The Whistler

Breeding studies:
Brahminy Kite, Little Tern and Noisy Pitta

Bird populations of:
Broughton Island
Forest Road, Duns Creek
Tank Paddock
Two small Manning Valley wetlands

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- ***To encourage bird observing as a leisure-time activity***

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Authors wishing to contribute articles of general bird and birdwatching news to the club newsletter, which has 6 issues per year, should submit to the Newsletter Editor: Dan Williams scythrops@yahoo.com.au

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Front cover: Little Tern *Sternula albifrons* - Photo: Steve Merrett

Back cover: Brahminy Kite *Haliastur indus* - Photo: Lois Wooding

The *Whistler* - Editorial

The papers in this volume of *The Whistler* demonstrate the ability of amateur bird watchers to make important contributions not only to our knowledge of the avifauna of the Hunter Region but also of Australian birds more widely. Pride of place goes to Lois Wooding for her meticulously documented study of a pair of Brahminy Kite's breeding at the southern extremity of their range. To the best of our knowledge her study is the first detailed account of the chronology of the breeding sequence for this species, which is understudied relative to many other raptor species.

The Noisy Pitta is another species that has been found breeding in an unexpected area, further south and nearer the coast than expected. A note by Robert Kyte documents this potentially important development without disclosing its exact location. Also connected with breeding is a note by Joy Nicholls and Anne Williams on the behaviour of juvenile Australasian Figbirds while in care, demonstrating the kind of observation that may most easily be made by wildlife carers.

The short paper describing Grahame Felletti's equally persistent studies of the Brush Bronzewing in the Belmont area poses interesting questions. For instance, why are the Hunter records of Brush Bronzewing predominantly from that area? Why are there so few records outside spring and summer? Grahame seeks to answer those questions. Here is an outstanding opportunity for others to apply their birding skills and contribute to unravelling the mysteries surrounding the little-known status of this species in the Hunter Region.

We return to breeding studies with Neil Fraser's paper which documents Little Tern nesting at Winda Woppa in Port Stephens. Neil provides a comprehensive account of the spontaneous colonisation of the area taking opportunistic advantage of circumstances created by dumping of dredged material. Neil's background research provides anecdotal evidence that these events have occurred in the past, but in this instance the published record may assist land managers to make future interventions that will improve Little Tern breeding success.

Four papers provide detailed inventories of local bird populations, but the circumstances differ markedly. Jenny Powers and Liz Huxtable offer a study of a site close to Newcastle that many readers will have visited, fully documenting the results of eight years of surveys at the Tank Paddock, near Minmi. Such studies can be of considerable importance for HBOC's conservation efforts, especially as they relate to the Green Corridor and the overall wetland area that extends to Hexham.

Alan Stuart and others present the results of surveys on Broughton Island following the removal of invasive species. It is gratifying to see how quickly certain avian species will begin to use the new opportunities offered by the island.

Mike Newman demonstrates the value of roadside vegetation in a rural setting using data gathered by regularly walking a road near Paterson. This demonstrates the opportunities for observing birds along our country roads even though the land may remain off limits.

Alan Stuart contrasts the bird populations of two small lagoons in the north-east of the Hunter Region, adding further to our knowledge of the wetlands around the Manning Estuary, and posing interesting questions about the reasons for the differences.

The editorial team would like to congratulate the authors for providing a steady flow of publishable material, delivered in plenty of time for all the deliberations that necessarily precede publication. We are delighted with the diversity and balance of the material which we are presenting in this issue. This shows the increasing maturity of bird study within the HBOC community. But the job is never quite done, and there remains much to know about the avifauna of the Hunter Region. Perhaps this is an opportunity to reflect on where not only *The Whistler* but also the wider HBOC effort of which it is part should now be directed. After meeting overseas and discussing initiatives elsewhere, Mike and Harold wonder whether we might be able to learn from other regional groups of bird observers. For instance, the UK has estimates for the breeding populations of all bird species and in some areas the population estimates are available at the regional level. Even if the answer is 'No', it makes sense that continuing Hunter residents, who remain in touch with the situation on the ground, should reflect further upon the objectives of avian research in the Hunter for the future.

Mike Newman, Harold Tarrant and **Neil Fraser**
Joint Editors

Brahminy Kite nesting at Port Stephens, NSW: extension of southerly breeding range

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The existence of an active Brahminy Kite *Haliastur indus* nest at Lemon Tree Passage (Port Stephens, NSW), was confirmed on 31 May 2016. The nest site was monitored for eight months, and parental behaviour and time-budgets are described. Incubation lasted a maximum of 43 days (probably less), and the nestling period at least 50 days; development of the juvenile is described. The only identified prey items at the nest were fish. One juvenile was raised successfully by the adult pair; a second fledgling fell from the nest, was rescued, successfully raised in care and released. A second nesting attempt in the same year proved unsuccessful and the egg was presumed to be infertile. The nest location, which is currently the most southerly Brahminy Kite nest site in New South Wales to be identified, monitored and described, supports the view that Brahminy Kites are extending their southern breeding range.

INTRODUCTION

Brahminy Kites *Haliastur indus* are predominately coastal raptors, although they may occur inland along rivers, estuaries and wetlands (Marchant & Higgins 1993). Their distribution is widespread from coastal south-east Asia to Australia. Generally common along Australia's northern coastline, they range south to Shark Bay, in Western Australia, and the Hunter coastline in New South Wales (Marchant & Higgins 1993; Debus 2012). Historical evidence indicates that the eastern coastal range of the Brahminy Kite extended further south at the time of European settlement, to the Sydney region. A northern New South Wales range-contraction appears to have occurred during the first 80 years of European settlement (Cooper *et al*. 2014).

Contemporary data compiled by the NSW Bird Atlas and the Hunter Bird Observers Club (HBOC) indicate that sightings of Brahminy Kites are no longer a rarity along the Hunter coastline (Stuart 1994-2016; Cooper *et al.* 2014). HBOC nesting records for this species also suggest the steady consolidation of a southerly range reversal as more pair-based territories become established (Stuart 1994-2016). This paper describes nesting activity at a site one degree south of all Brahminy Kite nests reported to date (R. Cooper pers. comm.). The detail obtained, including on parental time-budgets, extends the few, incomplete behavioural studies of this species in Australia and globally (e.g. Rourke & Debus 2016), and provides the first detailed account of the nesting period. The pair also attempted a second clutch soon after the first brood fledged.

Background observations

The first reported sighting of Brahminy Kites at Port Stephens occurred in 2005 when two birds were recorded as "often present" at Bulls Island, Lemon Tree Passage (Stuart 2006). In subsequent years, single birds and pairs were routinely recorded at various locations within the estuary and along the coast. One pair was frequently seen hunting around Bulls Island, Lemon Tree Passage and Tilligerry Creek (Stuart 2006-2016). The frequency of Brahminy Kite sightings in the Port Stephens estuary strongly suggested the existence of a local nest.

In December 2012 a report, accompanied by photographs of a juvenile Brahminy Kite landing on the balcony rail of a residence overlooking Lemon Tree Passage, was received. The juvenile lost its balance and tumbled into some nearby mangroves, where it managed to right itself and perch on a branch before flying away. In one photograph two adult Brahminy Kites can be seen flying overhead (P. Eltoft, pers. comm. and photos). The awkwardness and inexperience of the juvenile indicated fledging from a nearby nest.

In 2013, there was further evidence suggesting a local nest when, during July, a Brahminy Kite was seen carrying a branch and flying towards Lemon Tree Passage (L. Crawford & C. Herbert, pers. comm.). No nest was found until December 2014,

when local birdwatcher, Pam Hill, heard about the location of a large nest. The nest was visited and photographed, but no activity was noted. However, discussion with local property owners, and showing them field-guide photographs, suggested that the nest had been occupied by Brahminy Kites.

During 2015 the nest site was visited on a monthly basis, but no activity was noted. On 21 April 2015, an east-coast, low-pressure weather system caused severe damage throughout the estuary. The nest tree was badly damaged, but the nest remained intact. The nest tree was scheduled for removal, but when alerted to the presence of the nest, a decision was made to lop the tree and make it safe rather than remove it. Brahminy Kites were seen regularly at Lemon Tree Passage during 2015 but the nest remained unoccupied, probably because lopping of the nest tree, and other trees in the area, occurred during the breeding season. On a routine visit on 31 May 2016, an adult Brahminy Kite was seen at the nest. Monitoring commenced immediately.

STUDY AREA AND METHODS

The nest was located in an urban setting at Lemon Tree Passage, Port Stephens, New South Wales (32º43'50"S, 152º02'03"E), 630 m from the northern entrance to the Passage, and 830 m from Tilligerry Creek (Google Earth 2015). The nest tree was a mature Blackbutt *Eucalyptus pilularis* (estimated canopy height: 45 m; estimated nest height: 28 m). Blackbutts dominated the area, along with an intermingling of mature Sydney Peppermint *Eucalyptus piperita*, which the kites often used when perching. The nest tree was situated at the intersection of one undeveloped and three developed building lots, on the eastern side of a steep slope leading up to a well-treed ridge. The topography, dense understorey and built environment made it impossible to accurately measure canopy height, nest height and trunk diameter with conventional survey equipment, so these parameters were estimated.

Observation position

Views of the nest interior were not possible; also foliage, surrounding trees, scrub and the built environment restricted nest observation to a position approximately 30 m north-west of the nest tree, at an angle of approximately 40º to the nest. Most observations were made from a vehicle. The adult birds, while appearing tolerant of the property owners, often showed signs of agitation when strangers approached. The car, always parked in the same position, was quickly accepted.

Identification

Determining the sex of the adult birds was initially difficult. In good light the presumed female appeared bulkier than the male, and her russet-coloured feathers looked dull. The lighter, brighter plumage of the presumed male had a noticeable sheen in sunlight. Behaviour (i.e. copulation, food drops, nestling), also helped to determine the gender of the adult birds, although herein gender is always putative (Lutter *et al*. 2006).

Observation schedule

Regular nest observations began on 31 May 2016, and continued until 21 December 2016. During this period the nest was visited on 58 occasions for a total observation time of 101.5 hours: eight visits, 9 h 35 min, during the pre-laying phase (to 16 June); 14 visits, 32 h 6 min, to hatching (2 August); seven visits, 15 h 50 min, in the chick's first 30 days (to 1 September); nine visits, 19 h 30 min, to fledging (21 September); and 19 visits, 24 h 8 min, over 65 days during the pair's second nesting attempt (15 October–21 December). The behavioural sequence for each observation session was logged and transferred to an Excel spreadsheet for analysis. Observations were made with binoculars (Swarovski EL10x50 SV) and a spotting scope (Swarovski HD 20x60). Photos and videos were taken using a Canon EOS 7D Mark II camera equipped with a Canon EF 100-400 f/4.5–5.6L IS USM lens, and a Nikon Coolpix P900 camera.

Nest monitoring began when nest preparation and courtship were already underway, and continued through the complete cycle of egg-laying, incubation, nestling period and fledging, to eventual nest desertion. During this time, a juvenile was seen to fledge and fly strongly. The presence of a second juvenile was confirmed when human disturbance caused an adult and the first juvenile to abandon the nest site, leaving a previously unseen, fledged juvenile to unsuccessfully attempt flight. The second juvenile was collected by a representative of Wildlife In Need of Care (WINC). The bird survived and was later transferred to the Australian Raptor Care and Conservation Centre for rehabilitation. The rescued juvenile was released in the Lemon Tree Passage area on 6 March 2017.

RESULTS

The nest

The size of the nest was estimated at 1 m (L) x 0.7 m (W) at the rim, with a cup-depth of 30 cm. Nest construction consisted of interwoven twigs and branches of varying lengths and diameters. The nest was wedged into the branching fork of a large secondary limb at an estimated distance of 8 m from the main trunk of the nest tree, at a height of 28 m (**Figure 1**).

Figure 1. Nest tree

Courtship and nest preparation

Very little nest preparation was observed. Photographs taken between December 2014, when the nest was first discovered, and May 2016 when observations began, showed little evidence of nest deterioration. Repair work may have been undertaken before the commencement of nest monitoring.

Courtship and nest preparation occupied 31 May to 16 June 2016, during which the female was on or near the nest for 99% of observation time (9.58 h), and the male for 14.8% (**Table 1**). The male was observed bringing a long, thin stick to the nest on two occasions, but the female did not place either stick into the nest structure. Both sticks dropped to the ground and no attempt was made to retrieve them. The female occasionally tugged at nest branches already in situ.

Throughout the entire 8 months of nest monitoring, both adults showed an individual preference for 2-3 different perches, all on exposed branches 2-15 m from the nest. Perch heights varied, and some were located in neighbouring trees, but all offered a clear line of sight to the nest. The daily choice of perch appeared to be a response to wind direction and sunlight, especially in the early morning and late afternoon. During the courtship phase the female sometimes joined the male on his perch, occasionally in response to his quiet call. Both adults then perched very close together for 5-35 min, looking around and occasionally touching bills. Copulation was witnessed on 1 and 3 June.

Three courtship (supplementary) food exchanges by the male were confirmed during this phase (= 0.31/h) and several more were reported by the property owners (A. & C. Morgan, pers. comm.). Food exchange usually occurred on the female's favourite perch. The food conveyed to the female was always identified as fish either visually during the exchange or from remains that fell to the ground.

Incubation

On 20 June, a distinct behavioural change was observed in both adults. One adult bird sat low in the nest at all times. Male and female exchanged places twice. From the observation station, the bird incubating was either low in the nest or not visible until the bird changed position. Repositioning was conducted slowly and carefully, usually with the head of the sitting bird out of sight below the nest rim. The bird's body movements suggested attention to an egg. It was assumed, but not confirmed, that an egg had been laid and incubation, or preparation for laying and incubation had commenced.

The behaviour witnessed during the 20 June observation was repeated during subsequent observations until 2 August. The female was responsible for the majority of incubation (79.5% of observation time; male 14.7%; = 32.1 h), with her shifts averaging 115 min (range 37-207 min). The male's shifts averaged 21 min (range 10-77 min) and signs of restlessness were sometimes observed if the female was absent for longer than 30 min. Both were on or near the nest for 88.9% (female) and 31.5% (male) of observation time. There were 17 observed incubation changeovers (= 0.53/h). When approaching and leaving the nest the male usually soared in 4-8 wide circles high above the nest. The female tended to fly directly to and from the nest and was never seen circling more

Table 1. Summary of nest activity over total observation period (31 May to 21 December 2016) expressed as a percentage of total observation time.

COURTSHIP AND NEST PREPARATION TO EGG LAYING (Observation period 31 May - 16 Jun = 17 days)

# Visits	Total Obs Time (min)	Female at nest	Male at nest	M & F both at nest	Female nearby	Male nearby	M & F nearby	Female absent	Male absent	M & F absent, nest unattended	Female feeding juvenile	Juvenile feeding itself	Female eating	Juvenile visible	Juvenile off nest	Food drops	Nest change-overs	Copul-ation
8	575	57.0		2.1	37.0	8.9	3.8		85.2							3		2

INCUBATION TO HATCH (Observation period 17 Jun - 2 Aug = 47 days)

# Visits	Total Obs Time (min)	Female at nest	Male at nest	M & F both at nest	Female nearby	Male nearby	M & F nearby	Female absent	Male absent	M & F absent, nest unattended	Female feeding juvenile	Juvenile feeding itself	Female eating	Juvenile visible	Juvenile off nest	Food drops	Nest change-overs	Copul-ation
14	1926	79.5	14.7	3.5	4.5	11.9	1.4	10.9	68.2	0.3						5	17	1

HATCH TO FIRST SIGHT OF JUVENILE (Observation period 2 Aug - 31 Aug = 30 days)

# Visits	Total Obs Time (min)	Female at nest	Male at nest	M & F both at nest	Female nearby	Male nearby	M & F nearby	Female absent	Male absent	M & F absent, nest unattended	Female feeding juvenile	Juvenile feeding itself	Female eating	Juvenile visible	Juvenile off nest	Food drops	Nest change-overs	Copul-ation
7	950	64.5	0.4	0.8	17.5	4.7	9.9	3.8	80.6	3.5	22.8		0.8			8		

FIRST SIGHT OF JUVENILE TO FLIGHT (Observation period 31 Aug - 21 Sep = 20 days)

# Visits	Total Obs Time (min)	Female at nest	Male at nest	M & F both at nest	Female nearby	Male nearby	M & F nearby	Female absent	Male absent	M & F absent, nest unattended	Female feeding juvenile	Juvenile feeding itself	Female eating	Juvenile visible	Juvenile off nest	Food drops	Nest change-overs	Copul-ation
15	1170	15.2		1.0	40.8	5.1	1.2	3.7	54.5	38.1	14.0	7.3	1.1	43.7	6.6	7		

SECOND NESTING ATTEMPT (Observation period 10 Oct - 21 Dec = 72 days) (Nest abandoned 3 Dec, 52 days after "2nd Sitting" was noticed)

# Visits	Total Obs Time (min)	Female at nest	Male at nest	M & F both at nest	Female nearby	Male nearby	M & F nearby	Female absent	Male absent	M & F absent, nest unattended	Female feeding juvenile	Juvenile feeding itself	Female eating	Juvenile visible	Juvenile off nest	Food drops	Nest change-overs	Copul-ation
18	1468	50.3	15.7	0.4	8.0	5.7	1.2	15.3	52.2	24.7							8	

than 3 times. Copulation occurred again on 12 July. At least four food deliveries by the male occurred (≥ 0.12/h) (**Table 1**).

On 2 August, the female appeared agitated, frequently shifting position and looking down into the nest. Over a period of 2 h 25 min the male was observed flying above the nest tree on four occasions, and perching nearby three times. During the male's presence the female sat very low and still, appearing to ignore him. When the male flew away for the fourth time the female stood up and began to tug at something in the bottom of the nest. She then flew to a nearby branch to defecate, and wipe her bill vigorously on the side of the branch before giving a soft call and returning to the nest. The male immediately flew in and walked around the nest rim, but the female sat low and motionless in the nest until he left.

Again the female flew off the nest. She perched in a nearby tree and was seen to drop something. When the female returned to the nest and settled, a search of the ground revealed half an egg-shell, which was photographed in situ then collected. The eggshell was later identified (from Beruldsen 1980) as being from a Brahminy Kite. It was assumed that a chick had hatched, and two nestlings were confirmed at fledging time (see later). Apparent incubation from 20 June to apparent hatching on or by 2 August gives a maximum incubation period of 43 days, but may be an overestimate as incubation behaviour could have commenced some days before laying (Lutter *et al.* 2006). If the removed eggshell (2 August) was from the second-hatched chick, the first may have hatched a day or two earlier.

Nestling period: first month

For 3 days post-hatch, a severe weather front passed through the area. Daytime high temperatures of 12ºC were recorded at the nest site. High winds buffeted the nest tree, amid falling branches, low light and heavy rain. The nest swayed violently at times, but held fast, and remained sound. The female sat low and tight, and was only seen to leave the nest to defecate then circle overhead 2-3 times before resettling. The male was only seen on three occasions, twice circling overhead and once bringing food.

On 3 August, the first indication that the female might be feeding a chick was noted. Twice, she stood up in the nest for 13-15 minutes with her head out of sight below the nest rim. Her jerky, intermittent body movements suggested she was tearing up food and passing it to a chick. When she lifted her head above the nest rim small morsels of food were seen on her bill. This action was repeated during all subsequent observations, and as the chick grew in size feeding activity was confirmed visually and photographed.

On 10 August, the fish dropped into the nest by the male was instantly seized by the female and taken to a favourite perch. On video, the fish was seen to open and close its mouth and twitch its body. The female held the fish firmly in her talons for several minutes, appearing to squeeze it. She also pecked at its gills. When the fish became still she carried it back to the nest and commenced feeding the chick.

During the chick's first 30 days the female was on or near the nest for 92.7% of observation time (= 15.83 h), at the nest for 64.5% and feeding the chick for 22.8%. The average time spent feeding the chick over the seven observation sessions was 30.4 min, ranging from 6 to 55 min. Initially feeding times were short and frequent, but gradually the time spent feeding increased, as did the breaks between feeds, consistent with the development of the chick, and the amount of food it could consume at each feeding session. The female was seen to consume food herself on only three occasions while in the nest.

During this phase the male brought food to the nest, but did not participate in brooding or feeding the chick. He was on or near the nest for 15.8% of observation time, at the nest 0.4%, and made eight food deliveries (= 0.51/h) (**Table 1**). Both adults were fastidious about cleaning their bills and talons. Much of their off-nest perching time was spent pecking at their feet and vigorously wiping their bills on a branch.

Nestling period: feathering to fledging

During the next phase of the nestling period (~30 days old to fledging), the female was on or near the nest for 58.2% of observation time (= 19.5 h), feeding the nestling for 14%; the nestling fed itself for 7.3%. The male was on or near the nest for 7.3% of time, and made five food drops to the nest (= 0.26/h) (**Table 1**).

From the egg-shell collection date (2 August) the juvenile was about 30 days old when first seen (1 September). Both adults were absent at the time, and the juvenile was photographed looking out over the rim of the nest. The juvenile was half to two-thirds the size of the adults. With the exception of bare areas around the eyes, the head

and body were covered in thick, greyish-white down, with a row of emerging feathers down the back of the neck. Dark pin feathers were visible beneath the wings, and dark feathering covered the back and upper wings (**Figure 2**). The juvenile preened frequently but unsteadily in high winds rocking the nest.

Figure 2. Juvenile 1 (~30 days)

Figure 3. Juvenile 1 (~32 days)

The juvenile developed rapidly. On 4 September (33 days), again while the parents were absent, the juvenile was photographed perching almost on the nest rim (**Figure 3**). This perch appeared precarious, but the juvenile showed no sign of the unsteadiness of 1 September. With most of its body visible the juvenile's size and feather development became more apparent. In three days it had grown larger, the wings seemed fully developed and although patches of down were still visible, feathering was well underway. The juvenile was alert. It watched the movements of people passing below and the flights of other birds in the area. Wing stretching, flapping and jumping were frequently noted. During this observation session the juvenile's activity periods averaged 30 min, after which it appeared to tire. It yawned, its eyelids closed momentarily, then it disappeared below the nest rim, presumably to sleep.

By 10 September (39 days) juvenile plumage was clearly evident (**Figure 4**). Although still accepting food from the female, it fed itself during her absence. By 17 September (46 days) it was frequently off the nest, jumping and flapping to nearby branches of the nest tree ("branching" behaviour) (**Figure 5**). On 21 September (50 days) the juvenile was making short flights around the nest area, and on 22 September (51 days) it was flying with the female, over the Lemon Tree Passage town site. The juvenile's robust appearance suggested it might be female.

Figure 4. Juvenile 1 (~40 days)

Figure 5. Juvenile 1 (~47 days)

Though flying well, the juvenile returned to the nest, to sleep over the next four days. One or both adults (usually the female) were sometimes nearby. On one occasion the perching female was joined briefly by the male, which then flew away. The female then flew to the nest and appeared to nudge the juvenile. The juvenile stood, stretched, yawned, and flew off with the female.

Apparent hatching on or by 2 August to fledging (first true flight from the nest tree) on 21 September gives a nestling period of a least 50 days, or possibly a day or two longer if the chick hatched a day or two before 2 August.

Second juvenile

No evidence of a second juvenile was seen. The following account is a compilation of verbal reports from local sources and raptor-carers.

On 28 September, a work crew began clearing the vacant building lot behind the nest tree. An adult and the juvenile Brahminy Kite, frightened by the commotion, left the nest site and flew towards Tilligerry Creek. Minutes later a second weak juvenile was seen struggling to the nest rim from which it made an unsuccessful attempt at flight (A. & C. Morgan, pers. comm.), i.e. fear-induced premature fledging. The bird fell into the backyard of a nearby house. The homeowner placed it in a large shrub, hoping that the adults would return and collect it. When no adults appeared, the bird was taken indoors overnight. It refused to eat or drink. Catherine Wroe, WINC's raptor-carer, collected the bird on 29 September, and had it examined by a veterinarian. Apart from poor condition (weight 460 g), there was no evidence of physical damage. X-rays detected the presence of developing gonads indicating that the bird was male (C. Wroe pers. comm.) The juvenile's age was difficult to assess, but based on plumage, it was estimated at between 50 and 55 days. The second fledgling's lag in development of about a week was perhaps related to food supply and dominance by the older chick.

The rescued bird thrived, and when visited on 27 October, it flew confidently around a large aviary looking healthy and alert (**Figure 6**). Its estimated age was 62-67 days. The bird was later transferred to the Australian Raptor Care and Conservation Centre Inc., where it responded well to rehabilitation. Plans to equip the bird with a geo-tracker were aborted by lack of funding (P. MacDonald pers. comm.). The bird, estimated at 6-6.5 months old, was released in the Lemon Tree Passage area 6 March 2017. In subsequent days it was observed flying by the author.

