . .'or '…. this is consistent with other studies (Jones 1983; Bell and Ferrier 1985).'– and in the Reference Section as:

Bell, H. L. and Ferrier, S. (1985). The reliability of estimates of density from transect counts. *Corella* 9: 3-13.

Jones, J. C. (1983). 'Sampling Techniques in Ornithology.'(Surrey Beatty and Sons: Chipping Norton, NSW.)

Figures (Maps and Graphs) and Tables:

The printable area of the page is 18 cm x 27 cm; double column figures/tables will be 18 cm across; single column figures/tables will be 8.5 cm across; widths between one column and double column can also be accommodated.

The captions for figures should be typed up onto a page separate from the figure.

Maps

Maps should be clear and relevant to the study and can be submitted in a variety of formats (.tif, .eps, .pcx) but there commended one is a high resolution .jpg file (colour is acceptable). In some instances simply listing the latitude and longitude may suffice instead of a published map. Maps should only show necessary information. Excessive labelling(including names of towns, roads, rivers) will clutter the figure making it difficult to locate key place names. Photocopies of original hand drawn maps are not suitable for publication. They should be submitted only initially. When the paper is accepted for publication, the originals must be submitted so that they can be scanned into an appropriate electronic format.

Graphs

Lines should be thick and dark and any fill used should show a clear distinction between sets of data (colour fills are acceptable). Borders around the graph and the key are not necessary. The recommended format is an .xls file – this makes it very easy to adjust fills, thickness of lines etc, if necessary.

Where possible, please present the figure at final size. Figures that seem satisfactory when they are large, can present problems when they are reduced. Remember that if the figure has to be reduced for publication the figure will reduce equally in all dimensions i.e. both width and height will reduce. This can cause some problems, such as: (i) Line graphs where the lines are very close together can lose clarity. (ii) The typeface will reduce. Please ensure that the final typeface size AFTER reduction will be a minimum of 10 times Times New Roman typeface.

Tables

The recommended format is an .xls file but tables created in Word are acceptable. These should normally have a maximum size of one page but larger tables can be accommodated, if necessary.

FOR MORE DETAILED INFORMATION OR ASSISTANCE IN THE PREPARATION OF FIGURES PLEASE CONTACT THE PRODUCTION EDITOR.

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