Figure 6. Juvenile 2 at WINC care facility (62-76 days)

Second nesting attempt

After the block-clearing incident on 28 September, local residents again reported sighting adult Brahminy Kites in the area (A. & C. Morgan, pers. comm.), but presence on the nest was not noted until 15 October 2016, 3.5 weeks after the first juvenile fledged. Between 15 October and 17 November (33 days) both adults resumed shared incubation duties (female on or near nest 59.9% of observation time, incubating for 50.3%; male on or near nest 22.6%, incubating for 15.7%; = 24.47 h). Again, regular change-overs were witnessed (= 0.33/h), with the female averaging longer shifts than the male. During observations between 17 and 29 November, the male was seen at the nest once. After 18 min he flew away leaving the nest unattended. The female persisted, but her increasing absence from the nest indicated waning interest. She was last seen at the nest 29 November (45 days), but was observed perching nearby until 3 December (49 days). It was assumed that the egg was infertile. The female's incubation time was 29.2% less than that during the first, successful incubation event (50.3%, vs 79.5% during the first event).

Observations continued until 21 December 2016. An adult Brahminy Kite (thought to be female) was seen flying overhead on two occasions, and on 3 December the female flew in and perched on one of her favourite branches. She was joined by the

male which perched close beside her. They sat quietly for 16 min before the male left. The female followed 4-5 min later. No Brahminy Kites were seen at the site after 3 December, until observations ceased on 21 December.

During the second nesting attempt the first juvenile was not seen at the nest site. One unconfirmed report was received of a juvenile and an adult Brahminy Kite seen flying in the vicinity of Bulls Is. (date and observer unknown). Since December a pair of adult Brahminy Kites have been routinely seen flying, perching and hunting, in the vicinity of Lemon Tree Passage and Tilligerry Creek.

Food

Fish, whole (~200 to 250 mm) or in portions (~100 to 150 mm) was the only identifiable food brought to the nest. The male was the main provider, although the female was occasionally seen delivering a fish during the nestling's feathering phase (second month until fledging). Fallen fish remains were either removed by the property owners to prevent the smell attracting vermin, or consumed by one of the three cats that regularly patrolled the area. Food remains found by the author were identified as Bream *Acanthopagrus australis* and Mullet *Liza vaigiensis* (Department of Agriculture & Fisheries).

DISCUSSION AND CONCLUSIONS

This study generally confirms and extends, or complements, previous studies on the breeding cycle of the Brahminy Kite. Breeding behaviour, parental time-budgets and development of the juvenile were similar to, and enlarge upon, previous descriptions, allowing for individual variation and the lack of prior data on the nestling period (cf. Marchant & Higgins 1993; Lutter *et al.* 2006; Indrayanto *et al.* 2011; Rourke & Debus 2016). The parental food delivery rate to nestlings was lower than that recorded by Hollands (2003) in the tropics. This study confirms pre-laying food exchanges, not recorded by some previous accounts (Marchant & Higgins 1993; Indrayanto *et al*. 2011; Rourke & Debus 2016), though observed by Lutter *et al.* (2006). Observed prey delivered to the nest (only or mainly fish) is consistent with some prior observations (Hollands 2003; Rourke & Debus 2016), although others have recorded a more diverse diet (e.g. Marchant & Higgins 1993; Lutter *et al.* 2006; Riddell 2013).

The presumed maximal incubation period of 43 days exceeds the estimated incubation period of about 35 days previously reported (Marchant & Higgins 1993; Rourke & Debus 2016), but may have been several days shorter for reasons given earlier. Lutter *et al.* (2006) observed incubation behaviour several days before laying. Development time from presumed hatching to fledging (50 days) is consistent with the literature (50-56 days: Marchant & Higgins 1993; Rourke & Debus 2016), but could have been a day or two over 50 days if the first chick hatched before 2 August.

The discovery of an active nest at Lemon Tree Passage supports the view that Brahminy Kites are extending their southern breeding range along Australia's eastern coastline. Given the number of sightings of a pair of Brahminy Kites in the vicinity of Lemon Tree Passage over the past 10 years (Stuart 2006-2016), a photographic report of a juvenile in 2012 (P. Eltoft, pers. comm.), comments by local residents (A & C. Morgan, pers. comm.), and the suggestion that some Brahminy Kites are thought to be territorial and site-faithful (Marchant & Higgins 1993; Rourke & Debus 2016), a pair of Brahminy Kites may have nested at the study site for several years.

The quick actions of carers of the rescued juvenile meant that the 2016 nest produced two young, although without human intervention only one might have reached independence. Two young reaching fledging age equates to 1.0 young fledged per attempt in 2016 but only 0.5 young per year over 2015-16, similar to that recorded by Rourke & Debus (2016) and reaffirming the negative impact of human disturbance. Double-clutching within a year in this species has previously been recorded only after failure of the first clutch (Rourke & Debus 2016). The short interval between fledging and the new clutch also suggests that the first juvenile may not have survived the post-fledging dependence period, which lasts at least 6-7 weeks (Rourke & Debus 2016).

Regular site visits will continue until the start of the 2017 breeding season. The nest will be monitored photographically for signs of deterioration and evidence of reoccupation recorded. A request has been submitted to the Port Stephens Council asking that the nest tree be registered in their catalogue of "Significant Trees in the Port Stephens Area" to try to assure its protection in the event of future housing development.

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Observations of Noisy Pitta nestlings through to fledging

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INTRODUCTION

The Noisy Pitta comprises two sub-species, *Pitta versicolor simillima* which occurs in Northern Queensland and *Pitta versicolor versicolor* which is found is southern Queensland and southward to the Hunter River area of NSW and beyond. It is a colourful, ground-dwelling bird that spends its time foraging for food on the forest floor. This very secretive bird is more often heard than seen with its lyrical call known as 'walk-to-work'. It is listed as being of least concern by BirdLife International but may be diminishing in numbers due to habitat loss in the lowland regions of its autumn and winter range (Cooper *et al.* 2014). Most records for the Hunter Region come from higher altitude forested gullies and rainforest areas where there are damp conditions suitable for feeding or from lowland observations during winter months. The Noisy Pitta is regarded as being a partial migrant moving toward the lower coastal regions during the winter months and returning to higher altitude breeding grounds in the summer months (Higgins *et al.* 2001).

Noisy Pittas have been recorded at the location regularly over the past six years. A pair were found to be breeding in December 2012 but the nest was predated and the young taken. In late 2016 a juvenile bird was photographed by a local birdwatcher and posted on Hunterbirding, the birdwatchers' chatroom of the Hunter Bird Observers Club (HBOC). This bird showed immature plumage and a striking orange gape and orange tip to the bill which indicated it was likely to be less than two months old (Higgins *et al.* 2001).

The study area

The area covers a south-facing slope of wet sclerophyll remnant rainforest with a creek running along the valley floor from north to east. This remnant rainforest covers <2 hectares and comprises a mixture of native and planted species. The upper canopy comprises a mix of eucalypt trees, planted pines and other native species including Giant Stinging Tree *Dendrocnide excelsa*, Sydney Blue Gum *Eucalyptus saligna*, Turpentine *Syncarpia glomulifera*, Black Wattle *Callicoma serratifolia*, Bollygum *Neolitsea dealbata* and Rosewood *Dysoxylum fraseranum* with the presence of Strangler Fig *Ficus macrophylla*. The mid and lower canopy includes Privet, Sandpaper Fig *Ficus coronata*, Lilli Pilli *Acmena smithii*, Blueberry Ash *Elaeocarpus reticulates*, Bangalow Palm *Archontophoenix cunninghamiana* and Cabbage Palm *Livistona australis*. Abundant ferns include Gristle Fern *Blechnum cartilagineum*, Rainbow Fern *Culcita dubia* and Giant Maiden Hair *Adiantum formosum*. The forest floor is generally open, rich bare soil with decomposing leaf litter, decomposing plant matter and scattered exposed bedrock.

There is a flying-fox colony close by hosting three species of flying-fox, Grey-headed Flying-fox *Pteropus poliocephalus*, Black Flying-fox *Pteropus alecto* and the Little Red Flying-fox *Pteropus scapulatus*.

The Noisy Pitta nest

Few Noisy Pitta nest sites have been found and documented in detail. A Noisy Pitta nest site is described as being beneath a canopy of rainforest with the nest situated usually on the ground: at the base of a tree, between buttress roots or beside a log, rock or tree-fern (Higgins *et al.* 2001). This description appears to relate to nest sites at a higher altitude and does not fully correspond to the nest that is the subject of this short paper. Though not strictly at ground level this nest was on a flat platform which extended out from ground level. The unique siting of this nest sets it apart from the usual description of a Noisy Pitta nest site.

The nest location was 109 masl and situated in a gully with a small creek running down in a south-easterly direction. There was also significant surface run-off from the bat colony down to the nest site and into the creek below. The effect from this could help disguise the scent from the nest and deter

predators (Higgins *et al.* 2001). The nest itself was built on top of a man-made structure of cemented stone blocks that formed the foundation of a wooden footbridge that had fallen into disrepair and rotted away. The structure was covered in thick Wandering Jew *Tradescantia fluminensis* which had engulfed three sides of the structure. *Tradescantia fluminensis* is a succulent creeping plant native to South America but well established in much of the subtropical and temperate rainforests of east coast Australia. It is treated as a weed in many reserves but in this case afforded some protection to the nest site both in its height and dense coverage. The nest overlooked the creek approximately 4 m below. The exterior of the nest comprised a framework of twigs from 2 mm to 3 mm in diameter, dried grasses, and dead leaves which surrounded the entrance. The nest rim was made of smaller twigs <1 mm and the inner chamber was moulded into a cup shape and lined with fine grasses. There was no sign of a platform outside the nest as described in other articles on this species (Snedic 2002). The nest contained three chicks that appeared no more than 3 days old as they were naked with a deep bluish-slate-grey colour, altricial with an orange gape and orange tip to the bill (Higgins *et al.* 2001). My opinion is that this may have been a second brood. A recently fledged juvenile was also recorded in the vicinity.

Observation position

I found a perfect position for viewing the nest from a bank on the opposite side of the creek. A shaded spot at the base of Privet and Sandpaper Fig provided perfect cover and could be accessed undercover from the opposite direction to that of the nest so avoiding any unnecessary disturbance. The observation point looked down onto the site which was approximately 10 m from and 3 m above the nest itself. The adult birds seemed to show no signs of agitation and visited the nest to feed the young soon after I settled in.

Observation schedule

The nest was studied on eight different occasions over the Christmas period from 11 December to 26 December 2016. The average observation period per visit was 3 h with five visits being early morning and three late afternoon. Total hours spent observing the nest were 24.15 h with the longest period spent at the site being the day the young fledged when I left the site after 7.5 h.

Visits to the nest by the adult birds and all noticeable movements of the young were logged in a notepad. Observations were made with Nikon 8x42 binoculars, Nikon x20 Field Scope and approximately 12 h (over 6GB) of recorded material was made using a Sony HDD HandyCam with x120 digital zoom. This recording includes the young calling from the nest, the adults landing with food away from the nest causing the young to leave the nest to receive the food and two of the young fledging.

Nest monitoring

On the day the nest was found, at 0700 h on 11 December 2016, two photographs were taken of three chicks in the nest cavity. There appeared to be a small size difference between the chicks with the larger chick lying on top of the two smaller chicks (**Figure 1**). I immediately sought to position myself a safe distance from the nest for observation. I waited no more than 15 min before an adult with food landed close to the nest. It cautiously approached the nest, stopped at the entrance and leant forward to feed the young. It then jumped into the nest and remained there. At this time I left the nest site to contact a colleague to report the find. On returning to the same observation point a short time later, an adult bird made several attempts at approaching the nest by landing close by and then flying off. On the next approach the bird landed at the nest site, fed the young and flew off with a faecal sac. A short time later two adult birds flew to perches overlooking the nest. One bird, with food in its bill flew direct to the nest and leant into the nest to feed the young showing a bright red vent which would indicate it as being a male bird. It then moved into the nest cavity and stayed there. At this time another Noisy Pitta was seen hopping around at the base of the column that supported the nest. On closer inspection this bird was seen to be a juvenile (**Figure 2**).

Figure 1. Three Noisy Pitta nestlings, approximately 3 days old.

Figure 2. Juvenile Noisy Pitta seen hopping around the base of the nest

Figure 3. Adult Noisy Pitta at nest

The next day of observation was 14 December, a cool, partly cloudy day. There were 14 visits to the nest by the adults in a 2 h period to feed the young and 1 visit to remove a faecal sac. The most notable observation was made at 0702 h when an adult flew to the nest and climbed inside. It could be seen shuffling around inside the nest before settling down. It stayed in the nest and could be seen tending the young while the second adult made several visits with food. The adult in the nest left at 0727 h.

On the 18 December there were 6 visits to the nest by the adult birds in this afternoon period of observation. A notable event was the appearance of a juvenile bird approximately 3 m behind the nest. Within a minute of this observation an adult to the right made a high-pitched 'kieerr' call before flying across the front of the nest and landing in a favoured perch of Sandpaper Fig which hung above the creek overlooking the nest. The juvenile behind the nest moved off to the left and disappeared into the bush. The adult made a bobbing type movement/motion before turning to face the nest and letting out another 'kieerr' call. It then flew off to the right. On each recorded visit to the nest on these two days by the adults, they approached the nest from a perch to the left, spent between 10 and 20 sec feeding young, before flying off to the right.

On 20 December at 0540 h two 'walk-to-work' calls were heard about 100 m from the nest site. Two much softer calls were heard closer to the nest site 15 min later. The downy young could be seen moving around in the nest and the first recorded visit by an adult on this day was at 0655 h. There were 10 visits with food by the adults in two hours. The young were noted to be more vigorous in their begging by leaning out of the nest and they could be heard begging for the first time. Interestingly, on every visit by the adults they flew direct to the nest from a regular perch (Snedic 2002) to the left and then flew off to the left. This pattern continued until the young fledged. On previous days it was noted the adults always flew off to the right. Average time spent at the nest per visit was between 10 and 20 sec and on the majority of occasions when the adults were at the nest they would look around before commencing feeding and immediately after feeding, before flying off.

Over the next four days, up to Christmas Eve, I visited the nest site three times, once during late afternoon and twice in the early morning. During this time the young had grown significantly with feathers developing. They also became more vocal when the adults arrived at the nest. On one occasion on 21 December a small twig fell from a tree, landed at the nest entrance and two chicks popped their heads out of the nest to beg, cuckoo-clock-like, before realising it was a false alarm and tucking themselves back away into the safety of the nest cavity. Their eyes appeared to be closed at this time. It was two days later, on 23 December that the young were more visible leaning out of the nest to be fed. They showed clear signs of feathering with olive cream chest and a vague, dark shade running down the middle with eyes open and orange tip to bill. The young appeared to be aware that an adult had arrived at the perch opposite the nest though no sound could be heard. They would clamber to the front of the nest in anticipation of the adult landing at the nest edge. On each arrival the adult was cautious, looking around before, during and after feeding the young then flying off to the left of my position (**Figure 3**). There were 13 visits to the nest by the adults in just over two hours. On visiting the nest late afternoon on the 24 December the young were seen to be resting their heads on the edge of the nest. An adult visited with food and removed a faecal sac before two of the three chicks perched

themselves on the edge of the nest with the third chick nestled in behind. The young were much more alert and active, even starting to beg vocally several seconds before the adult arrived at the nest (Taylor *et al.* 1995). At one point the larger of the three chicks clambered over the two other chicks and ventured out of the nest into the *Tradescantia* and then back in again. The chick was well feathered with a bright blue rump, olive-green wings, bright blue bar and evident white wing spots. The adults visited the nest only eight times in a two-hour period removing a large faecal sac on three occasions. This observation period was one of the few times that food could be seen in the adult's bill, a sizeable white grub.

I was back at the nest site early morning on 26 December. The first visit by an adult was within five minutes of my arriving and the young were pushing themselves out of the nest to get their share. The chicks filled the nest cavity and each displayed juvenile-like plumage with a distinctive white collar. Once the adult bird left, the chicks hung out of the nest for a short time before two retreated to the back of the nest. One chick in particular was ever present at the edge as if on sentry duty. At one point this chick clambered out of the nest and crawled amongst the *Tradescantia* for two minutes before making its way back into the nest and perched itself on the edge. A short mournful call from an adult bird could be heard coming from the left of my position when the chick picked its head up, focussed on the call and, suddenly at 0735 h, flew from the edge of the nest off to the left in the direction of the call and in the direction from where the adults had approached the nest for the past few days.

Within the next 20 minutes there were a further two visits to the nest by the adults with food with one faecal sac being taken away. Overall there were nine visits by the adults in the first 60-minute period of observation on this day. From this point on, the short mournful call could be heard intermittently from about 15-20 m away. There was one more visit from an adult with food at 0813 h and the two remaining chicks perched on the edge of the nest calling alternately in a two-tone call similar to the mournful whistle that encouraged the first chick to leave the nest. The two young often picked at insects around the nest while waiting for the adults to arrive and at one point both were out of the nest amongst the *Tradescantia* but soon found comfort back on their perch. At 1001 h two adults flew to perches close to the nest at the same time. One flew in and landed about 0.5 m from the nest causing the young to clamber out to meet the adult with food and the young stayed outside the nest for over a minute before crawling back to the nest. There was another visit to the nest by an adult a short time after and five minutes later another visit where the adult landed in front of the nest causing the young to come out and meet the adult. The adult flew off without seemingly feeding the young. The young again returned to the nest and were very active moving around within the nest chamber and hopping onto the edge of the nest. There continued to be heard a faint melancholy whistle from off to the left and at 1040 h there was the last visit to the nest site by an adult bird when it brought food close to the nest forcing the chicks to come out to meet the adult and feed. Once it had fed the young it took a faecal sac from outside the nest and flew to the left. At 1058 h without notice one of the chicks took off from the *Tradescantia* and flew to the left. An adult bird arrived within a split second but did not stay. For the next two hours the lone chick moved around the nest, sat on the edge, preened and called in response to the adult call. At 1315 h I noticed the calls from the adult seemed to be getting further away and coming from a different direction. At 1315 h they stopped. The chick continued to call and appeared more agitated, hopping in and out of the nest and dropping a faecal sac at the edge of the nest. At 1332 h, it then moved 2 m out of the nest and sat on an exposed ledge calling constantly. The vulnerable chick remained in this position until suddenly it flew from the ledge to the left in the same direction as the other fledglings.

After nearly eight hours at the nest site I had witnessed all three nestlings fledging at 18 days old. The first chick fledged at 0730 h and the last fledged at 1346 h.

The nest site was visited on two separate days after the young had fledged and on both occasions there was no sighting of the birds nor any calls heard.

Food

The general lighting underneath the canopy at the nest was poor for much of the observation period. On only a few occasions could food be seen in the mouths of a visiting adult even though the adults were definitely feeding the young. At the times food was visible there appeared to be worms, grubs and beetles dangling from the bill of the adult.

CONCLUSIONS

Breeding usually occurs between October and December and is widespread throughout much of

the species' range but mainly in Northern New South Wales along Western Slopes and major rivers and tributaries (Woodall 1994). The brood size and nestling period of the subject nest corresponds with existing literature (Higgins *et al.* 2001) though there is scarce material relating to pairs having two broods (Beruldsen 2003), particularly in the same nest. I believe it is possible that two broods were reared from this nest as a fledged juvenile visited the active nest site on two separate occasions. Further study is required to confirm this fact. Records of nesting in an urban environment should be regarded as unusual as there are no other records. The presence of a suitable, tranquil habitat with a ready supply of food in a rainforest environment has played a key role in attracting Noisy Pittas to this region.

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Observations of Little Tern nesting at Winda Woppa, Port Stephens, 2016-2017

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A nesting colony of Little Tern *Sternula albifrons* at Winda Woppa was surveyed regularly from 13 December 2016 to 8 February 2017. Data on the numbers of nest sites, eggs, chicks and fledglings was collected and analysed. Observations of predation, disturbance and Little Tern behaviour were also recorded. As many as 122 Little Tern were present, 49 nest sites with 106 eggs were recorded and 28 fledglings were successfully raised. A minimum of 23 breeding pairs was estimated to have been present. The number of fledglings per nest site was 0.57 which was less than rates recorded from the Manning Estuary, NSW. Birds fledged per egg was 26.4% which indicated breeding success was lower than recorded in the Manning Estuary. Quantitative data showed that egg predation by Australian Raven *Corvus coronoides* and possibly Lace Monitor *Varanus varius* was minimal. Observation of chick predation by Silver Gull *Chroicocephalus novaehollandiae* suggested they were the primary predator. An analysis of the nesting sites indicated there were significant differences in predation and disturbance across the colony but overall the location is considered to be ideally suited for Little Tern nesting. Proactive protection of the site by the local and State Government authorities is required to ensure the success of future nesting events.

INTRODUCTION

A nesting colony of Little Tern *Sternula albifrons* was located at Winda Woppa, Port Stephens (32°40'44"S, 152°08'46"E) in mid-December 2016. Although Little Tern have been previously reported nesting at Winda Woppa (Smith 1990; A. Morris pers. comm.; I. McMaster pers. comm.; C. Patterson pers. comm.), this is the first documented study of a nesting event at this site (see **Figure 1**).

The Little Tern is a migratory species found in small flocks on coastlines worldwide during summer. Three subspecies are recognised. Those found in East Asia and northern and eastern Australia belong to the subspecies *Sternula albifrons sinensis*. Three populations of Little Tern are recognised around the Australian coast; a population that visits Australia in its non-breeding season, a northern Australian population that nests in northern Australia, and a south-eastern Australian population that nests in eastern Australia (Department of the Environment 2017). In NSW, Little Tern are present as a medium-sized, non-breeding population that is relatively stable and a small, threatened breeding population (Chafer & Brandis 1991). Territories may overlap but the two populations are believed to be sexually isolated. The majority of Little Tern present in south-eastern Australia in spring and summer are non-breeding birds from colonies in Japan (Smith 1995; Minton 1996).

The Little Tern that breeds along the NSW coast is listed as a migratory species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In NSW it is listed as an endangered species on Schedule 1, Part 1, of the *Threatened Species Conservation Act 1995* (TSC Act). The species is considered to be an ecological specialist, which has a population and distribution reduced to a critical level, poor recovery potential and severe threatening processes. Garnett (1992, 1993) classified the Australian breeding population of the Little Tern as vulnerable. The breeding population in south-eastern Australia has declined and its beach-nesting sites are particularly prone to human disturbance, predation and natural catastrophes (NSW National Parks and Wildlife Service 2003).

The objective of this study was to document the nesting event, estimate breeding success, identify predators and other threats and assess the suitability of the site.

Figure 1. Location of Little Tern nesting site, Winda Woppa, Port Stephens.

Location and description of the nesting site

The nesting site is located on a sandspit at the western end of Jimmys Beach at Winda Woppa, Port Stephens. The sandspit is part of the estuary of the Myall River where the eastern arm flows into Port Stephens. The site is part of the General Use Zone of the Port Stephens - Great Lakes Marine Park. The Corrie Island Nature Reserve is located approximately 200 m to the west. In 2015, the Mid Coast Council dredged 90,000 cu m of sediment from the river mouth to be used for nourishment of nearby eroded beaches and to improve environmental flows in the lower Myall River. The dredged spoil was pumped onto the sandspit. The dredging also created a small sand cay approximately 250 m southwest of the sandspit. Little Tern were observed nesting on the dredged spoil and on an adjacent area of beach. All council activity on the sandspit was suspended from 1 November to 31 March during the migratory shorebird nesting period.

The spoil pile is elongate in shape, approximately 200 m long, 70-100 m wide and maximum height of 8 m. The outer section of the pile is 3-6 m high and forms a berm 4-10 m wide surrounding an internal depression 1-2 m below the rim of the berm. A conical pile approximately 5 m high is located within the centre of the depression. The dredge spoil is comprised of a mixture of coarse sand, shell grit, broken shell fragments, driftwood, small rocks and other marine debris. It also includes a small section of semi-consolidated muddy sediment. Little Tern were observed nesting in three locations. Area 1 and Area 2 were located on the spoil pile and Area 3 was at the southwest end of the sandspit (see **Figure 2**).

Area 1 is located on a wide section of berm on the north-eastern side of the spoil pile, 4-5 m above the sandspit. Here, nests were clustered around the edge of the pile in an area approximately 80 x 10 m. There is no vegetation on Area 1. In Area 2, nests were present in an area approximately 40 x 20 m covering a narrow section of the berm on the south and east side of the spoil pile and the adjacent internal depression. The berm is 3-4 m above the sandspit while the depression is 1.5-2 m below the berm. Sparse vegetation is present on the southern section of berm.

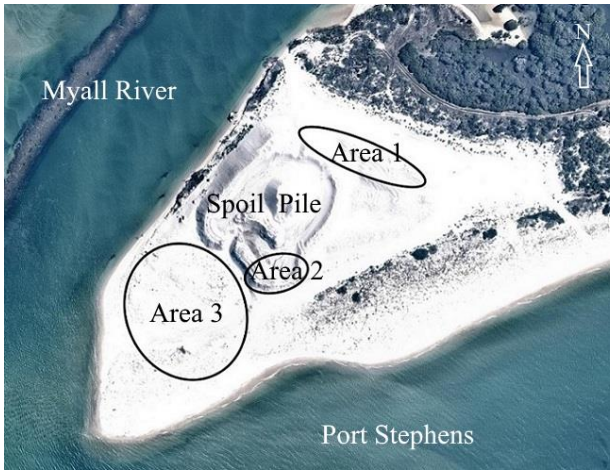

Figure 2. Location of nesting areas on Winda Woppa sandspit.

Area 3 lies at the southwestern end of the sandspit. Little Tern nests were present over most of the area which is roughly circular in shape, approximately 60 m in diameter and has beach on three sides. Most of the area is covered with 0.5-2.5 m of dredge spoil while a narrow section of the original sandy beach is preserved on the southern side. A channel scoured by returning dredge water runs across the southern side of the area, partially separating the area of dumped spoil from the section of sandy beach.

The majority of Area 3 is sparsely vegetated with 3-5% coverage by plants with a low, spreading form. The most common plants are Sea Rocket *Cakile maritima* and Spinifex Grass *Spinifex sericeus.* Other plants present are Coastal Wattle *Acacia longifolia sophorae*, Pigface *Carpobrotus glaucescens* and Pennywort *Hydrocotyle bonariensis*, Beach Daisy *Arctotheca populifolia, Yucca filamentosa* and Sea Holly *Eryngium maritimum*. The section of sandy beach has 15-20% vegetation coverage which is dominated by Sea Rocket with lesser amounts of Spinifex Grass.

The majority of the nest sites were located well above the high-tide mark, on relatively flat ground. The nests were unadorned shallow scrapes in areas of soft, loose sand and shell grit. Other adjacent debris provides camouflage for the mottled eggs.

Egg colour varied through shades of grey, grey-green and olive and mottling varied from dark grey, dark green-grey to black. The maximum depth of water at high tide in adjacent areas of Port Stephens and the Myall River is 2-3 m.

The sandspit at Winda Woppa is Crown Land over which the Mid Coast Council has a lease for the stockpiling of dredge spoil. The land is zoned Environmental in the Local Environmental Plan and has considerable conservation significance. It is located within the Port Stephens - Great Lakes Marine Park and is within 200 m of the Corrie Island Nature Reserve which was added to the Ramsar site covering the Myall Lakes National Park in March 1999. The sandspit lies within the buffer zone of the Ramsar site for which land use should be 'of sustainable use through ecosystem management, consistent with the maintenance of the ecological character of the wetland' (Ramsar Convention Secretariat 2010, p. 30).

METHODOLOGY

On the initial inspection of the site it was recognised that a significant nesting event was underway and it was decided to survey the site methodically on a regular basis. To ensure the surveying was conducted in accordance with appropriate ethical considerations, the "Monitoring Procedure for Threatened Beach-nesting Shorebirds" developed by the NSW Office of Environment and Heritage was adopted (Office of Environment and Heritage, Animal Ethics Committee 2015).

Between 13 December 2016 and 8 February 2017, ten weekly surveys of the site were conducted. The initial survey was the most extensive as nesting areas within the site were identified and surveyed for the first time. Areas with a high incidence of alarm calls from Little Tern flying overhead were surveyed in detail on traverses approximately 5 m apart. All nest sites were photo-graphed and surrounding details recorded. Areas with little or no alarm-call activity were surveyed in less detail to ensure there were no indications of nesting activity. Information recorded for each nest site included the number of eggs, number of chicks, site distinguishing features and evidence of predation. Behaviour of the Little Tern was recorded including observations of agonistic behaviour towards other avian species. Disturbance by recreational beach users was also recorded.

The above process was repeated for each survey. Photographs of nest sites from each survey were compared to identify repeat observation records. Due to the high incidence of large shell fragments and other marine debris, each nest site had unique characteristics that allowed accurate discrimination. Site visits were between two and three hours and were conducted between 7.30 am and 10.30 am. Nest sites were surveyed early in the day when there was minimum disturbance from recreational beach users and temperatures were moderate. Surveys were conducted as quickly as possible to minimise disturbance to chicks and incubating birds. Counts of Little Tern numbers and other observations were made mid-morning when the birds began to form flocks flying over the site or roosting on the adjacent beach. Other observations included numbers of fledglings and non-breeding birds, chick and fledgling feeding behaviour, courtship behaviour, leg bands, other avian species present and behaviour of potential predators.

To evaluate the recorded data, fledglings per nest site, fledglings per breeding pair and fledglings per egg were calculated. The results were compared with Little Tern monitoring data from the Manning Estuary from 1996 to 2012. In order to compare Winda Woppa monitoring data directly with Manning Estuary data, Manning Estuary fledgling ratios were recalculated using records for fledglings counted only.

RESULTS

The survey data from the three nesting areas is presented in **Table 1** and final numbers are summarised in **Table 2**. A total of 49 nests were located which contained 106 eggs, 5 of which involved instances where the clutch increased between surveys. A total of 38 nests were located only once and 11 were recorded on repeat occasions. As the initial survey was conducted several weeks after nesting commenced and the subsequent surveys were conducted at weekly intervals, it was not possible to accurately determine the commencement of individual nesting attempts, hatching success or the full extent of predation. In particular, the records of chicks in **Table 1** is not indicative of breeding success due to the concealment of chicks by parents within 24-48 hours of hatching and the absence of quantitative predation data. Some 'runner' chicks were undoubtedly recorded more than once.

The total number of Little Tern on site increased over the survey period. Initially numbers increased as additional birds in breeding plumage joined the colony and subsequently as fledglings were recruited into the flock. The initial counts included a mixture of birds in breeding plumage and non-breeding birds. The maximum count of non-breeding birds in December was 26 but by the end of the survey period this had increased to 48 as the plumage of fledglings changed to that of non-breeding birds. The maximum number of birds in

Table 1. Summary of nest observations, fledglings and total numbers (adult and fledged) of Little Tern.

Site Surveys		13/12/16	20/12/16	28/12/16	03/01/17	10/01/17	17/01/17	25/02/17	27/02/17	01/02/17	08/02/17
Area 1	**New Nest Sites**	12									
	Eggs	33									
	Repeat Nest Records		1								
	Eggs		2								
	Chicks		3								
Area 2	**New Nest Sites**	2		1	1	1					
	Eggs	4		1	1	2					
	Repeat Nest Records				1	2	3	1	1		
	Eggs				2*	4*	4				
	Chicks		2		2	2	2	2	3	2	
Area 3	**New Nest Sites**	6	7	5	7	4	2	1			
	Eggs	12	15	11	11	6	3	2			
	Repeat Nest Records				1	7	5	4	3		
	Eggs				3	13**	9	1			
	Chicks	4			2	2	1	7	6	3	
Fledglings				5	7	21	15	3	4	4	7
Total Little Tern		-	60	75	-	105	80	67	80	84	122

*Includes one additional new egg ** Includes 3 additional new eggs

breeding plumage is estimated to have been around 65. However, it is noted that all birds in breeding plumage do not necessarily breed, and consequently this number is not an indication of total breeding birds on site. The plumage of fledglings was noted to change rapidly and within three weeks they became indistinguishable from other non-breeding birds. The number of newly fledged birds present at each survey is shown in **Figure 3**. These counts represent birds that had readily identifiable juvenile plumage. However, some birds were undoubtedly counted on more than one occasion. The number of fully-fledged birds at the end of the survey period was considered to be 28 birds. This figure should however be regarded with some caution as some of the earlier fledged birds may have already dispersed.

At the first survey conducted on 13 December, 20 nests were located all of which were considered to be first nesting attempts. This indicated that a minimum of 20 breeding pairs were present on site at that time. This number could be higher as the number of failed nesting attempts prior to this date is unknown. On subsequent surveys, fewer new nests were located (see **Figure 3)**. These additional nests could be the result of first nesting attempts by late arrivals to the colony or re-nesting attempts by birds following earlier failures.

Data from other recent nesting sites in NSW (NSW National Parks and Wildlife Service 2003) records Little Tern re-nesting on average 10-12 days after loss of all eggs or chicks. Little Tern will re-lay up to twice after failure (Higgins & Davies 1996). The average number of eggs per nest over the survey period is shown in **Figure 3**. Most of the initially located nests contained three eggs while nests located subsequently contained one or two eggs. The decline in average number of eggs per nest is shown in **Figure 3**. Three new nests, each with three eggs, were located in surveys in the two weeks following the initial survey and were considered to be first nesting attempts. It was therefore considered that there was a minimum of 23 breeding pairs in the colony.

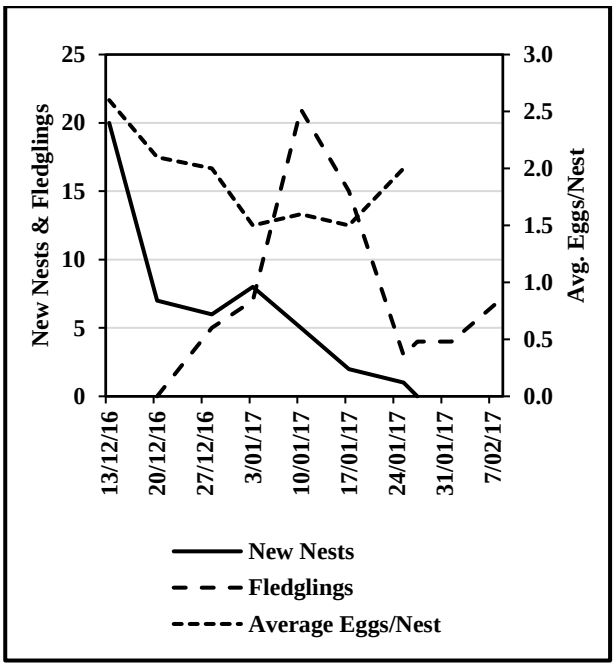

Figure 3. Chart showing number of new nests located, average number of eggs in new nests, and fledglings observed over the survey period.

Table 2. Comparison of nesting data, Winda Woppa 2016-17 and Manning Estuary 1996-2012.

	Winda Woppa 2016-17	Manning Estuary 1996-2012	
		Range	Median
Breeding Pairs	23	84 - 152	120
Nest Sites	49	103 - 219	143
Eggs Found	106	217 - 453	311
Fledglings	28	94 - 251	106
Fledglings/nest site	0.57	0.38 - 1.88	0.77
Productivity Rate (Fledglings/pair)	1.20	0.60 - 1.81	0.93
Breeding Success (Fledglings/egg)	26.4%	18.0 - 79.0%	35.5%

Breeding period

Day-old chicks were located in nests in Area 3 on the first survey of the site on 13 December 2016. Studies by other researchers in NSW have recorded incubation periods of 17-22 days at Forster (Smith 1994) and 20-21 days at Botany Bay (Campion 1963). By assuming an average incubation period of 21 days for Winda Woppa, incubation for these chicks would have commenced around 22 November 2016. Smith (1994) also recorded a fledging period of 17-19 days for Little Tern at Forster. Fledglings were first recorded at Winda Woppa on 28 December 2016. Assuming a fledging period of 18 days and that the birds fledged intermediate between the two survey dates, incubation would have commenced around 43 days previously on 16 November 2016.

These estimates indicate that egg laying and incubation had commenced at the site by mid-November. Mid Coast Council beach nourishment activity with earth-moving equipment was terminated at the site on 31 October. It would be reasonable to assume nesting activity commenced soon after this date.

These estimated dates are in accordance with the findings of Hitchcock (1959) who found breeding typically began in NSW in mid-October to mid-November and continued through into January or February. The timing of breeding of individual colonies varied greatly between years, nevertheless there was a general pattern of breeding beginning in colonies on the North Coast in October or November and colonies on the South Coast in November or December.

During the survey period only one nest was located that was observed through the full laying, incubation and hatching period. Nest 22 in Area 3 was first observed on 3 January 2017 with one egg and again on 10 January with two eggs. Two chicks, each one day old, were observed in the nest on 25 January 2017. These dates indicate an incubation period for this nest of 21 days, assuming the second egg was laid on 4 January. This agrees with other incubation records from NSW (Campion 1963; Smith 1994).

New nest sites with eggs continued to be recorded up until 10 January and all nesting activity had finished by 8 February when no new nests or eggs were located. This indicates nesting activity occurred from early to mid-November to early February, a period of around 13 weeks.

Predation and disturbance

When considering the large numbers of individual nests (49) and eggs (106) located across the site and the number of successfully fledged birds (28), it is apparent that significant natural predation and mortality occurred over the nesting period. Five potential predators, Silver Gull, Australian Raven, Australian Pied Oystercatcher *Haematopus longirostris*, Lace Monitor and Ghost Crab *Ocypode cordimanus* were identified at or near the nesting site. Two of these were confirmed to be active predators at Area 3. A Silver Gull was observed to predate a chick (Shaun McKay pers. comm.) and intervention by the author prevented another from

doing so. An Australian Raven was observed to predate a nest in Area 3, probably taking an egg. Australian Raven were however rarely noted in the vicinity of the site. Australian Pied Oystercatcher were observed being mobbed by Little Tern when they ventured near the nesting sites at Area 3 on two occasions and their tracks were observed across the area on other occasions.

There are a number of potential ground predators in the area. Lace Monitor tracks were observed in Area 3 on two occasions. Their tracks were also observed leading towards the Area 1 nest site and material that may have been coagulated egg contents was noted in two empty nest sites in this area on 20 December. Ghost Crab burrows were common in the south of Area 3 where several nest sites were located. However, no burrows were found within or adjacent to nest sites.

Repeat observations of 11 nests did not reveal any loss of eggs prior to hatching. All of these repeat observations were in Area 2 and Area 3. It is considered that egg predation in these two areas was minimal.

Red Fox *Vulpes vulpes* is the most frequently recorded and most destructive predator of Little Tern colonies in NSW (NSW National Parks and Wildlife Service 2003). A significant part of NPWS funding for Little Tern management is directed towards fox threat abatement and specific plans have been developed to manage this predator (Office of Environment and Heritage 2011). No fox tracks were identified on or around the nesting site. Wild Dogs *Canis lupus* ssp. are also known to be present in the area but no tracks were identified. Control programmes for Wild Dogs and foxes have previously been conducted on Corrie Island and the Winda Woppa peninsula. (Office of Environment and Heritage 2014). The absence of Red Fox and Wild Dogs may be an indication that these management programmes have been successful. Other potential predators are Cats *Felis catus* and Black Rats *Rattus rattus*. No indications of their presence were noted.

While some limited quantitative data was obtained relating to egg predation, no quantitative data was obtained for predation of chicks. It is considered that the main predators of eggs were Australian Raven and possibly Lace Monitor. From limited observations it is considered that the main predator of chicks was Silver Gull and the majority of predation occurred to both newly hatched and 'runner' chicks. The number of Silver Gull recorded on the beach adjacent to Area 3 during surveys varied from 1 to 12. However, 65 Silver Gull were observed roosting within Area 3 on the final survey after nesting had been completed.

Human disturbance was widespread across the site. The Winda Woppa sandspit is a recreational beach area frequented by holiday makers, fishermen and local residents, a number of whom are accompanied by dogs. The spoil pile is popular with visitors for climbing and scenic photography and as a play area for children. The extent of damage to nest sites by people and dogs is unknown, but is considered to be a factor influencing the breeding success of Little Tern at this site. Warning posters were installed by the Mid Coast Council in late December, but had limited impact on visitor behaviour.

Nesting was not impacted by any adverse weather events during the survey period. There were no storm events and the January king tides did not encroach upon the nest sites. The record hot weather of January did not appear to impact nesting and no abandoned eggs were located. Two dead chicks were located during the surveys. A chick less than one week old was found in Area 2 and a near-fledged chick was found in Area 3. Cause of death was not apparent.

Behavioural observations

As breeding activities restricted Little Tern movement to the immediate vicinity of the nesting site it was possible to make extended observations of behaviour. Paton & Rogers (2009) note that several small-sized species of tern are central-place foragers with their foraging locations restricted by the location of their nest site. The birds were observed feeding singly and in flocks in adjacent shallow waters of Port Stephens and the Myall River. Little Tern hover momentarily before diving from a height of 5-10m to take small fish. Abandoned fish found on the site were Whitebait *Hyperlophus vittatus* and Hardyhead *Atherinosoma microstoma*. Little Tern were observed fishing on the Myall River up to 2 km from the nesting site.

Breeding birds were observed presenting fish to potential mates as part of a courtship ritual. This behaviour continued up until early January when the last new nest sites were recorded. Adults were observed feeding developing chicks within the nesting site and newly-fledged birds on the adjacent beach. As the nesting period proceeded and fewer birds were engaged in breeding activities, flocks of Little Tern began to vacate the beach around the sandspit and roost on the nearby sand cay,

particularly at low tide. There was comparatively little difference between the total numbers of birds roosting at high and low tide.

Throughout the nesting period Little Tern continued to make nest scrapes in the sand across the site. This activity was recorded up until early February, three weeks after the last new nest was recorded. The majority of these scrapes were not used.

Incubating Little Tern were observed sitting on nests for relatively short periods only. Disturbance from natural sources and occasionally from humans, appeared near constant. The incubating birds frequently took flight with the adjacent roosting flock whenever they were disturbed. Studies by Weston *et al*. (2012) showed the mean flight initiation distance for Little Tern was 21.5 m with a standard deviation of 7.9 m. Similar flight initiation distances were observed at Winda Woppa.

When eggs hatch, the incubating birds were observed to leave the newly-hatched chicks in the sand scrape for 24 to 48 hours before moving them to the cover of adjacent vegetation, usually Sea Rocket. In areas where there was no vegetation, the developing chicks remained in depressions in the sand or crouched against large items of marine debris for up to a week. Chicks maintained a very cryptic appearance and lay motionless with their heads down. Some newborn chicks were a uniform pale cream while others were light brown with dark streaks on the head and back.

When flying over the site, adult birds were observed to be constantly giving alarm calls. The calls could be heard at a considerable distance from the site, regardless of the presence of obvious intruders. Large numbers of birds in breeding plumage were also observed mobbing potential avian predators.

When nesting activity was completed and chicks fledged, the plumage of some breeding adults changed rapidly. Within one week yellow bills became red-brown and the black cap receded as feathers at the front of the head began to be replaced by white feathers.

A boat survey of shorebirds in the Winda Woppa area on 10 February 2017 recorded 176 Little Tern. The final land-based survey two days previously had recorded 122 birds. This suggests birds from other locations were temporarily joining the colony at Winda Woppa. It also indicates there were likely to be adequate fish resources in the area to support these population numbers.

A number of other avian species were observed roosting on the beach around Area 3 at various times, often in close proximity to the Little Tern. These were Silver Gull, Crested Tern *Thalasseus bergii*, Australian Pied Oystercatcher, Sooty Oystercatcher *Haematopus fuliginosus*, Red-necked Stint *Calidris ruficollis*, Red-capped Plover *Charadrius ruficapillus* and Ruddy Turnstone *Arenaria interpres*. The Red-capped Plover were also observed breeding in Area 3 and successfully raised two chicks. A nest site was located around 5 m from a Little Tern nest. It is possible that Red-capped Plover nest within the Little Tern colony to take advantage of the added protection from predation provided by the Little Tern. Generally, there was no interaction between the different species although Red-capped Plover chased off Little Tern when they ventured to close to their chicks. Agonistic behaviour by Little Tern was observed towards Australian Pied Oystercatcher and Silver Gull.

DISCUSSION

Breeding success

A summary of total breeding pairs, nest sites, eggs and fledgling numbers is presented in **Table 2**. Here, the data is compared with records for Little Tern nesting in the Manning Estuary from 1996-2012 (Fawcett & Thomas 2012). The Manning Estuary is a nominated priority site for Little Tern in NSW with significantly more nesting pairs than Winda Woppa. Nesting activity in the Manning Estuary is systematically monitored and managed (NSW National Parks and Wildlife Service 2003).

The number of Little Tern fledged per nest site was 0.57. This is less than the median value for the Manning Estuary (**Table 2**), although it lies within the overall range (Fawcett & Thomas 2012). This figure should be regarded with some caution due to the difficulty of accurately identifying fledged birds as discussed above. The minimum fledging rate required to maintain a stable population of Little Tern is approximately 0.5 (Hadden & Knight 1983).

The number of fledglings per pair, which is a measure of productivity, was 1.20. This is more than the median value for the Manning Estuary (**Table 2**) and lies around the middle of the overall range (Fawcett & Thomas 2012). This value however, should be treated with some caution. The number of breeding pairs (23) is a minimum estimate due to monitoring commencing several weeks after nesting commenced.

Breeding success for Little Tern in eastern Australia is often low, with overall success of only 6.5-17.9% of birds fledged per egg at some colonies (Higgins & Davies 1996). At Winda Woppa in 2016-17 the success rate was 26.4%. This figure should be regarded with some caution as surveys did not start for several weeks after nesting commenced and predation rates are poorly understood. The success rate is less than the median value for the Manning Estuary (**Table 2**) and lies towards the lower end of the overall range (Fawcett & Thomas 2012).

Overall, breeding success at Winda Woppa was less than that achieved in the Manning Estuary. The higher rates in the Manning Estuary can be attributed to the systematic monitoring and management of that site. Higher predation rates at Winda Woppa may have resulted in fewer fledglings but no quantitative data was obtained to support this conclusion.

Previous records of Little Tern in Port Stephens

The earliest documented records of Little Tern in Port Stephens were probably made by members of the Royal Australian Ornithologists Union (RAOU) in November 1928 and January 1931. Chisholm & Cayley (1928) reported a small flock of Fairy Tern *Sternula nereis* in Port Stephens and Hordern & Hordern (1931) reported the species as being very common. The locations of the observations were not reported. Subsequently, Sharland (1938) concluded that the RAOU observers had most likely misidentified Little Tern *Sternula albifrons*.

Corrie Island was recorded as a nesting site by Hitchcock (1959) and Campion (1963) and approximately ten pairs were reported nesting on a sandspit on the island in 1972-73 (Morris 1979). Several pairs were reported to have nested on the nearby sandspit at Winda Woppa in 1979-80 (Smith 1990). Local Hawks Nest residents report Little Tern have been present on the sandspit in summer for many years (I. McMaster pers. comm.; C. Patterson pers. comm.)

Since 2004, members of Hunter Bird Observers Club, in conjunction with NSW National Parks and Wildlife Service (NPWS), have conducted regular summer surveys of shorebirds in Port Stephens. Surveys were conducted in February, except for 2005 when the survey was conducted in March. Little Tern were recorded in all the surveys except 2005 and 2009. The birds were recorded on a sand-spit on the southern end of Corrie Island (see **Figure 1**), on sand cays along the eastern shore of Corrie Island, and on the sandspit at Winda Woppa. The maximum count was 87 Little Tern in February 2016 (Stuart 2015; Alan Stuart pers. comm.). As these surveys were conducted from a boat it was difficult to confirm that the birds were nesting.

The above reports indicate that Little Tern have bred on various occasions in the Corrie Island/Winda Woppa area since at least 1959 and probably much earlier. It is also evident that they use different sites for nesting within this area from time to time.

Suitability of nesting sites

The Little Tern in NSW is strictly a coastal species, nesting in estuaries or on coastal beaches, and feeding in nearby waters. Most of the nesting sites in NSW are sandspits, sand islands or beaches within or adjacent to the estuaries of rivers, creeks and coastal lakes. Nesting usually occurs at or near the mouth of an estuary (NSW National Parks and Wildlife Service 2003). Little Tern have been observed nesting on newly deposited dredge-spoil from numerous locations in NSW. Such sites may support large and highly successful colonies, as occurred on an artificial sand island at Forster in the 1993-94 season (Smith 1994). The Winda Woppa sandspit meets all the above criteria and appears to be an ideal site for Little Tern nesting. The three nesting areas identified at Winda Woppa (Areas 1, 2 and 3) are shown in **Figure 2**.

Area 1 is an elevated (4-5 m), relatively flat site on the northeast end of the spoil pile. It is comprised of deep soft sand and shell grit and has commanding views of its surrounds. Twelve nests were found clustered around the edge of the spoil pile on the first survey of the site. All sites were within 150 m of the water. Two of these nesting attempts produced chicks. However, there was no repeat nesting in this area. There could be several reasons for this. Area 1 is only 30-50 m distant from the natural bush on the peninsula and would have the highest risk of predation by ground predators such as Lace Monitor, fox and dogs. There is no vegetation on Area 1, and consequently no natural cover for protection of developing chicks. Chicks observed in this area were crouched down in depressions in the sand. Area 1 also lies immediately adjacent to a location where boat-borne visitors access the spoil pile from the Myall River. Overall, Area 1 is considered to be the least suitable of the three areas, with the greatest potential for predation and disturbance.

Area 2 is also elevated (3-4 m) and is in part located on a narrow section of the berm surrounding the

spoil pile on its eastern and southern sides. The eastern section of the berm is comprised of deep soft sand and shell grit and has no vegetation. The southern section of the berm is comprised of compacted muddy sediment and has a sparse covering of Sea Rocket. Two initial nest sites were located here, one on the eastern berm and one on the southern berm. Both sites produced chicks. Subsequent nesting attempts resulted in three further nests in the internal depression, below the berm. This area is comprised of hard-packed sand and shell grit, has no vegetation and has a very limited view of surrounds. All nests in this location produced chicks. All nest sites were within 100 m of the water. No predators or predator tracks were observed in the area, although the remains of one recently deceased chick were found. Newly-hatched chicks in this area were observed crouched down in depressions in the sand or huddled against a large piece of marine debris. One near-fledged chick was observed sheltering in the Sea Rocket. Despite its drawbacks, Area 2 had the highest ratio of observed chicks to known nest sites.

Area 3 is relatively low-lying (0.5-2.5 m) and is surrounded by water on three sides. A thin covering of dredge spoil comprising soft sand and shell grit, shell fragments and other marine debris covers the majority of the site while the southern section is fine beach sand. A channel scoured through the area has exposed a harder substrate. Vegetation in varying amounts is present over all of the site. Little Tern were observed nesting over the entire site at varying times. All nest sites were within 50 m of the water and there was good visibility in all directions. Two thirds of all nests (32) located at Winda Woppa were in Area 3. Initially the majority of the nests were located towards the west of the area but subsequent nesting was dominantly in the south. This change is postulated to be due to the distribution of vegetation. There is very little vegetation that could provide cover for chicks in the western area, compared to the southern area. The site was subject to near constant daily disturbance by visitors, some of whom were accompanied by dogs, but their activities were generally restricted to the beach. Predation by Silver Gull and Australian Raven was confirmed, while there were indications that other predators including Lace Monitor, Australian Pied Oystercatcher and Ghost Crab had been active on site. While Area 3 is the preferred nesting site for most of the Little Tern, it is also subject to the most disturbance and has the highest incidence of observed predation.

The Winda Woppa site covers over 3 ha and most of the area is considered suitable for Little Tern nesting. Nest density was relatively low and the minimum distance between nests was observed to be around 7 m. The lack of agonistic behaviour between nesting Little Tern also indicated there was adequate space between nest sites. The site is considered to be capable of successfully supporting a much larger nesting colony.

Breeding success ratio also provides a measure of the suitability of the site. The number of fledged Little Tern per nest at Winda Woppa lies within the overall range achieved in the Manning Estuary.

The presence of the waters of Port Stephens on the southern side of the nesting location and the Myall River to the north adds to the suitability of the site. When conditions on Port Stephens are choppy, the calmer waters of the Myall River continue to provide a suitable fishing environment for Little Tern. Paton & Rogers (2009) have shown foraging only in the open ocean presents risks for successful breeding of Fairy Tern *Sternula nereis* in the Coorong, SA. They also demonstrated that it is essential to have an adequate resource of a suitable-sized fish for successful breeding. The Winda Woppa area appears to meet this requirement. The authors have also shown that Fairy Tern, which are a similar size to Little Tern, will not forage more than 2 km from the nest site. Similar fishing distance observations were made at Winda Woppa.

During the survey period, the southern end of Corrie Island was also visited to check for the presence of Little Tern. None was located on the two sandspits in this area which are 1.2 km and 2 km southwest of the Winda Woppa site. Little Tern have been previously reported nesting there in 1972-73 (Morris 1979) and have been recorded as present in all but two surveys conducted by the Hunter Bird Observers Club between 2004 and 2016 (Stuart 2015; Alan Stuart pers. comm.). Both sites are now heavily overgrown with Saltwater Couch *Sporobolus virginicus.*

CONCLUSIONS

A small colony of Little Tern nested successfully at Winda Woppa in the summer of 2016-17. However, the lack of quantitative data on egg and chick predation prevented a complete evaluation of nesting success. Future monitoring of nesting should be on a more frequent basis and adopt a more targeted approach to data gathering. The current and historical records indicate that the Winda Woppa site and adjacent Corrie Island have been used by Little Tern since 1959 and possibly much earlier.

The dredge spoil deposited on the sandspit in 2015 appears to have created an ideal habitat and may have stimulated the current nesting activity. It is probable that the site will be used for nesting in future years. However, the continued use of the dredged spoil to re-nourish eroded nearby beaches may eventually result in the loss of the habitat. It remains to be seen if the Little Tern will continue to nest on the sandspit without the spoil pile.

Considerable disturbance of the site by recreational users, particularly over the Christmas/New Year holiday period may also be impacting breeding success, but to an unknown extent. The management of behaviour of this group, many of whom are short-term visitors, will present a significant challenge. Short-term exclusion barriers around nesting areas may be the only effective option.

Although the nesting colony at Winda Woppa is smaller than those in the Manning Estuary it is one of a very few sites with the requisite ecological requirements for successful nesting of Little Tern in the Hunter Region. The disturbance issues identified in this study point to the need for ongoing management and protection to ensure this site is able to continue to make a contribution towards the conservation of this species. Breeding success rates comparable with the Manning Estuary would undoubtedly be achieved by a proactive programme of monitoring and management, including public education and increased protection of the site by local authorities. Additionally, programmes to provide threat abatement from foxes and wild dogs on the Winda Woppa peninsula and Corrie Island should be continued on a regular basis.

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A record (2002-2009) of the birds of the Tank Paddock site within the Green Corridor, Lower Hunter Valley NSW

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The Tank Paddock covers 147 hectares and lies immediately to the north of the village of Minmi. It is a key part of the Green Corridor connecting Stockton Bight and Hexham Swamp to the east, with Lenaghans Swamp to the north, Pambalong Swamp to the west and a forested corridor extending southwest towards Mount Sugarloaf and the Watagans. Although somewhat degraded, the Tank Paddock contains significant habitat, including dry and wet forested areas linked to the surrounding wetlands. Over eight years of surveys a total of 153 species was recorded in the Tank Paddock. Of these, four species were listed as threatened in NSW, five species were rare or uncommon in the Hunter Region and at least eight other species were recorded as breeding. The number and diversity of bird species highlight the importance of the Tank Paddock as a significant avian-rich habitat within the Green Corridor of the Lower Hunter Valley.

INTRODUCTION

In June 2001 Newcastle City Council initiated the "Stockton Bight to the Watagans and Lake Macquarie Conservation Framework" which led to the establishment of a Green Corridor extending from Stockton Bight to the Watagans. A key part of the Green Corridor, the Tank Paddock connects Hexham Swamp to the east, with Lenaghans Swamp to the north, Pambalong Swamp to the west and a forested corridor extending southwest towards Mount Sugarloaf and the Watagans. In 2001 the Tank Paddock was the subject of a proposed housing development.

Due to the potential importance of the Tank Paddock to the proposed Green Corridor, members of Hunter Bird Observers Club were asked to conduct avian surveys of this area by the Coordinator, Green Corridor Coalition in 2002. At the time the land, Lot 1 DP 1007615, was owned by Coal and Allied Industries Limited (Coal and Allied). Some of the property had been degraded by cattle and vehicular tracks made by four-wheel drives, cars and motor bikes. However, the Tank Paddock was shown to contain significant habitat with ecotones between dry and wet forested areas and between the forest and fringing wetlands (Umwelt 2003).

The pertinent characteristics of the site are as follows:

Site Location: The Tank Paddock is roughly rectangular in shape, covers 147 hectares and lies immediately north of the village of Minmi (32°53'0"S 151°43'0"E). Its location is shown in **Figure 1**. It is bounded to the west by the M1 Motorway, Lenaghans Drive to the southwest, the abandoned Richmond Vale Railway line to the southeast and Lenaghans Swamp to the north.

Vegetation communities: The nomenclature and classification of vegetation communities followed that of the Lower Hunter and Central Coast Regional Environmental Management Strategy (House 2003; see **Figure 1**).

The dominant vegetation is Coastal Foothills Spotted Gum - Ironbark Forest (CFSGIF, light blue, **Figure 1**) which covers approximately 65% of the Tank Paddock. It is present along the central north-south ridge and adjacent slopes to the west and east. The dominant forest species are Spotted Gum *Corymbia maculata*, Grey Ironbark *Eucalyptus siderophloia*, Grey Gum *Eucalyptus paniculata* and White Mahogany *Eucalyptus acmenoides*. An understorey of juvenile eucalyptus, melaleuca, leptospermum and wattle is present above a mixture of grasses and herbaceous plants.

Approximately 25% of the Tank Paddock, to the northwest and northeast is Cleared Land (CL) with a mixture of native and introduced grasses and weeds.

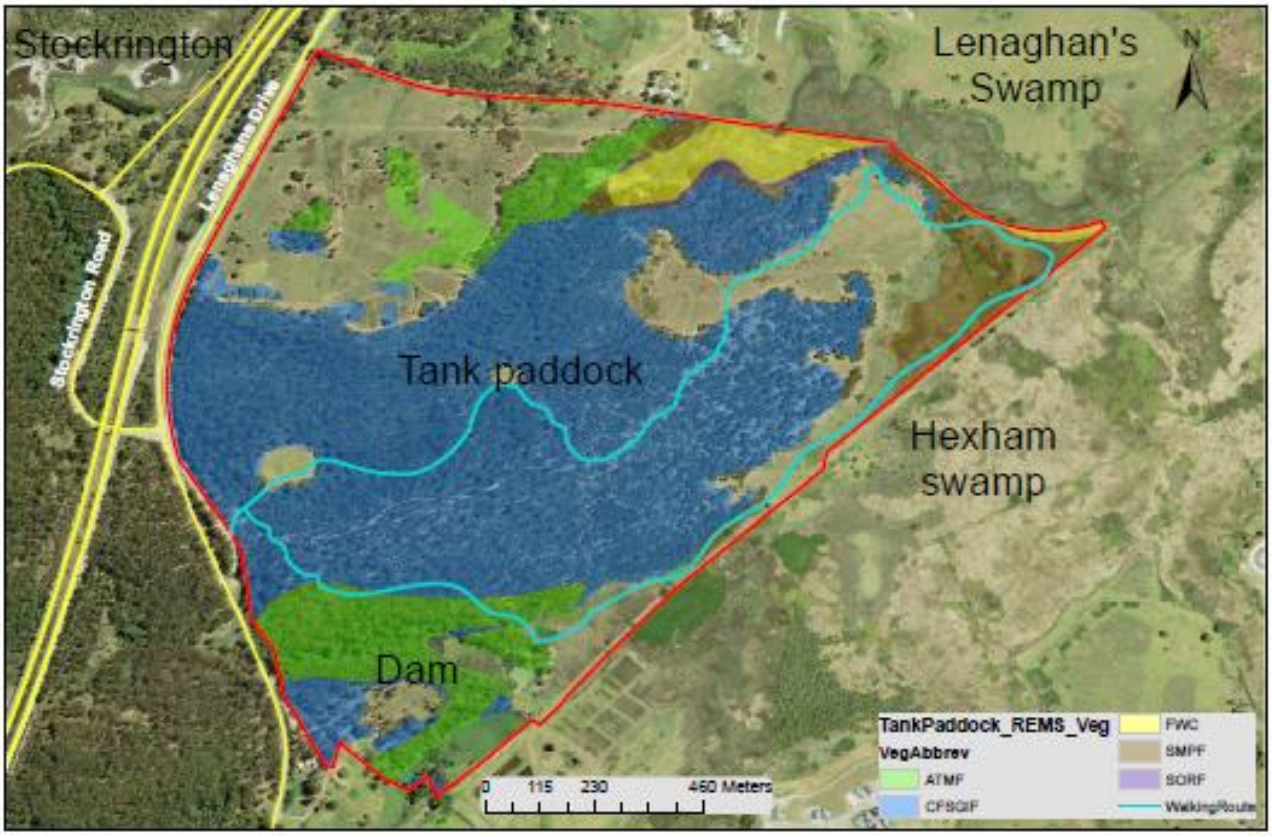

Figure 1. Image of Tank Paddock showing boundary, vegetation communities and adjacent landmarks

Two areas of Alluvial Tall Moist Forest (ATMF, light green, **Figure 1**) comprise approximately 5% of the area. They are located along the lower slopes of the central ridge in the northwest and on the lower slopes of the ridge in the south. The dominant species are Spotted Gum, Sydney Blue Gum *Eucalyptus saligna*, and White Mahogany. The understorey is comprised of she-oak, juvenile eucalyptus, myrtle, rosewood, clerodendrum, turpentine and wattle above a mixture of grasses, sedges, ferns, mat-rush, flax and vines.

In the northeast corner of the Tank Paddock, Swamp Mahogany - Paperbark Forest (SMPF, brown, **Figure 1**) covers approximately 4% of the site. The dominant species are Swamp Mahogany *Eucalyptus robusta*, Broad-leaved Paperbark *Melaleuca quinquenervia*, Flax-leaved Melaleuca *Melaleuca linariifolia*, Prickly-leaved Melaleuca *Melaleuca styphelioides* and Swamp Melaleuca *Melaleuca ericifolia*. The understorey is a mixture of juvenile melaleuca, sedges, ferns, rushes and weeds. Along the northern boundary and surrounding the Tank Paddock in Lenaghans and Hexham Swamps, the vegetation is a Freshwater Wetland Complex (FWC, yellow, **Figure 1**). There is a small area of Swamp Oak Rushland Forest (SORF, purple, **Figure 1**) along the southern edge of the Freshwater Wetland Complex. The dominant vegetation is Swamp Oak *Casuarina glauca* with an understorey of lantana and rushes. There are also some remnant Forest Red Gums *Eucalyptus tereticornis* with weedy understorey, possibly remnant Hunter Lowlands Redgum Forest (HLRF), along the northern boundary of the site.

Site significance: The Tank Paddock is the narrowest part of the 60-kilometre-long Green Corridor connecting Stockton Bight to the Watagans. As well as providing much of the last forested area on the edge of Hexham Swamp, the Tank Paddock has regional value due to its variety of vegetation communities which have been largely lost to urban expansion. The diversity of vegetation communities within the Tank Paddock is a potential driving force for the avian species richness found as a result of these surveys.

This paper aims to describe and record the diversity of avian species using the Tank Paddock, and hence demonstrate the importance of this area to the Green Corridor.

METHODOLOGY

The Tank Paddock was surveyed regularly between 2002 and 2009. Surveys were generally conducted on a

monthly basis between July 2002 and August 2005 with a break until August 2006. From that time, surveys were conducted on a three-monthly basis until June 2009. Between two and eight observers participated in the surveys, however more commonly there were two or three observers. Species were identified and recorded during surveys of the Tank Paddock which were designed to traverse all of the vegetation communities present. Raptors observed soaring over the fringing wetlands in Hexham Swamp were included.

The surveys started from Lenaghans Drive at the most western and highest point in the Tank Paddock, then followed a ridge along the centre of the paddock in a northeast direction through CFSGIF. The ridge overlooks farms behind Lenaghans Swamp to the north and Hexham Swamp to the east. Descending towards the northern boundary of the paddock, observers looked over SORF, HLRF and FWC towards Lenaghans Swamp. The survey route headed east through CL, SMPF and SORF (pale blue, **Figure 1**).

The survey route then turned southwest along the eastern boundary of the Tank Paddock traversing through a mixture of SMPF, CL and FWC until reaching a large dam in the south of the paddock. The route traversed around the dam and then turned southwest through a section of ATMF. It then ascended to the ridge through more CFSGIF to return to the starting point. The surveys started around first morning light, traversed approximately 3.5 km and lasted between three and four hours. Earlier surveys in 2002 were not as extensive, covering less of the ATMF, and less of the eastern end of the Tank Paddock.

Identification of birds was made visually or by call. Evidence of breeding was recorded. Species were classified as either resident in the Hunter Region or migratory (Stuart 2014).

To analyse the results it was decided to address the presence or absence of species on a seasonal basis as it was considered there were insufficient surveys to analyse the records on a monthly basis. In some months there were only two or three surveys conducted (**Table 1**). There was also a concern that the variable monthly survey effort would bias the results. A more uniform survey effort was obtained by accumulating the survey data on a seasonal basis: summer - December to February; autumn - March to May; winter - June to August; spring - September to November.

The overall reporting rate was calculated as the number of surveys during which a species was observed as a percentage of all surveys and is shown in **Appendix 1.** Species reporting rates were calculated in a similar manner for each of the four seasons and seasonal reporting rates should be considered in the context of the number of surveys conducted in each season.

Table 1. Monthly surveys conducted at the Tank Paddock between July 2002 and June 2009.

Month	2002	2003	2004	2005	2006	2007	2008	2009	Monthly Totals
January		1	1	1					3
February		1	1	1		1	1	1	6
March		1		1					2
April		1	1	1					3
May		1	1	1		1	1		5
June		1	1	1				1	4
July	1	1	1	1					4
August	1	2	1	1	1	1			7
September	1	1	1				1		4
October	1		1						2
November	1	2	2		1	1	1		8
December	1	1							2
Total	**6**	**13**	**11**	**8**	**2**	**4**	**4**	**2**	**50**

RESULTS

Over the eight years of the survey period a total of 153 species was recorded in the Tank Paddock (see **Appendix 1** for details). The majority of these species are generally common throughout the Hunter Region and are resident throughout the year. The classification used here for resident and migratory species is adopted from Stuart (2014). The classification resident includes birds classified by Stuart as birds of passage (Straw-necked Ibis *Threskiornis spinicollis*, Yellow-billed Spoonbill *Platalea flavipes* and Musk Lorikeet *Glossopsitta concinna*).

The reporting rate data highlights a significant number of migratory species that use the Tank Paddock at various times of the year. The survey records also document the presence of four threatened species using the Tank Paddock, five species that are rare or uncommon in the Hunter Region and at least eight other species that have bred there (**Table 2**).

Table 2. Number of seasonal surveys and number of species recorded in the Tank Paddock.

	All Years	Summer	Autumn	Winter	Spring
Number of surveys	50	12	10	14	14
Total species recorded	153	121	124	100	134
Resident species	130	104	111	96	113
Migratory species	23	17	13	4	21
Threatened species	4	3	2	2	3
Breeding records	8	6	0	0	2

Migratory species

A total of 23 of the species recorded in the Tank Paddock are migratory or partially migratory, either within Australia or to overseas destinations.

The most common summer migrants were Sacred Kingfisher *Todiramphus sanctus*, Dollarbird *Eurystomus orientalis*, Rufous Whistler *Pachycephala rufiventris* and Australian Reed-Warbler *Acrocephalus australis*. Sacred Kingfisher was present throughout the Tank Paddock in summer (83%) and spring (79%), occasionally in autumn (10%) and not in winter. Dollarbird was recorded in summer (75%) and spring (64%). Rufous Whistler was in forested areas of the Tank Paddock during spring (93%), summer (92%) and autumn (50%). Australian Reed-Warbler was seen in and near FWC in spring (86%), summer (67%) and autumn (40%).

Six species of migratory cuckoos have been recorded throughout the Tank Paddock; Eastern Koel *Eudynamys orientalis*, Channel-billed Cuckoo *Scythrops novaehollandiae*, Horsfield's Bronze-Cuckoo *Chalcites basalis*, Shining Bronze-Cuckoo *Chalcites lucidus*, Pallid Cuckoo *Heteroscenes pallidus* and Brush Cuckoo *Cacomantis variolosus*. Eastern Koel, Channel-billed Cuckoo and Brush Cuckoo were recorded in spring and summer while Horsfield's Bronze-Cuckoo and Pallid Cuckoo were reported in spring only. Eastern Koel and Channel-billed Cuckoo were reported most frequently in spring (64%). The Pallid Cuckoo was only reported once, in spring. The Shining Bronze-Cuckoo was reported in spring (50%), autumn (20%) and winter (7%).

Spangled Drongo *Dicrurus bracteatus* is a winter migrant and was recorded in or near ATMF in autumn (40%) and in winter (14%).

Both Fairy Martin *Petrochelidon ariel* and Tree Martin *Petrochelidon nigricans* were recorded with overall reporting rates of 30% and 40% respectively. The Fairy Martin was reported most frequently in summer and spring with rates of 42% and 43% respectively, and then declined in autumn to 10%. Reporting rate in winter was 21%. The Tree Martin had reporting rates of 50% in summer, 60% in autumn, declining to 36% in winter and 29% in spring.

Other migrant species were White-throated Needletail *Hirundapus caudacutus*, White-throated Gerygone *Gerygone olivacea*, Cicadabird *Edolisoma tenuirostris*, Rufous Fantail *Rhipidura rufifrons*, Leaden Flycatcher *Myiagra rubecula* and Black-faced Monarch *Monarcha melanopsis*. Overall reporting rates ranged from 14% to 30%, with highest reporting rates occurring in spring (29% to 64%), lower rates in summer (17% to 42%) and no reports of White-throated Needletail or Cicadabird in autumn. White-throated Gerygone had an overall reporting rate of 30% and was present in spring (64%), summer (42%) and autumn (20%). Rufous Fantail was present in or near ATMF in spring (43%), summer (33%) and autumn (20%). Leaden Flycatcher was recorded in CFSGIF in spring (29%), summer (17%) and autumn (10%). Black-faced Monarch was present in ATMF in spring (50%), summer (42%) and autumn (10%).

The migrants with lowest overall reporting rates (2%-4%) were Latham's Snipe *Gallinago hardwickii* reported in FWC in summer (17%), Rainbow Bee-eater *Merops ornatus* reported during one survey in spring (7%), White-winged Triller *Lalage tricolor* recorded in spring (7%) and autumn (10%) and Satin Flycatcher *Myiagra cyanoleuca* (4%) recorded in CFSGIF in spring 2003 (7%) and summer 2004 (8%).

Threatened species

Four species listed as threatened under the NSW *Threatened Species Conservation Act 1995* were recorded in the Tank Paddock. Australasian Bittern *Botaurus poiciloptilus* listed as Endangered, was seen in FWC to the south of the Tank Paddock in September 2003. Little Eagle *Hieraaetus morphnoides* listed as Vulnerable, was recorded in February 2003 and January 2004. Little Lorikeet *Glossopsitta pusilla* listed as Vulnerable, was

regularly recorded in CFSGIF in nine of the twelve months, but was not recorded in the summer. More than 50 individuals were recorded in April 2005. Varied Sittella *Daphoenositta chrysoptera* listed as Vulnerable, had an overall reporting rate of 30% and was regularly seen in CFSGIF close to the ridge. The species was recorded in small flocks in seven months of the year, most frequently in April, May and June. Numbers of individuals ranged from one in June 2003, to more than 20 birds, seen in May 2005.

Breeding records

Observations of probable breeding within the Tank Paddock were recorded for eight species. Adult Purple Swamphen *Porphyrio porphyrio*, Lewin's Honeyeater *Meliphaga lewinii*, Cicadabird and White-breasted Woodswallow *Artamus leucorynchus*, Leaden Flycatcher, Little Grassbird *Poodytes gramineus* and Mistletoebird *Dicaeum hirundinaceum* were all observed with dependent young. A Shining Bronze-Cuckoo was begging for food and being fed by a White-browed Scrubwren *Sericornis frontalis* on the ground in the ATMF in September 2003. Two other species, for which adults were observed to be accompanied by immature or juvenile birds, may also have bred within the Tank Paddock. These were Black Swan *Cygnus atratus* and Chestnut-breasted Mannikin *Lonchura castaneothorax*.

Rare and uncommon species in the Hunter

Five species listed as rare or uncommon residents in the 2013 Hunter Region Annual Bird Report (Stuart 2014) were Australasian Bittern, Satin Flycatcher, Pacific Baza *Aviceda subcristata*, Painted Button-Quail *Turnix varius* and Chestnut-breasted Mannikin. The overall reporting rate for the first four species was low with single birds sighted in summer or spring: Australasian Bittern in September 2003, Satin Flycatcher in November 2003 and February 2004, Pacific Baza in February and September 2003, and in September 2004, and Painted Button-Quail in February 2007. Both Satin Flycatcher and Pacific Baza were in CFSGIF. A single Satin Flycatcher was present in November 2003 (7%) and February 2004 (8%). The species is rarely recorded in the Lower Hunter region (Stuart 2005). The Painted Button-Quail was foraging along the ridge in an open section of CFSGIF bordering the large cleared area to the north-east of the Tank Paddock. Chestnut-breasted Mannikin had an overall reporting rate of 26%, and were most commonly reported in autumn (50%), winter (29%) and summer (25%) and less often in spring (7%). Chestnut-breasted Mannikin were feeding in flocks of between 3 and 20 birds at the margins of FWC and SMPF near the eastern end of the Tank Paddock.

Eagles, hawks and falcons

Of the 21 species of terrestrial birds of prey that are known to be present in the Hunter Region, 13 have been recorded in the Tank Paddock. These were Black-shouldered Kite *Elanus axillaris*, Pacific Baza, White-bellied Sea-Eagle *Haliaeetus leucogaster*, Whistling Kite *Haliastur sphenurus*, Brown Goshawk *Accipiter fasciatus*, Grey Goshawk *Accipiter novaehollandiae*, Swamp Harrier *Circus approximans*, Wedge-tailed Eagle *Aquila audax*, Little Eagle, Nankeen Kestrel *Falco cenchroides*, Brown Falcon *Falco berigora*, Australian Hobby *Falco longipennis*, Peregrine Falcon *Falco peregrinus*. Most of these species were seen foraging over CL in the north and east of the Tank Paddock and over Hexham Swamp adjoining the Tank Paddock. In contrast Pacific Baza and Brown Goshawk were observed in CFSGIF, and Grey Goshawk was seen in SMPF. The most frequently reported species over all the surveys was the Whistling Kite (76%) followed by Swamp Harrier (48%) and White-bellied Sea-Eagle (36%). Both White-bellied Sea-Eagle and Whistling Kite were seen roosting and possibly nesting in taller trees in CFSGIF in the Tank Paddock. Seasonal reporting rates varied greatly without any definite trends. The Little Eagle, listed as Vulnerable under the NSW *Threatened Species Conservation Act 1995*, was reported on two occasions.

Owls

The only owl species recorded during the surveys was the Southern Boobook *Ninox boobook* which was observed early in the day in April 2004 at the edge of dense understorey in CFSGIF.

Passeriformes

Including migratory, threatened, rare and uncommon species, 70 passeriformes were identified in the Tank Paddock (see **Appendix 1** for more details). Many resident species were commonly observed in CFSGIF: White-throated Treecreeper *Cormobates leucophaea*, Superb Fairy-wren *Malurus cyaneus*, Variegated Fairy-wren *Malurus lamberti*, White-browed Scrubwren, White-throated Gerygone, thornbills, pardalotes, honeyeaters, Eastern Whipbird *Psophodes*

olivaceus, Black-faced Cuckoo-shrike *Coracina novaehollandiae*, Golden Whistler *Pachycephala pectoralis*, Rufous Whistler, Grey Shrike-thrush *Colluricincla harmonica*, Australasian Figbird *Sphecotheres vieilloti*, Olive-backed Oriole *Oriolus sagittatus*, Grey Fantail *Rhipidura fuliginosa*, robins and Mistletoebird. Butcherbirds, Australian Magpie *Gymnorhina tibicen*, Pied Currawong *Strepera graculina*, Australian Raven *Corvus coronoides*, Torresian Crow *Corvus orru*, Magpie-lark *Grallina cyanoleuca* and White-winged Chough *Corcorax melanorhamphos* were often seen in more open areas of CFSGIF. Fairy-wrens, White-breasted Woodswallow, Willie Wagtail *Rhipidura leucophrys*, Silvereyes, finches and Australasian Pipit *Anthus novaeseelandiae* were found around the edges of SMPF and FWC. The presence of 1-5 Double-barred Finch *Taeniopygia bichenovii* (4%) in spring 2004 (7%) and summer 2005 (8%) is a notable record for this species which is rare in near-coastal habitat in the Hunter Region (BirdLife Australia Birdata records accessed 2016). Golden-headed Cisticola *Cisticola exilis*, Tawny Grassbird *Cincloramphus timoriensis* and Little Grassbird *Poodytes gramineus* were commonly seen and heard in or near FWC. Black-faced Monarch, Satin Bowerbird *Ptilonorhynchus violaceus*, Brown Gerygone *Gerygone mouki*, Crested Shrike-tit *Falcunculus frontatus* were found in or near ATMF. Welcome Swallow *Hirundo neoxena*, Tree and Fairy Martins were commonly seen hawking over CL and FWC.

DISCUSSION

The number and diversity of bird species identified during eight years of surveys of the Tank Paddock highlight the importance of conserving this area as part of the Green Corridor. Despite degradation of parts of the Tank Paddock at the time of the surveys, the existing vegetation supported 153 different species, including four species listed as threatened in NSW, and another four species listed as rare or uncommon in the Hunter Region (Stuart 2014). The range of habitats within and adjoining the Tank Paddock is essential for the protection of these eight bird species. The high species richness (153 species) and regular occurrence of a majority of these species documented for a relatively small area of land (147 ha) at the interface of forest, woodland and wetland habitats indicates that Tank Paddock is an important location for avian diversity.

The Tank Paddock appears to provide an important link between vegetation communities along the Green Corridor, allowing different species to move from wetlands to the mountains and vice versa. For example, some of the raptors have been observed foraging in Hexham Swamp and using tall trees in the Tank Paddock as roosting and nesting sites. It is believed that other species such as the Sacred Kingfisher, Scarlet Honeyeater, Black-faced Monarch, Leaden Flycatcher, Rose Robin, Rufous Fantail and Rufous Whistler make use of the Tank Paddock during seasonal and altitudinal migrations. Further research should aim to discover how indicator species, such as rare, threatened and keystone species such as predators, use the Tank Paddock and the Green Corridor as habitat.

Although these surveys provide a comprehensive inventory of the birds of the Tank Paddock both overall and seasonally, changes over time could not be investigated as survey effort and reporting differed for earlier and later surveys. During the first few years, surveys were conducted on a monthly basis, whereas from 2006 surveys were conducted quarterly. Early surveys were not as extensive as later surveys, potentially resulting in an under-survey of some of CL, SMPF and ATMF. In addition, estimates of numbers of birds were not recorded during the early surveys. These factors mean that trends in abundance of birds could not be determined. Other factors were likely to affect the species seen. For several months in 2005, the large cleared area to the northeast was turned into a motorbike track, which was used recreationally on weekends, then access to the Tank Paddock by the Hunter Bird Observers Club was withdrawn for part of 2005 and 2006.

Despite these caveats, the results provide a significant historical record of species resident in the Tank Paddock or using it seasonally. It is recommended that future monitoring of avian diversity in the Green Corridor should be carefully designed to facilitate interpretation of results. As urban development of the region continues, information obtained about use of the Green Corridor will be essential to understanding the needs for habitat connectivity of many of the species reported in this study.

CONCLUSION

The eight years of surveying in the Tank Paddock have highlighted the importance of this area to the conservation of the region's avian populations. The six vegetation communities present provide a wide range of habitats that have been demonstrated to support 153 different resident and migratory species. At least eight of these species have been

recorded breeding in the Tank Paddock. It has also been shown to provide suitable habitat for four species listed as threatened in NSW, and an additional five species that are listed as rare or uncommon in the Hunter Region (Stuart 2014). The results of this long-term study support the view that the Tank Paddock provides a significant avian-rich habitat within the Green Corridor of the Lower Hunter Valley.

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APPENDIX 1 - List of species recorded in Tank Paddock together with overall reporting rate and seasonal reporting rates

Common Name	**Scientific Name**	**RR all surveys (%)**	**RR Summer (%)**	**RR Autumn (%)**	**RR Winter (%)**	**RR Spring (%)**
Wandering Whistling-Duck	*Dendrocygna arcuata*	2	0	0	0	7
Black Swan	*Cygnus atratus*	70	50	70	86	71
Hardhead	*Aythya australis*	12	0	10	29	7
Australasian Shoveler	*Spatula rhynchotis*	4	8	0	0	7
Pacific Black Duck	*Anas superciliosa*	96	92	100	100	93
Northern Mallard	*Anas platyrhynchos*	2	0	0	0	7
Grey Teal	*Anas gracilis*	24	0	30	43	21
Chestnut Teal	*Anas castanea*	72	58	60	79	79
Australian Wood Duck	*Chenonetta jubata*	36	33	30	57	29
Brown Quail	*Synoicus ypsilophora*	10	8	10	0	21
Australasian Grebe	*Tachybaptus novaehollandiae*	12	0	10	7	29
Rock Dove	*Columba livia*	2	0	10	0	0
Spotted Dove	*Streptopelia chinensis*	12	25	10	0	21
Brown Cuckoo-Dove	*Macropygia phasianella*	6	0	0	0	21
Wonga Pigeon	*Leucosarcia melanoleuca*	4	0	10	0	7
Crested Pigeon	*Ocyphaps lophotes*	44	92	40	36	21
Bar-shouldered Dove	*Geopelia humeralis*	12	8	10	14	14
Pheasant Coucal	*Centropus phasianinus*	26	50	10	7	43
Eastern Koel	*Eudynamys orientalis*	26	42	0	0	64
Channel-billed Cuckoo	*Scythrops novaehollandiae*	26	42	0	0	64
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	4	0	0	0	14
Shining Bronze-Cuckoo	*Chalcites lucidus*	20	0	20	7	50
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	54	25	60	50	79
Brush Cuckoo	*Cacomantis variolosus*	10	8	0	0	36
Pallid Cuckoo	*Heteroscenes pallidus*	2	0	0	0	7
Tawny Frogmouth	*Podargus strigoides*	2	0	10	0	0
Australian Owlet-nightjar	*Aegotheles cristatus*	2	0	10	0	0
White-throated Needletail	*Hirundapus caudacutus*	14	25	0	0	36
Buff-banded Rail	*Hypotaenidia philippensis*	6	8	10	0	14
Purple Swamphen	*Porphyrio porphyrio*	88	100	80	71	100
Dusky Moorhen	*Gallinula tenebrosa*	12	33	10	7	0
Eurasian Coot	*Fulica atra*	2	0	0	0	7
Black-winged Stilt	*Himantopus leucocephalus*	6	0	0	0	21
Masked Lapwing	*Vanellus miles*	82	67	70	100	86
Latham's Snipe	*Gallinago hardwickii*	4	17	0	0	0
Painted Button-Quail	*Turnix varius*	2	8	0	0	0
Silver Gull	*Chroicocephalus novaehollandiae*	2	0	10	0	0
Australian Pelican	*Pelecanus conspicillatus*	52	33	60	64	50
Australasian Bittern	*Botaurus poiciloptilus*	2	0	0	0	7
Nankeen Night-Heron	*Nycticorax caledonicus*	2	8	0	0	0
Cattle Egret	*Bubulcus ibis*	66	100	40	50	71
White-necked Heron	*Ardea pacifica*	50	25	50	43	79
Eastern Great Egret	*Ardea alba modesta*	36	17	40	43	43
Intermediate Egret	*Ardea intermedia*	12	25	0	7	14
White-faced Heron	*Egretta novaehollandiae*	88	83	100	93	79
Australian White Ibis	*Threskiornis moluccus*	94	83	100	93	100
Straw-necked Ibis	*Threskiornis spinicollis*	78	67	90	86	71
Yellow-billed Spoonbill	*Platalea flavipes*	4	8	0	7	7
Royal Spoonbill	*Platalea regia*	18	25	10	14	21
Little Pied Cormorant	*Microcarbo melanoleucos*	20	25	10	14	29
Great Cormorant	*Phalacrocorax carbo*	12	17	10	0	21
Little Black Cormorant	*Phalacrocorax sulcirostris*	14	25	10	0	21

Appendix 1 - List of species recorded in Tank Paddock together with overall reporting rate and seasonal reporting rates (continued)

Common Name	Scientific Name	RR all surveys (%)	RR Summer (%)	RR Autumn (%)	RR Winter (%)	RR Spring (%)
Pied Cormorant	*Phalacrocorax varius*	2	0	0	0	7
Black-shouldered Kite	*Elanus axillaris*	10	0	10	14	14
Pacific Baza	*Aviceda subcristata*	6	8	0	0	14
Wedge-tailed Eagle	*Aquila audax*	10	8	10	21	0
Little Eagle	*Hieraaetus morphnoides*	4	17	0	0	0
Swamp Harrier	*Circus approximans*	48	42	40	57	50
Grey Goshawk	*Accipiter novaehollandiae*	14	25	20	7	7
Brown Goshawk	*Accipiter fasciatus*	10	8	20	0	14
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	36	25	60	36	36
Whistling Kite	*Haliastur sphenurus*	76	75	90	64	71
Southern Boobook	*Ninox boobook*	2	0	10	0	0
Rainbow Bee-eater	*Merops ornatus*	2	0	0	0	7
Dollarbird	*Eurystomus orientalis*	34	75	0	0	64
Sacred Kingfisher	*Todiramphus sanctus*	42	83	10	0	79
Laughing Kookaburra	*Dacelo novaeguineae*	90	100	80	86	93
Nankeen Kestrel	*Falco cenchroides*	24	8	40	36	14
Australian Hobby	*Falco longipennis*	22	42	30	7	14
Brown Falcon	*Falco berigora*	20	17	10	43	7
Peregrine Falcon	*Falco peregrinus*	6	0	20	7	0
Yellow-tailed Black-Cockatoo	*Zanda funereus*	14	8	20	14	14
Galah	*Eolophus roseicapilla*	74	92	80	64	64
Long-billed Corella	*Cacatua tenuirostris*	14	25	10	14	7
Little Corella	*Cacatua sanguinea*	34	42	40	36	29
Sulphur-crested Cockatoo	*Cacatua galerita*	94	100	90	100	86
Australian King-Parrot	*Alisterus scapularis*	8	8	10	0	14
Red-rumped Parrot	*Psephotus haematonotus*	14	0	10	14	29
Eastern Rosella	*Platycercus eximius*	100	100	100	100	100
Musk Lorikeet	*Glossopsitta concinna*	2	0	0	0	7
Little Lorikeet	*Glossopsitta pusilla*	38	25	70	29	43
Rainbow Lorikeet	*Trichoglossus moluccanus*	70	42	70	93	71
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	6	8	10	0	7
Satin Bowerbird	*Ptilonorhynchus violaceus*	10	17	20	0	7
White-throated Treecreeper	*Cormobates leucophaea*	94	100	100	100	79
Variegated Fairy-wren	*Malurus lamberti*	88	83	80	93	93
Superb Fairy-wren	*Malurus cyaneus*	82	75	90	86	79
Southern Emu-wren	*Stipiturus malachurus*	20	25	10	21	21
Scarlet Honeyeater	*Myzomela sanguinolenta*	62	67	60	36	86
Striped Honeyeater	*Plectorhyncha lanceolata*	10	0	10	29	0
Noisy Friarbird	*Philemon corniculatus*	58	25	80	64	57
Brown Honeyeater	*Lichmera indistincta*	2	0	10	0	0
White-naped Honeyeater	*Melithreptus lunatus*	72	42	90	79	79
Eastern Spinebill	*Acanthorhynchus tenuirostris*	80	58	100	79	86
Lewin's Honeyeater	*Meliphaga lewinii*	96	100	100	86	100
Red Wattlebird	*Anthochaera carunculata*	18	0	50	21	7
Fuscous Honeyeater	*Ptilotula fusca*	14	0	20	36	0
Yellow-faced Honeyeater	*Caligavis chrysops*	96	83	100	100	100
Bell Miner	*Manorina melanophrys*	100	100	100	100	100
Noisy Miner	*Manorina melanocephala*	100	100	100	100	100
Spotted Pardalote	*Pardalotus punctatus*	88	67	100	100	86
Striated Pardalote	*Pardalotus striatus*	20	8	10	29	29
Brown Gerygone	*Gerygone mouki*	76	58	90	86	71

Appendix 1 - List of species recorded in Tank Paddock together with overall reporting rate and seasonal reporting rates (continued)

Common Name	**Scientific Name**	**RR all surveys (%)**	**RR Summer (%)**	**RR Autumn (%)**	**RR Winter (%)**	**RR Spring (%)**
White-throated Gerygone	*Gerygone olivacea*	30	42	20	0	64
White-browed Scrubwren	*Sericornis frontalis*	94	92	90	100	93
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	22	17	40	21	14
Yellow Thornbill	*Acanthiza nana*	90	92	90	93	86
Striated Thornbill	*Acanthiza lineata*	68	50	80	79	64
Brown Thornbill	*Acanthiza pusilla*	94	83	100	100	93
Varied Sittella	*Daphoenositta chrysoptera*	30	17	70	29	14
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	94	92	100	93	93
Cicadabird	*Edolisoma tenuirostris*	20	33	0	0	50
White-winged Triller	*Lalage tricolor*	4	0	10	0	7
Rufous Whistler	*Pachycephala rufiventris*	58	92	50	0	93
Golden Whistler	*Pachycephala pectoralis*	92	83	100	100	86
Grey Shrike-thrush	*Colluricincla harmonica*	90	83	90	93	93
Crested Shrike-tit	*Falcunculus frontatus*	24	17	30	21	29
Eastern Whipbird	*Psophodes olivaceus*	100	100	100	100	100
Australasian Figbird	*Sphecotheres vieilloti*	6	8	0	14	0
Olive-backed Oriole	*Oriolus sagittatus*	40	58	40	0	71
Pied Currawong	*Strepera graculina*	52	25	50	64	57
Australian Magpie	*Gymnorhina tibicen*	98	100	100	93	100
Pied Butcherbird	*Cracticus nigrogularis*	94	100	100	93	86
Grey Butcherbird	*Cracticus torquatus*	92	92	90	93	93
White-breasted Woodswallow	*Artamus leucorynchus*	42	75	40	0	64
Spangled Drongo	*Dicrurus bracteatus*	12	0	40	14	0
Willie Wagtail	*Rhipidura leucophrys*	94	100	100	79	100
Rufous Fantail	*Rhipidura rufifrons*	24	33	20	0	43
Grey Fantail	*Rhipidura fuliginosa*	100	100	100	100	100
Torresian Crow	*Corvus orru*	2	0	10	0	0
Australian Raven	*Corvus coronoides*	100	100	100	100	100
Leaden Flycatcher	*Myiagra rubecula*	14	17	10	0	29
Satin Flycatcher	*Myiagra cyanoleuca*	4	8	0	0	7
Magpie-lark	*Grallina cyanoleuca*	100	100	100	100	100
Black-faced Monarch	*Monarcha melanopsis*	26	42	10	0	50
White-winged Chough	*Corcorax melanorhamphos*	34	17	60	36	29
Rose Robin	*Petroica rosea*	34	0	50	79	0
Eastern Yellow Robin	*Eopsaltria australis*	86	92	80	93	79
Mistletoebird	*Dicaeum hirundinaceum*	84	100	90	71	79
Chestnut-breasted Mannikin	*Lonchura castaneothorax*	26	25	50	29	7
Red-browed Finch	*Neochmia temporalis*	98	100	100	93	100
Double-barred Finch	*Taeniopygia bichenovii*	4	8	0	0	7
Australasian Pipit	*Anthus novaeseelandiae*	4	8	0	0	7
Golden-headed Cisticola	*Cisticola exilis*	66	75	70	64	64
Tawny Grassbird	*Cinclorhamphus timoriensis*	38	58	30	7	57
Little Grassbird	*Poodytes gramineus*	60	58	50	43	86
Australian Reed-Warbler	*Acrocephalus australis*	48	67	40	0	86
Fairy Martin	*Petrochelidon ariel*	30	42	10	21	43
Tree Martin	*Petrochelidon nigricans*	40	50	60	36	29
Welcome Swallow	*Hirundo neoxena*	82	75	90	86	79
Silvereye	*Zosterops lateralis*	98	100	100	100	93
Common Starling	*Sturnus vulgaris*	28	33	10	29	43
Common Myna	*Acridotheres tristis*	30	42	40	14	36

Birds of Forest Road, Duns Creek 2008-2014

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Bird surveys were carried out along a road through a rural sub-division involving acreage blocks near Paterson, New South Wales between 2008 and 2014. A total of 113 bird species was recorded, reflecting the diversity of habitat available adjacent to the road. A number of dams, mostly small, provided habitat for waterbirds, including species seeking drought refuge and normally associated with larger bodies of water. A few shorebirds utilised muddy margins, when these were exposed.

The park-like environment provided by partially cleared acreage blocks was suitable habitat for Grey-crowned Babbler *Pomatostomus temporalis*. Three clans of this species, which is listed as vulnerable under the *Threatened Species Conservation Act 1995* (NSW), were resident, coexisting with aggressive colonies of Noisy Miners *Manorina melanocephala*. The occasional occurrence of species present in surrounding areas of remnant woodland suggested that in conjunction with roadside vegetation the acreage developments provided connectivity between surrounding woodland remnants. Ongoing habitat modification may eventually compromise the important role that areas like Forest Road play in sustaining the avian diversity of the Paterson area.

INTRODUCTION

Roadside vegetation is an important asset for both birds and birdwatchers. For birds it provides habitat and for birdwatchers it provides easily accessible places to watch birds. Previously, I have documented the results of periodic visits to Black Rock Road, Martins Creek (Newman 2014). The success of that study inspired a similar project at Forest Road, Duns Creek; a quiet road in a semi-rural setting near my home, where I could generate a bird list while enjoying an early morning walk.

METHODS AND ANALYSIS

Surveys, 103 in total, were conducted in the morning between July 2011 and February 2014, typically starting about one hour after sunrise. All birds seen and heard were recorded while walking the return trip along Forest Road, Duns Creek near Paterson NSW (32º37'44"S 151º38'44"E). The time taken was variable depending on the amount of bird activity, but typically about 1.5 hours. All birds seen and heard were submitted to BirdLife Australia's (BLA) Birdata archive as 500m area surveys (Birdata site ID 433364).

For analysis the results were broken down into four periods involving between 19 and 31 surveys (**Table 1**). The initial period 2008–2011 involved occasional visits at irregular intervals. Based on the experience gained during this period the frequency of surveys was progressively increased with two or three surveys conducted in most months. These results have been evaluated for the final three fiscal years (July to June) commencing 2011/12. This avoids splitting the breeding season for summer migrants as occurs when results are presented for calendar years. The last survey was in February 2014 and the results for 2013/14 only cover the first 8 months of the 2013/2014 fiscal year.

Table 1. Survey Statistics

	All surv-eys	2008–2011	2011 /12	2012 /13	2013 /14
Number of surveys	103	22	19	31	31
Number of species	113	94	78	92	95
Species per survey	36.5	31.1	34.0	38.2	40.1
Species (RR>80%)	12	7	13	16	20
Species (RR>40%)	40	32	41	42	46

Reporting Rates (RRs) were used to compare the differences in the occurrence of species. The RR, expressed as a percent value, is the number of surveys in which a species was recorded divided by the number of surveys conducted.

RESULTS

A total of 113 species was recorded between August 2008 and February 2014 with typically around 90 to 95 species seen in a single fiscal year. Overall the average number of species seen per survey was 36.5, but this metric progressively increased during the study from 31.1 in 2008–2011 to 40.1 in 2013/14 (**Table 1**).

Twelve species had RRs >80% and an additional 28 species had RRs >40%. These metrics were lower during the initial surveys in 2008–2011 (**Table 1**).

The thirteen most commonly recorded species with RR>80% are shown in **Table 2** ranked in order of frequency of presence (RR). The White-throated Gerygone *Gerygone olivacea*, a summer visitor, has been added to this list based on an RR>40% for the period of approximately 6 months when it was present.

Commonly recorded birds with RRs in the range 40 to 79% are listed in **Table 3**, which contains four summer visitors, based on an RR>20% for the period of approximately six months when they were present.

Table 2. Very commonly recorded species (RR>80%)

Common Name	Scientific Name	All surveys RR (%)	2008–2011 RR (%)	2011/12 RR (%)	2012/13 RR (%)	2013/14 RR (%)
Australian Magpie	*Gymnorhina tibicen*	99.0	100.0	94.7	100.0	100.0
Eastern Rosella	*Platycercus eximius*	97.1	95.5	100.0	93.5	100.0
Magpie-lark	*Grallina cyanoleuca*	94.2	100.0	89.5	90.3	96.7
Willie Wagtail	*Rhipidura leucophrys*	93.2	72.7	100.0	100.0	96.7
Noisy Miner	*Manorina melanocephala*	92.2	77.3	89.5	100.0	96.7
Laughing Kookaburra	*Dacelo novaeguineae*	91.3	86.4	89.5	87.1	100.0
Superb Fairy-wren	*Malurus cyaneus*	91.2	72.7	100.0	93.5	96.7
Pacific Black Duck	*Anas superciliosa*	90.3	90.9	84.2	90.3	93.5
Australian Wood Duck	*Chenonetta jubata*	88.3	81.8	78.9	93.5	93.5
Masked Lapwing	*Vanellus miles*	87.4	72.7	89.5	93.5	90.4
Bar-shouldered Dove	*Geopelia humeralis*	84.5	68.2	89.5	93.5	83.9
Yellow-faced Honeyeater	*Caligavis chrysops*	80.6	59.1	94.7	87.1	80.6
White-throated Gerygone*	*Gerygone olivacea*	43.7	22.7	52.6	29.0	67.7

*Summer Visitor

Table 3. Commonly recorded species (RR in range 40 to 80%)

Common Name	Scientific Name	All surveys RR (%)	2008–2011 RR (%)	2011/12 RR (%)	2012/13 RR (%)	2013/14 RR (%)
Grey Fantail	*Rhipidura fuliginosa*	78.6	63.6	94.7	74.2	83.9
Welcome Swallow	*Hirundo neoxena*	78.6	63.6	94.7	74.2	83.9
Grey-crowned Babbler	*Pomatostomus temporalis*	76.7	59.1	63.2	93.5	80.6
Grey Butcherbird	*Cracticus torquatus*	75.7	72.7	78.9	64.5	87.1
Crested Pigeon	*Ocyphaps lophotes*	72.8	68.2	63.2	80.6	74.2
Pied Butcherbird	*Cracticus nigrogularis*	70.9	77.3	63.2	71.0	71.0
Jacky Winter	*Microeca fascinans*	69.9	63.6	68.4	83.9	61.3
Australian Raven	*Corvus coronoides*	68.9	86.4	68.4	77.4	48.4
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	65.1	63.6	68.4	51.6	77.5
Galah	*Eolophus roseicapilla*	65.0	59.1	73.7	35.5	93.5
Australasian Grebe	*Tachybaptus novaehollandiae*	64.1	22.7	68.4	71.0	83.9

Table 3. Commonly recorded species (RR in range 40 to 80%) cont.

Common Name	Scientific Name	All surveys RR (%)	2008–2011 RR (%)	2011/12 RR (%)	2012/13 RR (%)	2013/14 RR (%)
Cattle Egret	*Bubulcus ibis*	63.1	63.6	68.4	71.0	51.6
Wonga Pigeon	*Leucosarcia melanoleuca*	61.2	72.7	52.6	48.4	71.0
Eastern Whipbird	*Psophodes olivaceus*	60.2	54.5	47.4	64.5	67.7
Red Wattlebird	*Anthochaera carunculata*	60.2	40.9	94.7	61.3	51.6
Grey Teal	*Anas gracilis*	55.4	36.4	52.6	48.4	77.5
White-winged Chough	*Corcorax melanorhamphos*	52.4	54.5	42.1	61.3	48.4
Hardhead	*Aythya australis*	52.4	4.5	68.4	67.7	61.3
Spotted Pardalote	*Pardalotus punctatus*	50.5	36.4	63.2	67.7	35.5
Lewin's Honeyeater	*Meliphaga lewinii*	49.5	36.4	57.9	61.3	41.9
Straw-necked Ibis	*Threskiornis spinicollis*	48.6	36.4	26.3	71.0	48.4
Striated Pardalote	*Pardalotus striatus*	48.5	40.9	63.2	71.0	22.5
White-faced Heron	*Egretta novaehollandiae*	45.6	45.5	42.1	51.6	41.9
Striated Thornbill	*Acanthiza lineata*	44.6	22.7	42.1	51.6	54.8
Rainbow Lorikeet	*Trichoglossus moluccanus*	43.7	50.0	42.1	41.9	41.9
Australian King-Parrot	*Alisterus scapularis*	43.7	27.3	31.6	74.2	32.3
Pied Currawong	*Strepera graculina*	42.7	59.1	31.6	48.4	32.3
Rufous Whistler*	*Pachycephala rufiventris*	36.9	31.8	36.8	29.0	48.4
Sacred Kingfisher*	*Todiramphus sanctus*	34.0	27.3	21.1	22.6	58.1
Eastern Koel*	*Eudynamys orientalis*	26.2	13.6	10.5	19.4	51.6
Dollarbird*	*Eurystomus orientalis*	27.2	22.7	21.1	19.4	41.9

* Summer visitor

Moderately commonly recorded species with RRs in the range 20 to 39% are shown in **Table 4**, which includes three summer migrants, based on an RR of >20% for the period of approximately 6 months during which they were present.

Table 4. Moderately commonly recorded species (RR 20 to 39%)

Common Name	Scientific Name	All Surveys RR (%)	2008–2011 RR (%)	2011/12 RR (%)	2012/13 RR (%)	2013/14 RR (%)
Satin Bowerbird	*Ptilonorhynchus violaceus*	37.9	18.2	21.1	45.2	54.8
Olive-backed Oriole	*Oriolus sagittatus*	37.8	18.2	52.6	25.8	54.8
Noisy Friarbird	*Philemon corniculatus*	36.9	22.7	42.1	51.6	29.0
Brown Thornbill	*Acanthiza pusilla*	35.9	31.8	15.8	54.8	32.3
Eurasian Coot	*Fulica atra*	35.9	0.0	0.0	25.8	93.5
Dusky Moorhen	*Gallinula tenebrosa*	32.1	0.0	0.0	19.4	87.1
Eastern Yellow Robin	*Eopsaltria australis*	29.1	36.4	15.8	16.1	45.2
White-browed Scrubwren	*Sericornis frontalis*	27.2	36.4	26.3	29.0	19.4
Common Myna	*Acridotheres tristis*	27.2	22.7	21.1	32.3	29.0
Golden Whistler	*Pachycephala pectoralis*	26.2	36.4	31.6	12.9	29.0
Chestnut Teal	*Anas castanea*	25.3	9.1	31.6	51.6	6.5
Eastern Spinebill	*Acanthorhynchus tenuirostris*	24.3	27.3	21.1	25.8	22.5
Grey Shrike-thrush	*Colluricincla harmonica*	21.4	27.3	42.1	19.4	6.5

Table 4. Moderately commonly recorded species (RR 20 to 39%) cont.

Common Name	Scientific Name	All Surveys RR (%)	2008–2011 RR (%)	2011/12 RR (%)	2012/13 RR (%)	2013/14 RR (%)
Red-browed Finch	*Neochmia temporalis*	21.4	9.1	0.0	25.8	38.7
Channel-billed Cuckoo*	*Scythrops novaehollandiae*	19.4	18.2	10.5	9.7	35.5
Leaden Flycatcher*	*Myiagra rubecula*	16.5	0.0	0.0	22.6	32.3
Latham's Snipe*	*Gallinago hardwickii*	12.6	4.5	0.0	16.1	22.5

*Summer migrant

Species which were infrequently recorded with RRs <20% are shown in **Table 5**. An additional species, Pacific Baza *Aviceda subcristata*, was recorded during an informal visit.

Table 5. Infrequently recorded species (RR <20%).

Common Name	Scientific Name	All Surveys RR (%)	2008–2011 RR (%)	2011/12 RR (%)	2012/13 RR (%)	2013/14 RR (%)
Purple Swamphen	*Porphyrio porphyrio*	19.4	4.5	15.8	25.8	25.8
Scarlet Honeyeater	*Myzomela sanguinolenta*	18.5	18.2	42.1	3.2	19.4
Yellow Thornbill	*Acanthiza nana*	18.4	13.6	10.5	22.6	22.5
White-necked Heron	*Ardea pacifica*	18.4	4.5	10.5	9.7	41.9
Black Swan	*Cygnus atratus*	17.4	22.7	36.8	16.1	3.2
Black-fronted Dotterel	*Elseyornis melanops*	16.5	4.5	0.0	19.4	32.3
Mistletoebird	*Dicaeum hirundinaceum*	16.3	44.5	0.0	6.5	16.1
Variegated Fairy-wren	*Malurus lamberti*	13.6	18.2	0.0	12.9	19.4
Blue-faced Honeyeater	*Entomyzon cyanotis*	11.7	18.2	0.0	12.9	12.9
Little Black Cormorant	*Phalacrocorax sulcirostris*	11.7	9.1	10.5	6.5	19.4
Sulphur-crested Cockatoo	*Cacatua galerita*	10.7	18.2	5.3	12.9	6.5
Little Pied Cormorant	*Microcarbo melanoleucos*	8.8	0.0	15.8	12.9	6.5
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	7.8	9.1	5.3	12.9	3.2
Royal Spoonbill	*Platalea regia*	7.8	9.1	10.5	9.7	3.2
Silvereye	*Zosterops lateralis*	6.8	4.5	0.0	9.7	9.6
Rose Robin	*Petroica rosea*	5.8	4.5	10.5	6.5	3.2
Great Egret	*Ardea modesta*	4.9	18.2	5.3	0.0	0.0
Long-billed Corella	*Cacatua tenuirostris*	4.9	4.5	5.3	9.7	0.0
Yellow-tailed Black-Cockatoo	*Zanda funereus*	3.9	9.1	5.3	3.2	0.0
Little Lorikeet	*Glossopsitta pusilla*	3.9	4.5	5.3	6.5	0.0
White-naped Honeyeater	*Melithreptus lunatus*	3.9	4.5	5.3	3.2	3.2
Black-faced Monarch	*Monarcha melanopsis*	3.9	0.0	5.3	6.5	3.2
Musk Lorikeet	*Glossopsitta concinna*	2.9	13.6	0.0	0.0	0.0
Australasian Shoveler	*Anas rhynchotis*	2.9	4.5	0.0	0.0	6.5
Pallid Cuckoo	*Heteroscenes pallidus*	2.9	4.5	0.0	0.0	6.5
Little Corella	*Cacatua sanguinea*	2.9	0.0	5.3	0.0	6.5
Spangled Drongo	*Dicrurus bracteatus*	2.9	0.0	0.0	0.0	9.6
Great Cormorant	*Phalacrocorax carbo*	2.0	0.0	0.0	0.0	6.5
Brush Cuckoo	*Cacomantis variolosus*	1.9	4.5	0.0	0.0	3.2
Cicadabird	*Edolisoma tenuirostris*	1.9	4.5	0.0	3.2	0.0
Crimson Rosella	*Platycercus elegans*	1.9	4.5	0.0	3.2	0.0

Table 5. Infrequently recorded species (RR <20%) cont.

Common Name	Scientific Name	All Surveys RR (%)	2008–2011 RR (%)	2011/12 RR (%)	2012/13 RR (%)	2013/14 RR (%)
Tree Martin	*Petrochelidon nigricans*	1.9	4.5	0.0	0.0	3.2
Wedge-tailed Eagle	*Aquila audax*	1.9	4.5	0.0	0.0	3.2
Hoary-headed Grebe	*Poliocephalus poliocephalus*	1.9	0.0	0.0	3.2	3.2
Pheasant Coucal	*Centropus phasianinus*	1.9	0.0	0.0	3.2	3.2
Whistling Kite	*Haliastur sphenurus*	1.9	0.0	0.0	3.2	3.2
White-bellied Cuckoo-shrike	*Coracina papuensis*	1.9	0.0	0.0	3.2	3.2
Australasian Figbird	*Sphecotheres vieilloti*	1.0	4.5	0.0	0.0	0.0
Double-barred Finch	*Taeniopygia bichenovii*	1.0	4.5	0.0	0.0	0.0
Regent Bowerbird	*Sericulus chrysocephalus*	1.0	4.5	0.0	0.0	0.0
Swift Parrot	*Lathamus discolor*	1.0	4.5	0.0	0.0	0.0
Torresian Crow	*Corvus orru*	1.0	4.5	0.0	0.0	0.0
Brown Goshawk	*Accipiter fasciatus*	1.0	0.0	5.3	0.0	0.0
Brown-headed Honeyeater	*Melithreptus brevirostris*	1.0	0.0	0.0	0.0	3.2
Collared Sparrowhawk	*Accipiter cirrocephalus*	1.0	0.0	0.0	0.0	3.2
Common Starling	*Sturnus vulgaris*	1.0	0.0	5.3	0.0	0.0
Crested Shrike-tit	*Falcunculus frontatus*	1.0	0.0	5.3	0.0	0.0
Little Egret	*Egretta garzetta*	1.0	0.0	0.0	3.2	0.0
Shining Bronze-Cuckoo	*Chalcites lucidus*	1.0	0.0	0.0	0.0	3.2
Spotted Dove	*Streptopelia chinensis*	1.0	0.0	0.0	3.2	0.0
Topknot Pigeon	*Lopholaimus antarcticus*	1.0	0.0	5.3	0.0	0.0
White-headed Pigeon	*Columba leucomela*	1.0	0.0	0.0	3.2	0.0

Habitat description

Starting from the junction with Duns Creek Road (**Figure 1**) there are paddocks on both sides of the road which is fringed by rows of trees with a limited shrub layer. There is a large dam on the left side of the road which is used for irrigation purposes, on which cattle were intermittently present. Water levels often fell in summer providing muddy margins. A smaller dam, on the opposite side of the road, became progressively choked with water hyacinths during the study, but was cleared after the surveys ceased. There was only one dwelling in this area, a house on the right-hand side near the road junction.

Approximately 500 m from the junction the land was subdivided into large acreage properties. In most instances the dwellings were set well back from the road. The extent to which the land had been cleared was variable. Two creeks crossed the road at extremities of this zone and both were fringed by dense understorey vegetation, including Lantana. Beyond the second of these creeks the area opened up with more paddocks and a dam set back from the road on the left side of the road. Horses grazed this area, their sheds providing roosts and nest sites for some species. Food provided for egg-laying hens attracted some bird species and towards the end of the study a new resident to the area started feeding birds, attracting a number of species including cockatoos and pigeons.

Figure 1. Surveys involved walking Forest Road from the junction with Duns Creek Road to an area beyond the second dam on the northern side of road as shown above.

Beyond the paddocks on the left-hand (northern) side of the road (**Figure 1**) the terrain was highly wooded and rose steeply to an extensive area of undeveloped land, which was mainly regrowth forest. On the other side there were patches of lowland woodland in a network of large acreage properties and small farms extending to the Butterwick flood plain, adjacent to the Paterson River located beyond the property Yaraandoo.

DISCUSSION

Typically around 90 species were recorded each year, involving between 19 and 31 surveys (**Table 1**). The number of species/survey increased during the study from 31.1 in 2008-2011 to 40.1 in 2013/14, the final year of the study. This increase probably reflects the gradual transition of data collection from occasional casual surveys (2008–2011) to a more rigorous project style. In addition, as familiarity with the area and survey frequency increased the niches of elusive species were known, and their presence was targeted, resulting in more efficient detection of some species. This is apparent from the increases in the average number of species observed per survey and the increased number of commonly observed species with RRs greater than 80% and 40% (**Table 1**). In 2013/14, all the surveys were conducted in the first 8 months of the year when summer migrants were present and breeding birds were vocal, providing a bias to increased species lists.

In the similar study involving an almost identical number of surveys (104) conducted at Black Rock, located approximately 7 km to the north, 124 species were recorded with an average of 49.3 species/survey; 23 and 52 species having RRs > than 80 and 40% respectively (Newman 2014). These metrics are all higher than at Forest Road, which partly reflects the longer duration and increased size of the area surveyed at Black Rock.

Very common species (RR>80%)

Most of the 13 species in **Table 2** also had RRs >80% in the surveys at Black Rock (Newman 2014) and are species well adapted to a highly modified and fragmented rural landscape. Indeed, species like the Noisy Miner *Manorina melanocephala* and Eastern Rosella *Platycercus eximius* thrive in the park-like conditions created by the clearing of vegetation for small scale and hobby farming (Newman 2010). The Pacific Black Duck *Anas superciliosa* was the only species in **Table 2** which was appreciably more frequently recorded in this study, reflecting the increased availability of waterbird habitat at Forest Road compared with the Black Rock study area.

Commonly recorded species (RR in range 40 to 79%)

A total of 31 species fall into this category when the four summer migrants are included (**Table 3**).

The Grey-crowned Babbler *Pomatostomus temporalis* (RR 76.7%) was particularly well represented, which is discussed further in the threatened species section. White-winged Choughs *Corcorax melanorhamphos* (RR 52.4%), like the babblers, are a ground-foraging species suited to lightly-timbered areas with limited understorey. This species bred regularly at one location. Both are communal breeding species and the choughs form larger aggregations in winter which forage over an extended area.

Jacky Winter *Microeca fascinans*, another woodland species, found the combination of light timber at the interface with open paddocks ideal, where fence lines provided perches when foraging. In winter, like the choughs, this species formed flocks in paddocks on adjacent properties (Newman 2012) like Yaraandoo (**Figure 1**).

The larger of the two dams frequently supported waterbirds including Australasian Grebe *Tachybaptus novaehollandiae* (RR 64.1%), Grey Teal *Anas gracilis* (RR 55.4%) and Hardhead *Aythya australis* (RR 52.4%). The period 2012–2014 when these two duck species were regularly present appears to have corresponded to an influx of these species into the Hunter Region (Birdata statistics; portal accessed December 2016). Hardhead, which are usually associated with larger water bodies (Stuart 2016), were also occasionally present on two much smaller dams on Forest Road.

Moderately commonly recorded species (RR 20 to 39%)

The 17 species in this category include three summer migrants (**Table 4**). Most of these species fall into two categories: woodland birds which were mainly restricted to a small belt of relatively unmodified woodland with creek-side understorey vegetation, located near the middle of the area surveyed; and waterbirds found on the dams. Species in this category include the Eastern Yellow Robin *Eopsaltria australis* (RR 29.1%), Golden Whistler *Pachycephala pectoralis* (RR 26.2%) and Grey Shrike-thrush *Colluricincla harmonica* (RR

21.4%), all of which were probably resident in the riparian creek-side vegetation, but infrequently detected because of limited suitable habitat immediately adjacent to the road. The Olive-backed Oriole *Oriolus sagittatus* (RR 39.2%) was more broadly distributed across the study area, but less frequently recorded in winter.

Several species associated with the dams featured in this group including Eurasian Coot *Fulica atra* (RR 35.9%) and Dusky Moorhen *Gallinula tenebrosa* (RR 32.1%). Coots are normally associated with larger bodies of water. Occurrence of the more elusive Dusky Moorhen was almost exclusively restricted to a smaller dam, whereas Latham's Snipe *Gallinago hardwickii* (RR 12.6%), a summer visitor, preferred the muddy margins of the largest dam, where it was seen on five occasions between September and December in 2012/13, in contrast to 2013/14 when five of the six occurrences were between late November and late January.

Infrequently recorded species

Many of the 53 species in this category (**Table 5**) plus the additional record of the Paciifc Baza, were seen in a number of years, indicating their intermittent occurrence in the area as opposed to occasional residence. The Spangled Drongo *Dicrurus bracteatus* was an exception, taking temporary residence in a belt of trees in February 2014.

It is interesting that there were so few records of the smaller cuckoo species, the Fan-tailed Cuckoo *Cacomantis flabelliformis* (RR 7.8%) being the most reported species, but much less frequently than for contemporary surveys at Black Rock (Newman 2014). There was just one record of the Shining Bronze-Cuckoo *Chalcites lucidus*. Perhaps this reflects the limited breeding habitat available to their hosts as well as the apparent widespread decrease of this guild of species (see comment for Fan-tailed Cuckoo in Stuart 2016).

The Double-barred Finch *Taeniopygia bichenovii* was only recorded once in keeping with its patchy occurrence in the Paterson area (Newman 2014). However, it was recorded reasonably frequently (RR 19%; n=36) at a 2-ha survey site approximately 500 m beyond the end of Forest Road at the time of these surveys.

The single record of a Regent Bowerbird *Sericulus chrysocephalus* compared with the Satin Bowerbird *Ptilonorhynchus violaceus* (RR 37.9%) reflects not only the relative abundance of these two species in the Paterson area, but the reluctance of the former species to move outside its forest habitat. In contrast the Satin Bowerbird appears to have benefitted from habitat modification.

The largest lagoon attracted short-term visits from a number of waterbirds including Royal Spoonbill *Platalea regia* (RR 7.8%), egret and cormorant species. Increased use for irrigation in 2012/13 and 2013/14 resulted in less use by a pair of Black Swan *Cygnus atratus* (RR 17.4%) which bred locally and increased occurrence of Black-fronted Dotterel *Elseyornis melanops* (RR 16.5 %), which appreciate the muddy margins created by rapidly falling water levels.

Annual variations

For many species an increase in annual RR is apparent in **Tables 2**–**5**. Often the increase was a consequence of two types of observer bias. In 2013/14 the surveys ceased at the end of February resulting in a disproportionately high number of surveys during the spring and summer months, when many species are breeding and more easily detected and summer migrants are present. Secondly, I became increasing familiar with specific locations where I could locate elusive species, the Dusky Moorhen being an example.
However, for other species the annual variations reflect changes in species' status, examples of which have been highlighted above. These changes may be a consequence of environmental conditions such as the balance between coastal and inland rainfall resulting in the Hunter Region becoming a drought refuge for waterbirds. Local management may also contribute, such as the use of dams for irrigation, infestation of dams by weeds, clearing of vegetation and changes in the availability of food provided for poultry and wild birds, all of which occurred during this study.

Threatened species

While three species listed as vulnerable under the *Threatened Species Conservation Act 1995* (NSW) were recorded during the study, only the Grey-crowned Babbler (RR 76.7%; **Table 3**) was common. This is an exceptionally high RR for the Hunter Region, where the long-term RR is 8.7% across the species' range (Stuart 2016). During the period 2012–2014 three clans of this communal species were present at Forest Road; two at the extremities of the road and one near the centre. Each of these territories was shared with Noisy Miners and disputes were frequent, with the

babblers relatively unconcerned by the aggressive behaviour of the miners.

Three other studies provide RRs for Grey-crowned Babblers in the Paterson area: 66% at a Butterwick Cattle Property (Newman 2007); 19% in woodland at Green Wattle Creek (Newman 2009); and 1% at Black Rock (Newman 2014). In these studies the survey duration and area surveyed were two to three times higher than at Forest Road, highlighting the suitability of the habitat at Forest Road for babblers. The decreased occurrence of Grey-crowned Babbler, Noisy Miner and Grey Butcherbird at Green Wattle Creek following the removal of cattle and the increased growth of understorey vegetation (Newman 2010) provides insights into why the habitat at Forest Road is suitable. The babbler territories appear centred on acreage blocks which have been partially cleared and are largely devoid of understorey vegetation, providing a combination of ground-foraging opportunities, nest sites and cover. In this park-like situation they are not directly competing for resources with the Noisy Miners, which predominantly forage in foliage. It is possible babblers may derive some benefit from co-habiting with miners in terms of early detection and deterrence of predators and exclusion of competing ground-feeding avian species. The Butterwick cattle property (RR 66%) adjacent to the Green Wattle Creek study site superficially has similar attributes to Forest Road where about 15% remnant vegetation in fragmented patches provides nest sites and cover, but the rank grass of the open areas is often unsuitable; overall, farmland appears less suitable than acreage properties with more continuous tree cover. At Black Rock the habitat involved a combination of farmland, larger patches of remnant woodland and fewer, more isolated dwellings than at Forest Road. Grey-crowned Babblers (RR 1%; Newman 2014) were absent other than one sighting at the extremity of the survey area. However, immediately below the survey area they were present in acreage blocks similar to those along Forest Road. Collectively these observations suggest Grey-crowned Babblers thrive in fragmented modified habitat, but only if there is continuity of suitable habitat, as occurs around Paterson. Indeed, large congregations involving up to 20 birds have been seen on the Paterson golf course, which again involves a park-like environment.

There were single records of the other two Threatened Species, the Swift Parrot *Lathamus discolor* and Little Lorikeet *Glossopsitta pusilla*.

Introduced species

The Common Myna *Acridotheres tristis* (RR 27.2%) was the only introduced species regularly present, usually found around the cleared areas. There were single sightings of the Spotted Dove *Streptopelia chinensis* and the Common Starling *Sturnus vulgaris*. Noisy Miners may play an important role in preventing the occurrence of Common Starlings (M. Newman unpublished results).

Absent species

Most of the woodland birds regularly recorded and presumed resident in the Paterson area (Newman 2007, 2009, 2012a, 2014 and 2015) were recorded in this study. Notable absentees in this study included the Varied Sittella *Daphoenositta chrysoptera* and Speckled Warbler *Chthonicola sagittata*, which are both listed as vulnerable under the *Threatened Species Conservation Act 1995* of NSW (Roderick & Stuart 2016). It is perhaps surprising that the Varied Sittella was not recorded as it is known to occur in roadside vegetation in fragmented landscapes (Newman 2015). In addition to the Speckled Warbler, other species from the guild of small ground-feeding birds were either absent (Buff-rumped Thornbill *Acanthiza reguloides* and Yellow-rumped Thornbill *Acanthiza chrysorrhoa*), or scarce (Double-barred Finch RR 1.0%). The absence of the Yellow-rumped Thornbill was particularly surprising as this is a relatively common species, which is well distributed in the Hunter Region and favours open woodland (Stuart 2016). The Yellow-tufted Honeyeater *Lichenostomus melanops* is another widespread species which was not recorded, although a colony existed approximately 0.5 km from the uphill end of the study area. Similarly absent was the White-throated Treecreeper *Cormobates leucophaea*, regularly present in continuous woodland surrounding Forest Road. Its absence is consistent with the well-known issues associated with the dispersal of treecreepers in fragmented landscapes (Doerr *et al*. 2011).

No nocturnal species were recorded, although Tawny Frogmouth was breeding at the time (H. McCall pers. comm.)

Forest Road in perspective

When this study commenced, the objectives were limited: namely to survey birds while undertaking an early morning walk along a quiet road near my home. Soon the potential for generating an

inventory of a local bird population became apparent. Hence, the concept of this paper was born.

As the study progressed I built friendships with other walkers and was able to draw on their knowledge of the area. Gradually a partial understanding emerged of how ongoing anthropogenic habitat modification was shaping the local bird population.

Four habitat types make unique contributions to the variety of bird species recorded. Paddocks provide open spaces for aerial hawkers like Welcome Swallows and larger ground-feeding species such as Cattle Egret and Straw-necked Ibis. Dams provide opportunities for waterbirds and their edges intermittently support shorebirds like Latham's Snipe. Roadside vegetation involving narrow strips of trees and understorey vegetation along the edges of paddocks provide not only foraging opportunities, but assist the movement of a number of smaller species between the patches of remnant woodland and the continuous woodland on the escarpment on the northern side (**Figure 1**) and beyond the end of the road. Partially cleared acreage blocks provide a park-like environment which supports a variety of woodland birds, ranging from small species favouring the dense riparian undergrowth of creek lines (e.g. Superb Fairy-wren and Red-browed Finch) to the more open areas favoured by Noisy Miner, Grey-crowned Babbler and White-winged Chough.

Previous sections highlighted the occurrence and absence of various species based on the results of long-term studies of surrounding areas, including studies of remnant woodland (Newman 2009), farms with remnant vegetation (Newman 2007, 2012a and 2012b) and fragmented rural landscape (Newman 2014). The interaction between these various components of the Paterson area's landscape is dynamic with habitat modifications in each component impacting on the bird populations of the others.

Changes which affect bird populations are both natural and anthropogenic. The influences of rainfall patterns are well known, with both annual and seasonal variations important (Newman 2012c). The changes in bird populations from these variations are complex as exemplified by variations in Grey Fantail *Rhipidura fuliginosa* numbers at nearby Green Wattle Creek (Newman 2012c). This study demonstrated that local fluctuations of an apparently resident species may be influenced by environmental conditions outside the Hunter Region. This is more apparent in influxes of waterbirds seeking drought refuge to dams along Forest Road as discussed above for Hardhead and Eurasian Coot. Increasingly frequent and ferocious storms periodically uproot roadside trees, progressively degrading the amount of this dwindling feature of rural landscapes: a situation exacerbated by the removal of trees considered to constitute public risk.

The main anthropogenic change involves the removal of mature trees offset to a limited extent by re-planting of trees and shrubs; however, the balance tends to result in a net loss of both canopy and understorey cover and increased fragmentation. Plantings of larger flowering shrubs increase the numbers of larger aggressive honeyeater species, the Blue-faced Honeyeater *Entomyzon cyanotis* (RR 11.7%) being an example.

The extent to which the existing balance of sub-habitats supporting the current diverse bird population will be sustained is questionable. Perhaps the greatest risk is the ongoing net loss of mature trees as property ownerships change and landscape modifications are made reflecting the different lifestyle aspirations of successive owners. Loss of mature trees and understorey vegetation may result in the increased dominance of aggressive species and colonisation by introduced species, which were mainly absent during the study (e.g. Common Myna, Spotted Dove and Common Starling). Such changes might be detrimental to Grey-crowned Babblers, in many ways the signature species of the area, as well as decreasing Forest Road's function as a corridor facilitating the movement of birds between woodland remnants.

Collectively, the contemporaneously generated data sets for Forest Road and surrounding habitats provide insights into the relative ability of different species to exist in and move through a fragmented, modified habitat. Species poorly represented in the Forest Road surveys, but known to be locally abundant nearby, may have difficulty surviving in a fragmented landscape; for instance, when local populations are eliminated by wildfires in a remnant woodland patch recolonization may not occur. A few examples have been discussed in the previous sections, but a more comprehensive evaluation than appropriate to the scope of this paper appears warranted.

Neither the Speckled Warbler nor Varied Sittella was recorded at Forest Road, although both are present on Yaraandoo property (**Figure 1**) at the

end of Forest Road (M. Newman unpublished results). Their absence in these surveys might suggest sustainability issues in a fragmented landscape, supporting their vulnerable status under the NSW *Threatened Species Conservation Act 1995*. Studies like this may highlight other at-risk species; for instance, the Crested Shrike-tit *Falcunculus frontatus*, for which there was only one record.

CONCLUSIONS

Acreage properties, farmland and roadside vegetation along Forest Road near Paterson, NSW support a diverse bird population. Over a six-year period 113 species were recorded during 103 surveys conducted in the early morning. This diverse, but highly modified habitat, supported three permanent clans of the Grey-crowned Babbler, a species classified as vulnerable under the NSW *Threatened Species Conservation Act 1995*. The babblers coexisted with aggressive colonies of Noisy Miner, both species favouring open-canopy woodland with limited understorey vegetation.

Many species occurring in surrounding woodland were recorded intermittently suggesting that the area provides important connectivity between woodland remnants in a fragmented rural landscape. Continual modification of vegetation, both natural (e.g. storm damage) and anthropogenic (e.g. clearing and the planting of exotic species) will inevitably cause ongoing environmental changes impacting on the area's bird population and its effectiveness as a corridor facilitating the movement of birds.

A number of dams, mostly small, provided habitat for waterbirds, including species seeking drought refuge and normally associated with larger bodies of water. Shorebirds utilised muddy margins when these were exposed.

Regularly repeated bird surveys conducted in conjunction with recreational exercise proved exceptionally effective in characterising a local bird population and the opportunity to provide advocacy for birds and their habitat requirements within the local community.

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Results from surveys for terrestrial birds on Broughton Island, 2012–2016

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Insights into the terrestrial bird population of Broughton Island, New South Wales have been developed, mainly through a series of systematic surveys carried out over 2012–2016. Feral animals were eradicated from the island in 2009, with expectations that its vegetation and thus its terrestrial bird life may change as a result. The current study was initiated in order to establish baseline information about the Broughton Island bird population so that future changes may be assessed.

From the surveys, 30 species were found to be resident or regular visitors to the island. These included 13 land birds, three shorebirds, six raptors, six species that utilise the coastal and inshore parts of the island, and two seabirds. There also were 27 species which occurred as vagrants, although in many cases with more than one record. Two seabird species known to breed on Broughton Island were not recorded.

Tawny Grassbird *Cincloramphus timoriensis* and Golden-headed Cisticola *Cisticola exilis* were the two most common land birds; numerous Brown Quail *Synoicus ypsilophora* and Silvereye *Zosterops lateralis* were also present. Sooty Oystercatcher *Haematopus fuliginosus* was the most common shorebird. The most commonly encountered raptors were the White-bellied Sea-Eagle *Haliaeetus leucogaster*, Whistling Kite *Haliastur sphenurus* and Swamp Harrier *Circus approximans*.

Since the removal of feral animals, two honeyeater species, Yellow-faced Honeyeater *Caligavis chrysops* and Little Wattlebird *Anthochaera chrysoptera*, have begun to be recorded. The numbers of Silvereye seem to be increasing, and some other bird population changes may be happening.

INTRODUCTION

The Broughton Group of islands lie ~15 km north-east of the entrance to Port Stephens New South Wales (NSW) (**Figure 1**). The main islands, Broughton Island, Looking Glass Isle, Gandja-Baa, Little Broughton Island, North Rock and Inner Rock are well-known seabird breeding colonies especially for Wedge-tailed Shearwater *Ardenna pacifica*, Short-tailed Shearwater *Ardenna tenuirostris* and White-faced Storm-Petrel *Pelagodroma marina*, also Little Penguin *Eudyptula minor* and Gould's Petrel *Pterodroma leucoptera* (Carlile *et al.* 2012, 2013a, 2013b, 2013c, 2013d, 2013e). Broughton Island is part of the Myall Lakes National Park (NP); the other islands are managed as Myall Coast Reserves (North Rock and Inner Rock are grouped together as Stormpetrel Nature Reserve) (NSW National Parks and Wildlife Service 2002).

Most of the islands of the Broughton Group are rarely visited by humans because of their ruggedness and the restrictions on public access to Nature Reserves (S. Callaghan pers. comm.). The exception is Broughton Island, which has some sheltered coves and sandy beaches and a long history of human visitation (NSW National Parks and Wildlife Service 2002). At times there were small permanent settlements. Several fishing huts remain and are frequently in use, and other boat-based visitors are common. The total area of Broughton Island is 132 ha, including a vegetated area of 117 ha (S. Callaghan pers. comm.).

Prior to Broughton Island becoming incorporated into Myall Lakes NP in 1972, its natural vegetation was being severely impacted by feral animals and the effects from frequent fires (Carlile *et al.* 2012). These impacts lasted a very long time – as long ago as 1883 the island was described as

"entirely destitute of trees" (Pittman 1883). Since 2009, after completion of a program to remove rats and rabbits (Priddel *et al.* 2011), the island is free of feral animals, whilst fires should now mostly occur naturally. These recent improvements in land management are expected to benefit the various breeding seabird colonies of the Broughton Group (Carlile *et al.* 2012). However, it was less clear what the implications would be for all other bird species on Broughton Island. Very little has been documented about the populations of non-seabirds on Broughton Island.

In 2012, a systematic study of Broughton Island was initiated, with assistance from other members of the Hunter Bird Observers Club. The aims of the study were to document the terrestrial birds occurring on the island shortly after the eradication of rodents and rabbits and then identify changes in species assemblages and numbers in subsequent years. This paper summarises the 2012–2016 findings.

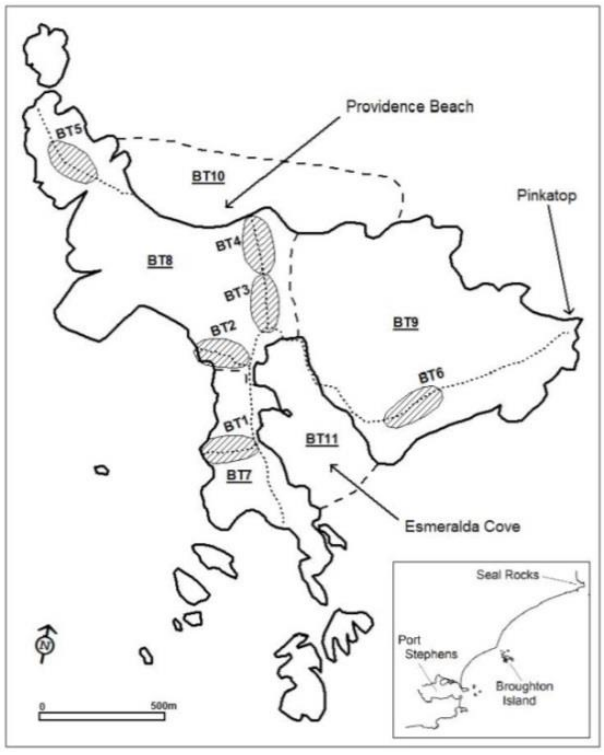

Figure 1. Broughton Island showing the survey areas BT1–BT11 and indicating the survey routes (Inset: location of the Broughton Group of islands)

Broughton Island ornithological history

The focus of all the reported previous visits to Broughton Island was breeding seabirds. Non-seabirds were occasionally mentioned in those reports. The first documented visit was in 1910 (Basset Hull 1910a). Wedge-tailed Shearwaters and White-faced Storm-Petrels were found in burrows; the only other birds mentioned were the Swamp Harrier *Circus approximans*, Great Cormorant *Phalacrocorax carbo* and White-bellied Sea-Eagle *Haliaeetus leucogaster*. Basset Hull made three subsequent visits over 1910–1911 as did Rohu in 1912; they mostly discussed seabirds (Basset Hull 1910a, 1910b, 1911, 1922; Rohu 1914).

Hindwood and others visited for three days in December 1959 to band nesting shearwaters; the report of that visit also discussed *inter alia* a number of shorter visits over preceding decades (Hindwood & D'Ombrain 1960). They listed 25 species (including 18 terrestrial ones). Differences between their findings and the current study will be discussed later.

All the post-1960 reports about Broughton Island had a strong focus on seabirds. Gulls, terns and cormorants were discussed in several reports, and Sooty Oystercatcher *Haematopus fuliginosus* and Eastern Reef Egret *Egretta sacra* were mentioned in some. Three reports described visits in the 1970s (Lane 1976; van Gessel 1978; Lane 1979). Carlile and colleagues visited the island several times over 2008–9 and documented their findings in 2012 (Carlile *et al.* 2012).

METHODS

Over 2012–2016, Broughton Island was visited by teams of 4-8 surveyors for a total of six 2-3 day periods in autumn (March-April) and spring (September-October). Systematic surveys were conducted during these visits, mostly done in teams of two people per survey and involving 2-3 surveys simultaneously in different parts of the island. The results have been supplemented with bird lists for the overall island from 1-2 day autumn and spring visits in 2015 and at various other times (mainly by TC and AS).

For the systematic surveys, the island including its inshore waters was surveyed as five sub-areas, each of approximately 500 m radius. Bird lists for each sub-area were generated over periods of several hours each day. Within the sub-areas, six 2-ha sites were delineated; overall these 2-ha sites provided a representative cross-section of the Broughton Island vegetation as it existed in 2012 (S. Callaghan pers. comm.). The 2-ha sites were surveyed for 20-minute periods once or twice per day.

The 11 survey areas are shown in **Figure 1**, while **Table 1** summarises their main characteristics. Observers recorded all bird species detected in each survey area. For the 2-ha sites, exact numbers were noted. For the 500-m area surveys, which often spanned several hours at various places within the survey area, observers were

Table 1. Broughton Island survey areas 2012–2016.

Area ID	Type	Mid-point	No. of surveys	No. of species	General description
BT1	2 ha	32º 37' 17"S 152º 18' 51"E	22	15	Grasses and heath, scattered small shrubs.
BT2	2 ha	32º 37' 05"S 152º 18' 49"E	22	24	Shrubs with some areas of grasses and heath, a small wetland.
BT3	2 ha	32º 36' 59"S 152º 18' 56"E	22	21	Shrubs including one large banksia.
BT4	2 ha	32º 36' 51"S 152º 18' 55"E	22	19	Shrubs and a large area of grasses and heath, and hind-dune swale.
BT5	2 ha	32º 36' 45"S 152º 18' 25"E	18	14	Grasses and heath, several small shrubs. An exposed elevated site affected by wind shear.
BT6	2 ha	32º 37' 12"S 152º 19' 06"E	15	8	Grasses and heath, a few small shrubs. An exposed elevated site affected by wind shear.
BT7	500 m	32º 37' 18"S 152º 18' 53"E	19	32	Grasses and heath with pockets of shrubs and trees; rocky foreshore and some inshore rock platforms.
BT8	500 m	32º 36' 56"S 152º 18' 44"E	23	40	Grasses and heath with pockets of shrubs and trees and a wetland; rocky foreshore and some inshore rock platforms.
BT9	500 m	32º 37' 03"S 152º 19' 16"E	17	32	Grasses and heath with pockets of shrubs and trees; rocky foreshore and some inshore rock platforms
BT10	500 m	32º 36' 46"S 152º 18' 51"E	23	26	Extensive sandy beach (Providence Beach) with some inshore rock platforms and open water.
BT11	500 m	32º 37' 08"S 152º 18' 59"E	17	37	Esmeralda Cove: open waters, extensive inshore rock platforms, small sandy beaches.

Table 2. Broughton Island survey details

Dates	18-20/9/2012	8-9/4/2013	23-25/9/2013	24-25/3/2014	18-20/4/2016	10-12/10/2016
No. of surveys	40	29	43	40	42	24
No. of species	35	30	36	37	35	30

requested to note the exact numbers if that was feasible, or otherwise to make an estimate. All of the core group of surveyors were highly experienced, and completely familiar with the species encountered on the island.

The two survey methods (500 m radius and 2-ha / 20-minute) correspond with the main methods used in the BirdLife Australia Atlas project. All the results from Broughton Island systematic surveys were entered into the Atlas database, and into an Excel database maintained by AS where breeding records and reports from third parties also were captured.

RESULTS

Survey dates and the number of species recorded per visit are given in **Table 2**. In total, 218 systematic surveys were conducted, with an additional 28 surveys done on other dates over 2012–2016. Overall 57 species were confirmed to be present. Of these species, 30 were recorded on many and in some cases all of the visits, and often recorded daily and at many sites. An additional two seabird species, Short-tailed Shearwater and Gould's Petrel, which are known to breed on the island (Carlile 2012) were not recorded in the present study which focussed on diurnal surveys. These 32 species thus constitute the main birds of Broughton Island. They are listed in **Table 3** with their estimated population sizes.

For 27 other species, there have been only a relatively small number of records. In some cases, there has been more than one record but with gaps of a year or more at times. Those species are not discussed further in this paper but remain in the database; it is possible that some will eventually (re-)colonise the island as the vegetation recovers.

Of the six 2-ha survey areas, BT2 and BT3 yielded the most species (**Table 1**). Both sites include sizable areas of shrubs/small trees. The least productive 2-ha site was BT6, with only eight species recorded in 15 visits. Note that this list includes fly-over species such as Welcome Swallow *Hirundo neoxena* and raptors.

For the 500-m radius sites, the most productive ones were BT8, with some groves of well-established shrubs and trees, and BT10 which

often had shorebirds on Providence Beach and also coastal/inshore birds utilising the area.

Detailed results for individual survey areas are not provided in this paper. They have been captured in a database for future analysis of changes. This paper focusses on delivering an overview of the bird populations of the overall island.

Table 3. The main birds of Broughton Island.

Species	Est. Population*
Brown Quail	100-200
Bar-shouldered Dove	5-10
Wedge-tailed Shearwater#	50,000-100,000
Short-tailed Shearwater#	400-600
Gould's Petrel#	<10
Little Penguin#	50-80
Great Cormorant	20-30
Little Black Cormorant	5-10
Pied Cormorant	20-50
Eastern Reef Egret	4-8
Osprey	4-6
Black-shouldered Kite	1-2
White-bellied Sea-Eagle	4-6
Whistling Kite	2-4
Swamp Harrier	2-4
Peregrine Falcon	2-4
Lewin's Rail	10-20
Buff-banded Rail	5-10
Sooty Oystercatcher	10-20
Red-capped Plover	5-15
Ruddy Turnstone	4-6
Crested Tern#	50-100
Silver Gull#	100-200
Pheasant Coucal	4-6
Little Wattlebird	2-4
Yellow-faced Honeyeater	5-10
Australian Raven	2-4
Golden-headed Cisticola	200-400
Tawny Grassbird	150-250
Silvereye	50-100
Welcome Swallow	20-30
Australasian Pipit	6-10

*Estimated numbers of individual birds
#From Carlile *et al.* (2012)

DISCUSSION

Land birds

Five species, Brown Quail *Synoicus ypsilophora*, Golden-headed Cisticola *Cisticola exilis*, Tawny Grassbird *Cincloramphus timoriensis*, Welcome Swallow and Silvereye *Zosterops lateralis*, were recorded at every land-dominated site (BT1 to BT9) and with very high reporting rates at most of those sites.

The reporting rates for Golden-headed Cisticola and Tawny Grassbird were slightly greater in the spring surveys, which probably reflected their increased detectability during the breeding season due to territorial behaviour. The reporting rate for Welcome Swallow was greater in autumn; possibly involving migrating birds.

When Silvereyes were able to be identified to sub-species level, most were the non-migratory *cornwalli* sub-species ('Eastern Silvereye'). There was only one confirmed record of the sub-species *westernensis* ('South-eastern Silvereye').

Australian Raven *Corvus coronoides*, Pheasant Coucal *Centropus phasianinus*, Bar-shouldered Dove *Geopelia humeralis* and Australasian Pipit *Anthus novaeseelandiae* were regularly recorded in low numbers, as were Yellow-faced Honeyeater *Caligavis chrysops* since 2012 and Little Wattlebird *Anthochaera chrysoptera* since 2014. The two latter species are further discussed below (see *Indications of change*).

The surveys produced the first known records of Lewin's Rail *Lewinia pectoralis* on Broughton Island. However, it is a cryptic species, likely to be overlooked by those unfamiliar with its call. It was found at most of the land-based sites, although apparently in small numbers overall. It appears to be resident and perhaps has been so for a long time. The reporting rate for Lewin's Rail was higher in spring when birds presumably call more often. The similarly cryptic Buff-banded Rail *Hypotaenidia philippensis* was recorded in September 2013 and April 2016, and then in the October 2016 surveys birds were detected calling at many different parts of the island. There were several prior records over 1998–2012 (N. Carlile pers. comm.).

The presence of the two rail species on Broughton Island may have implications for the island ecology. The diets of both species include frogs and bird eggs (Marchant & Higgins 1993). The island is a refuge for the Green and Golden Bell Frog *Litoria aurea* (S. Callaghan pers. comm.) which is classified as Endangered under the *Threatened Species Conservation Act 1995* of New South Wales. Broughton Island is also an important seabird breeding colony. The Buff-banded Rail is known to predate eggs and young at Sooty Tern *Onychoprion fuscata* colonies (Taylor & van Perlo 1998). They have been described as 'may be a significant predator at tern breeding colonies, taking many eggs' (Taylor & van Perlo 1998). At Lady Elliot Island Queensland in 2001

and 2012, Buff-banded Rail was observed to take eggs of Bridled Tern *Onychoprion anaethetus* (FvG pers. obs.). It is unclear if a Buff-banded Rail would enter burrows, especially ones defended by aggressive shearwaters. However, White-faced Storm-Petrel eggs might be at risk if breeding resumed on Broughton Island.

Shorebirds

The most common shorebird was the Sooty Oystercatcher, with several pairs or small parties scattered around the shoreline and occasionally larger groups being recorded, particularly in spring. The highest count was 17 birds (including some immatures) in September 2012. This was a noteworthy count from a regional perspective (Stuart 2013). The Red-capped Plover *Charadrius ruficapillus* also was common, although it was not seen away from Providence Beach. Mostly 4-6 birds have been present; however, in March 2014 there were 13 birds. Most other shorebirds have appeared only as vagrants, except for Ruddy Turnstone *Arenaria interpres*, a migratory bird which was frequently found foraging along Providence Beach in the spring visits.

Coastal and inshore birds

Pied Cormorant *Phalacrocorax varius* and Great Cormorant were often seen hunting offshore or roosting on rock platforms, Little Black Cormorant *P. sulcirostris* less frequently. Eastern Reef Egret were frequently seen foraging on rock platforms; with a peak count of six birds on Providence Beach in January 2014 (L. Crawford pers. comm.). Silver Gull *Chroicocephalus novaehollandiae* and Crested Tern *Thalasseus bergii* also were widespread, although the Silver Gull generally favoured the Esmeralda Cove area whenever people were staying at the huts. In September 2012, large numbers of them (200-300 birds) were recorded in the BT7 survey area and ~70 birds in October 2016, but in the four other sets of surveys they either were absent from BT7 or were recorded in very low numbers.

Raptors

The main birds of prey recorded were White-bellied Sea-Eagle, Swamp Harrier, Whistling Kite *Haliastur sphenurus* and the Osprey *Pandion haliaetus*, all with reporting rates above 10% and seen all over the island. Peregrine Falcon *Falco peregrinus* (usually 1-2 birds, sometimes more) was common in the area around Pinkatop (in the BT9 survey area) and 1-2 Black-shouldered Kite *Elanus axillaris* in the western parts of the island. Five other raptor species were recorded less frequently.

Seabirds

Carlile *et al.* (2012) studied the breeding seabird colonies on Broughton Island. The main species were Wedge-tailed Shearwater (an estimated 55,000 pairs) and Short-tailed Shearwater (200-270 pairs), with 24-43 pairs of Little Penguin also found nesting, and at least one Gould's Petrel on a nest in 2009 (Carlile *et al.* 2012). The current project's objectives did not include surveying the nesting seabirds, particularly since the surveys were outside the main seabird breeding season. However, it was easily confirmed from casual observations that many Wedge-tailed Shearwater and some Little Penguin continue to breed on the island.

Population estimates and population densities

Estimates were made of the numbers of individual birds for each of the main species occurring on the island (see **Table 3**). These estimates were based on the consensus views of the authors and are not underpinned by any rigorous scientific method. However, they give an indication of the relative abundance of each species, for future comparisons.

Attempts to improve the population estimates for the two most common species, Golden-headed Cisticola and Tawny Grassbird, were unsuccessful. During the surveys in spring 2013, observers tried to identify specific territories for these species in each of the 500-m-radius survey areas. Another effort involved trying to count the territories within the 2-ha sites. It proved very difficult to track the movements of individual birds whilst also doing the standard surveys. Better results possibly could be obtained by conducting the population counts separately.

The estimated population density for Golden-headed Cisticola was 1.7-3.4 birds/ha (averaged across the 117 ha of vegetated area) and for Tawny Grassbird, 1.3-2.1 birds/ha. These densities are comparable with the values obtained elsewhere in favourable habitats for these species (Higgins *et al.* 2006).

Breeding records

In addition to seabirds, several other breeding records were obtained, although this was not a primary objective of the study. Initially the spring surveys were in mid to late September which may have been too early for most species to have begun breeding. Also, surveyors generally did not have time to look closely for evidence of breeding whilst doing a census. Several of the breeding records have been for birds near the huts at Esmeralda Cove, where surveyors spent their leisure time, and many others have been from visits to Broughton Island outside of survey periods.

One or more Osprey was regularly seen at a nest in April 2016 and October 2016. Breeding was confirmed in December 2016 when a near-fledged chick was in the nest (N. Carlile pers. comm.). There were regular breeding records for Welcome Swallow (up to four pairs nesting at the huts in spring) and Silver Gull. For the latter, there were several records of newly fledged birds begging and being fed on the beach in front of the huts at Esmeralda Cove. In October 2016, at least three pairs were on eggs on the adjacent rocky headland, and two pulli were present with adults on the beach in the following month. However, the main breeding activity occurred elsewhere. Carlile *et al.* found ~70 pairs breeding at Snapper Rocks (in the BT7 survey area) in 2009 and another ~30 pairs on rocks further to the south-west (Carlile *et al.* 2012). The 2012–2016 surveys did not find direct evidence of breeding by Silver Gull at either of those sites, but in October 2016 many birds were occupying and defending an area north-east of Snapper Rocks and were suspected to be breeding. This was confirmed in December 2016 when ~100 pairs had nests with young or were with pulli (N. Carlile pers. comm.). It seems that the breeding sites for Silver Gull on Broughton Island are variable.

Pairs of Golden-headed Cisticola and Silvereye had nests with young in January 2014 (L. Crawford pers. comm.) and October 2016 respectively. A Buff-banded Rail had three chicks in November 2016 (S. Callaghan pers. comm.). Australian Pied Oystercatcher *Haematopus longirostris* had a nest with one egg along Providence Beach in September 2012. The outcome is unknown (only one of the pair was found in a November 2012 visit, and there have been no subsequent records of this species).

Thirty pairs of Crested Tern were breeding at an area north-east of Snapper Rocks in December 2016, with over 250 birds attending the site (N. Carlile pers. comm.). There is a past record of Sooty Oystercatchers breeding on Broughton Island (S. Callaghan pers. comm.) and they have also bred on nearby Gandja-baa (Carlile *et al.* 2013d). A pair was defending an area on the north-western side of the island in mid-January 2014 (L. Crawford pers. comm.) which suggests they may have been breeding.

Prior to the surveys commencing, pairs of Red-capped Plover had nests with eggs on Providence Beach in September and November 2010 (TC pers. obs.). These were two separate breeding records, although the fate of either is unknown.

Comparisons with other islands

The Tawny Grassbird has been recorded on many of the islands in northern Australia (Higgins *et al.* 2006) but there are no records from islands further south (www.birdata.birdlife.org.au; accessed 16 February 2017). Golden-headed Cisticola and Silvereye are known from several offshore islands including Montagu Island and Gabo Island (Fullagar 1987; Reilly 1978). There are post-1997 Birdata records for them from those locations plus many islands off the Queensland coast (www.birdata.birdlife.org.au; accessed 10 December 2016). Brown Quail had not been recorded on Montagu Island in 1987 (Fullagar 1987) and their presence on NSW islands was not discussed in the NSW Atlas (Cooper *et al.* 2014). However, there are post-1997 Birdata records from Montagu Island and Boondelbah Island off Port Stephens as well as Broughton Island and many Queensland islands (www.birdata.birdlife.org.au; accessed 10 December 2016). Movement across open seas has been documented; for example, MacGillivray noted that they landed on Booby Island in Torres Strait each spring as they moved between Papua New Guinea and Australia (MacGillivray 1914).

Although generally considered to be sedentary and a relatively poor flyer, the Pheasant Coucal is known sometimes to make long distance movements although movements across open seas appear not to have been documented (Higgins 1999). Their presence on NSW islands is not discussed in the NSW Atlas (Cooper *et al.* 2016). A review of Birdata records for Pheasant Coucal on islands offshore from NSW only shows records

for Broughton Island and nearby Cabbage Tree Island (www.birdata.birdlife.org.au; accessed 10 December 2016). However, there are Birdata records for them from many islands off Queensland.

Indications of change

In the current study, some changes already are evident. A pair of Yellow-faced Honeyeater was recorded in the first surveys in 2012, at a large banksia in the BT3 survey area. There were no known previous records (TC pers. obs.; J. Pettifer pers. comm.) although some birds were found on Little Broughton Island in 1959 (Hindwood & D'Ombrain 1960). In the surveys since 2012, the numbers of Yellow-faced Honeyeater increased, to ten or so birds in 2016, and they spread to other parts of the island. Similarly, a pair of Little Wattlebird was recorded in March 2014, with no known prior records. They were present in every subsequent visit, mainly in the BT3 survey area.

The Silvereye was recorded on every visit. In the 2012–2013 surveys it was estimated that 20-40 birds were present each visit. The numbers were much greater in the autumn and spring 2016 surveys, and more than 100 birds were estimated to have been present in October 2016. The birds seemed attracted to the berries of *Monotoca elliptica* which were prolific at that time.

It is suggested that some changes have occurred between 1959 and now. Neither Brown Quail nor Silvereye were recorded in 1959 (Hindwood & D'Ombrain 1960); both now are very common on the island. Also, the Little Grassbird *Poodytes gramineus* was listed (there are no current records) but not Tawny Grassbird which now is common. It seems improbable that those two capable ornithologists would have mis-identified the species, nor does it seem to be a typographical error as they used both the then scientific name and the common name. The Little Grassbird is resident on some other islands off south-east Australia (Fullagar 1987; Reilly 1978).

CONCLUSIONS

Thirty-two species were resident or regular visitors to Broughton Island; this includes four seabirds (two of which were not recorded in the present study), three shorebirds, six raptors, six coastal and offshore birds, and 13 land birds. An additional 27 species were recorded as vagrants. Because the vegetation on Broughton Island is expected to continue to recover under the current Plan of Management, it seems possible in future that some vagrant species will decide to stay.

A baseline has been developed through the current study, which will allow future changes to the Broughton Island bird population to be identified. Some changes already seem to be occurring. Two honeyeater species, Yellow-faced Honeyeater and Little Wattlebird, have colonised (or re-colonised), and the numbers of Silvereye seem to be increasing. Possibly some other changes also are happening (e.g. rails).

The monitoring program should continue although the frequency of visits seems of secondary importance. Future changes in bird populations are likely to happen slowly from now on, driven by gradual changes to the vegetation.

It is also recommended that consideration be given to undertaking a banding study of the terrestrial birds of the island. This should generate insights about movements to and from Broughton Island and perhaps allow population estimates to be refined.

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Comparison of two ephemeral wetlands in the lower Manning Valley

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Systematic surveys over 2013-2017 at two small and mostly ephemeral wetlands near one another in the lower Manning Valley revealed differences in bird populations. The differences were statistically very significant for three species, Black-fronted Dotterel *Elseyornis melanops*, Red-kneed Dotterel *Erythrogonys cinctus* and Purple Swamphen *Porphyrio porphyrio.* They were significant for eight other species: Pacific Black Duck *Anas superciliosa*, Chestnut Teal *Anas castanea*, Australian Pelican *Pelecanus conspicillatus*, Little Pied Cormorant *Microcarbo melanoleucos*, Brown Honeyeater *Lichmera indistincta*, Golden-headed Cisticola *Cisticola exilis*, Little Grassbird *Poodytes gramineus* and Fairy Martin *Petrochelidon ariel.*

INTRODUCTION

Coopernook Corner wetlands and Cattai Creek wetlands are ephemeral waterbodies in the lower Manning Valley, situated approximately 5 km apart (**Figure 1**) and similar distances away from the well-studied Cattai Wetlands (Carlson 2015; Stuart 2017).

Coopernook Corner wetlands straddle Coopernook Road, commencing ~200m from the Pacific Highway turn-off. The southern section comprises a shallow pond which dried out several times over 2013-2017. The northern section includes a deeper pond that always held some water over 2013-2017. A small tree-lined creek connects the southern and northern sections, and the remainder of the wetlands is surrounded by a mixture of paddocks and trees. Cattai Creek wetlands comprise a shallow southern section which dried out several times over 2013-2017 and a deeper and more expansive northern section. A small grove of mature trees separates the two sections while the remainder of the wetlands is surrounded by paddocks.

The above descriptions suggest the two wetlands to be quite similar. However, comparison of results from systematic surveys conducted at them between June 2013 and June 2017 has revealed some significant differences in their bird populations. This in turn suggests important subtle differences in the habitats which they provide.

METHODS

Both wetlands are on private property and could not be accessed directly. They were surveyed from the nearest road (Coopernook Road and Harrington Road respectively) using 10 x 42 binoculars, occasionally supplemented with a telescope to confirm an identification. Usually, both sites were surveyed within the same 24-hour period and in most cases the time interval was less than an hour. Twice, unsuitable conditions prevented surveys at Cattai Creek within the targeted 24-hour timeframe.

Survey areas of nominal 2 ha size were defined at both sites. In each visit, all species identified in a 20-minute period were recorded and estimates made of their numbers. The results were entered into Birdata (the BirdLife Australia Atlas portal) as 2 ha/20 min surveys.

Systematic surveys at Coopernook Corner wetlands started in mid 2012 and in June 2013 at Cattai Creek wetlands. To eliminate any potential effects from unknown variables, only the surveys from June 2013 onwards for both sites were analysed for this report.

RESULTS

As shown in **Table 1**, 32 surveys were conducted at Coopernook Corner wetlands in the four-year period, yielding 69 species, and 30 surveys at Cattai Creek wetlands yielding 71 species. However, there were many one-off records and only 48 species at each site had multiple records. These included 43 species in common.

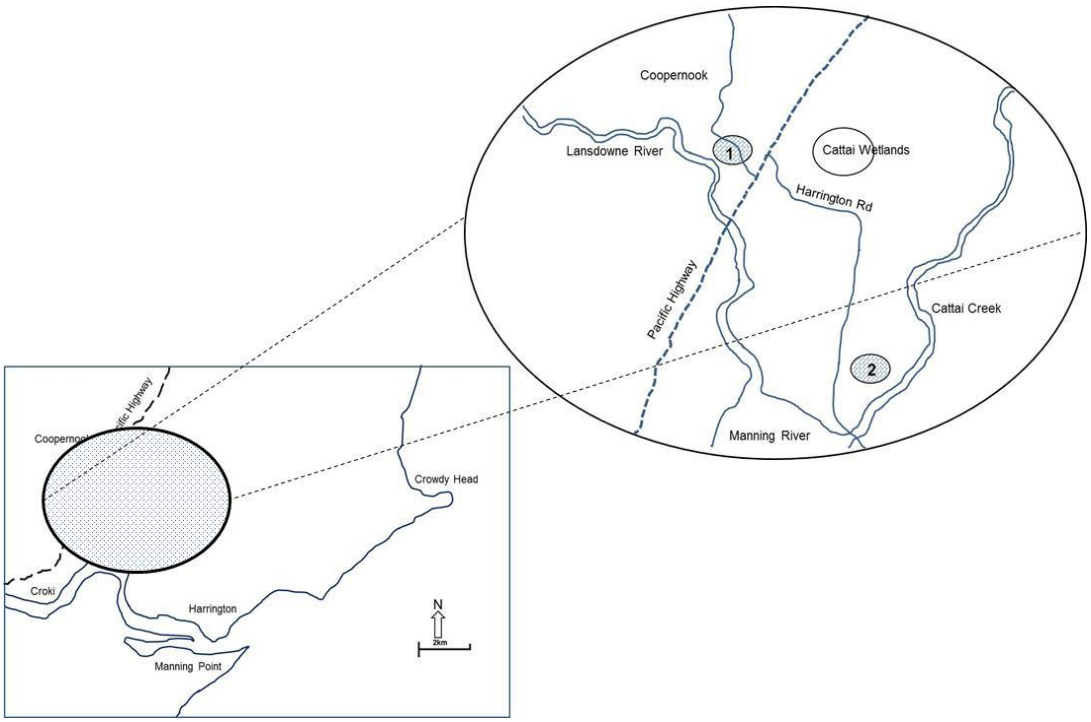

Figure 1. Location of the two wetlands in the lower Manning Valley. 1 = Coopernook Corner wetlands, 2 = Cattai Creek wetlands.

Table 1. Results from surveys at Coopernook Corner wetlands and Cattai Creek wetlands 2013-2017.

	Coopernook Corner	**Cattai Creek**
No. of surveys	32	30
No. of species	69	71
Species with a single record	21	23
Species with multiple records	48	48
Species in common at both sites	43	43

Differences in Reporting Rates (RRs) for species at the two sites were assessed statistically using the Yates-corrected Chi-square test (Fowler & Cohen 1994). In general, the Reporting Rates (RRs) for species at the two sites were of similar magnitude and any differences in RR were not statistically significant. However, eight species had RRs which were significantly different at the two sites and three species had RRs very significantly different. Details of differences in RRs for these species and certain others are given in **Table 2**.

DISCUSSION

The RRs for the Black-fronted Dotterel *Elseyornis melanops* were 81.3% at Coopernook Corner and 10.0% at Cattai Creek (**Table 2**). This is a very significant difference (at greater than 99% confidence level). The difference in RRs for the Red-kneed Dotterel *Erythrogonys cinctus* also were very significant (at greater than 99% confidence level). This indicates that the Coopernook Corner wetlands were more suitable for small shorebirds during the study period. Supporting this conclusion, the RRs for Sharp-tailed Sandpiper *Calidris acuminata* were 34.4% and 13.3% respectively. Although this difference is not statistically significant at 95% confidence level, it fits the same trend.

Coopernook Corner was also more important for Little Pied Cormorant *Microcarbo melanoleucos*, Brown Honeyeater *Lichmera indistincta*, Pacific Black Duck *Anas superciliosa* and Chestnut Teal *Anas castanea* (all at >95% confidence level). The presence of a small woodland fringing part of the Coopernook Corner wetlands explains why the Brown Honeyeater preferred this site. It is unclear why Pacific Black Duck and Chestnut Teal were recorded much more frequently there, particularly since the RRs for Grey Teal *Anas gracilis* were similar at both sites (40.6% and 36.7% respectively).

Purple Swamphen *Porphyrio porphyrio*, Australian Pelican *Pelecanus conspicillatus*, Golden-headed Cisticola *Cisticola exilis* and Fairy Martin

Table 2. Differences in Reporting Rate (RR) for selected species at the two wetlands.

Species	Coopernook Corner		Cattai Creek		*p*	Statistical significance
	RR	No. of records	RR	No. of records		
Pacific Black Duck *Anas superciliosa*	62.5%	20	20.0%	6	<0.02	Significant
Grey Teal *Anas gracilis*	40.6%	13	36.7%	11	~0.5	Not significant
Chestnut Teal *Anas castanea*	75%	24	33.3%	10	<0.03	Significant
Black-fronted Dotterel *Elseyornis melanops*	81.3%	26	10.0%	3	<0.01	Very significant
Red-kneed Dotterel *Erythrogonys cinctus*	68.8%	22	23.3%	7	<0.01	Very significant
Sharp-tailed Sandpiper *Calidris acuminata*	34.4%	11	13.3%	4	~0.12	Not significant
Purple Swamphen *Porphyrio porphyrio*	0%	0	33.3%	10	<0.01	Very significant
Australian Pelican *Pelecanus conspicillatus*	0%	0	26.7%	8	<0.02	Significant
Little Pied Cormorant *Microcarbo melanoleucos*	25.0	8	3.3	1	<0.05	Significant
Brown Honeyeater *Lichmera indistincta*	40.6%	13	10.0%	3	<0.03	Significant
Golden-headed Cisticola *Cisticola exilis*	0%	0	23.3%	7	<0.03	Significant
Little Grassbird *Poodytes gramineus*	12.5%	4	0%	0	<0.02	Significant
Fairy Martin *Petrochelidon ariel*	0%	0	23.3%	7	<0.03	Significant

Petrochelidon ariel were not recorded at Coopernook Corner wetlands in the study period (nor before it) but had RRs ranging from 23-33% at Cattai Creek (**Table 2**). The RR differences for the latter three species are statistically significant at 95% confidence level and very significant for the Purple Swamphen (at 99% confidence level). It is unclear why these differences occurred as superficially the habitats at the two sites seem quite similar. The areal extent of reeds and tall grass at Cattai Creek wetlands is larger than at Coopernook Corner which may partly explain why the RR for Golden-headed Cisticola is significantly higher. However, the converse occurred for the Little Grassbird *Poodytes gramineus* which had a statistically significantly higher RR at Coopernook Corner.

CONCLUSIONS

Two small wetlands situated within 5 km of one another and offering apparently similar mixes of habitat had some significant differences in the bird populations which they supported. Although 43 species were common to both sites, the Reporting Rates for eleven species were significantly different and were very significantly different for three of those species (Black-fronted Dotterel, Red-kneed Dotterel and Purple Swamphen). This illustrates that subtle differences in habitat can have important consequences.

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Brush Bronzewing at Belmont, NSW: recent field notes

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Brush Bronzewing *Phaps elegans* is a shy species of ground pigeon seen in coastal parts of the Hunter Region, notably in dense scrub near Belmont, NSW. These field notes report recent survey findings at two locations, which indicate a population in the Belmont area of at least 20 pairs. Further research into the distribution of this intriguing species appears warranted.

INTRODUCTION

Brush Bronzewing *Phaps elegans* is an endemic ground-feeding pigeon which was frequently recorded in consecutive spring-summer seasons (2015–16, 2016–17) at Belmont Wetlands State Park (BW) (33°02'05"S, 151°40'41"E) and Belmont Lagoon (BL) (33°02'38"S, 151°39'48"E) at Lake Macquarie, NSW. Records of this species in the Hunter Region are scarce (Stuart 2016); Birdata (2017) cites only 106 records there from 1998 to 2015 (RR = 0.8%). Its regional population size, distribution, seasonal movements and social behaviour are largely unknown (Higgins & Davies 1996). Despite its scarcity in the Hunter Region the conservation status of the Brush Bronzewing is considered to be of "least concern" in NSW (IUCN Red List of Threatened Species 2016).

There are two recognized sub-species; *Phaps elegans occidentalis* in south-western Australia, and *Phaps elegans elegans* dotted across its south-eastern coastline and islands. It is a robust, medium-sized, ground pigeon (length 25-33 cm; weight 170-260 g). On average, the adult male is slightly larger than the female, with a characteristic rufous - light brown forehead. The species is usually seen singly or in pairs (**Figures 1** and **2**).

Brush Bronzewing have a similar call and appearance to the Common Bronzewing *Phaps chalcoptera*, and their territories may overlap. The Common Bronzewing is more prevalent in western areas of the Hunter Region (Stuart 2016), and has not been reported in the vicinity of the study area (BW and BL). Hence all records of bronzewings were by default assumed to be Brush Bronzewings.

Brush Bronzewing was recorded by Laverick (LMCC 2001) in a 3-year study at Belmont Swamp (BS) which is now part of Belmont Wetlands State Park (BW). More recently it has been observed on regular surveys at BW and the adjacent Belmont Lagoon (BL), as reported below.

BL (50 ha) and BW (514 ha) are part of coastal hind-dunes being rehabilitated after a century of mining and commercial degradation. Scrub in these wetlands include thick stands of Broad-leaved Paperbark *Melaleuca quinquenervia*, Swamp Paperbark *M. ericifolia*, Coastal Wattle *Acacia sophorae*, Golden Wreath Wattle *A. saligna*, Coast Banksia *Banksia integrifolia*, Old Man Banksia *B. serrata*, and Coast Teatree *Leptospermum laevigatum* beside public walkways and dirt fire trails (BWSP Trust 2010).

Figure 1. Male Brush Bronzewing. Photo: Darryl Luck

Figure 2. Female Brush Bronzewing on powerline at Belmont Wetlands State Park on 2 November 2016. Photo: Grahame Feletti

METHODS

Regular (2-hour) bird surveys were usually conducted three times a month at each site (BL, BW) between 6.00 and 9.00am between 4 July 2015 and 11 April 2017 (Feletti in prep.). Details of all birds seen or heard were collated on a digital tape-recorder, along with details of the location of each record.

Brush Bronzewings were typically observed: ground-feeding or perched on powerlines; hidden but calling from nearby scrub; or seen briefly in flight after they flushed. Any bronzewings not positively identified were assumed by default to be Brush Bronzewing because there are no previous records of the similarly sized Common Bronzewing in the study area (Birdata 2017; Cooper *et al.* 2014; Stuart 2016). Tape-recordings of birds calling in this study were confirmed as Brush Bronzewing by checking against reference audio recordings and with local experts. Digital images obtained in this study were of Brush Bronzewing.

RESULTS

There were no observations of Brush Bronzewing at BL or BW on regular surveys between May and July in 2015 or in 2016. From late August male and female bronzewings were seen at both locations early in the morning. Sometimes Brush Bronzewing foraged in the company of Spotted Dove *Streptopelia chinensis* or Bar-shouldered Dove *Geopelia humeralis*. Brush Bronzewing was also seen resting under Coastal Wattle. On 12 November 2016 a male bird was seen courting a female at the end of a track at BL. He followed her closely (within a metre), bowed several times fanning his tail before mounting her for copulation. Both birds flew off within 5 minutes.

Brush Bronzewing seem to prefer dense coastal scrub and trees (melaleuca, acacia, banksia and leptospermum species) for nesting, foraging and resting. Several times in January, either one, or two birds were seen ground-feeding on dirt tracks or perched on powerlines, but for most of the spring-summer period individual Brush Bronzewing called from 4-5 m high thickets of Broad-leaved Paperbark or Coast Teatree scrub nearby. These birds were seldom visible. With regular surveys based on a 5 km perimeter walk, locating a calling bird's approximate position became fairly easy. It was also noted that when calling, (male) birds seemed to space themselves territorially at least 30 m apart. These two clues made it possible to estimate Brush Bronzewing numbers based on a combination of vocal and visual records. Seasonal variations in the number of bronzewings for the successive spring/summer periods 2015–16 and 2016–17 are shown in **Figure 3**.

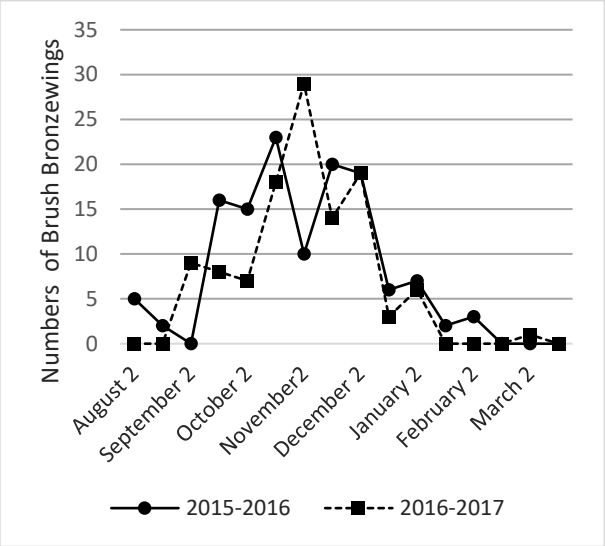

Figure 3. Combined numbers of Brush Bronzewing recorded at Belmont Lagoon and Belmont Wetlands for the spring/summer period of 2015–16 and 2016–17. The estimates are based on maximum number recorded during 15 or 16-day intervals (e.g. August 2 corresponds to the period 16-31 August).

The results for 2015–16 and 2016–17 are similar with numbers rising sharply to a peak in November for 4-6 weeks, before declining rapidly during January. The absence of calls cannot be taken to indicate that the birds moved elsewhere after breeding; one (female) bird was seen on powerlines at BW at the end of February 2016 and another at BL at the end of March 2017; but all calling at either location had ceased one month before.

During this study 30% (72/242) of all bronzewing records were visual and 70% (169/242) were heard calling. There was no obvious seasonal pattern to when the species was seen as opposed to heard. Laverick's results (2001) were almost the opposite: 72% (23/32) visual records and 28% (9/32) heard.

DISCUSSION

Many of the current observations gel with research findings summarized in Higgins & Davies (1996). Some are contrary. For example Gould's original notes indicated males called more often at evening, this study reported advertising calls in the morning. Ground-feeding and resting behaviour (under Coastal Wattle) are consistent with reports that it feeds mainly on native seeds and grit (to aid digestion). It is wary on open ground, flying off or walking quickly away when disturbed.

The results presented in **Figure 3** indicate that the Brush Bronzewing is an abundant species at both study areas between August and March. The observation of copulation and the apparent advertisement of territories suggest that birds recorded in this study were breeding, which is consistent with the August - February timing of breeding records in NSW (Cooper *et al.* 2014). The similarity in the number of records for the two breeding seasons (**Figure 3**) demonstrates a high level of site fidelity and, at least in the short term, a stable local population. However, Cooper *et al.* (2014) provide evidence of a long-term decline at the regional scale, which they suggested was associated with the increasing urbanization of coastal regions and the loss of heathland habitat.

There are two possible explanations for the dearth of records between March and July. One possibility is that the birds have moved away from the BL and BW. However, in general Brush Bronzewing are considered to exhibit limited seasonal movement (Griffieon & Clarke 2002) although there is some evidence of movement to the NSW coast in winter (Cooper *et al.* 2014; Marchant *in* Higgins & Davis 1996). An alternative explanation is more likely; the absence of records outside the breeding season is primarily associated with the low detectability of Brush Bronzewing other than when they are advertising territories.

The peak annual numbers (**Figure 3**) suggest that in combination BL and BW support a minimum of 20 to 30 pairs of Brush Bronzewing, assuming that the birds detected are primarily advertising males. Observed instances of advertising males in close proximity (30 m) suggests a high population density in suitable habitat.

The results provided in this note demonstrate the importance of BL and BW as prime habitat for Brush Bronzewing. The relatively undisturbed environment of these passive recreation areas and their management programs ensure that remnant coastal scrub continues to thrive alongside substantial re-planting of key native flora (BWSP Trust 2010). This is clearly conducive to the survival of the species. Many questions remain about its population size, movements, breeding and social behaviour. This study offers some guidelines on survey methods which will determine whether the species is present in other areas of apparently suitable coastal habitat during the breeding season. In the Hunter Region, breeding records are scarce; there is a single breeding record at Dudley in 1983 (Cooper *et al.* 2014). Unfortunately, there is no supporting information on the habitat, but Dudley is only 4 km north of Belmont. Neither nests nor fledglings have been reported at the Belmont location.

CONCLUSIONS

Surveys at BL and BW have demonstrated the presence of an apparently stable and relatively numerous population of Brush Bronzewing. It would be surprising if the distribution of this species is not more widespread than indicated by existing distribution data. This study provides survey protocols which should allow the presence/absence of Brush Bronzewing to be determined definitively in other coastal areas of the Hunter Region.

ACKNOWLEDGEMENTS

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Cooperative feeding among juvenile Australasian Figbirds

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Each summer between November and March young Australasian Figbirds *Sphecotheres vieilloti* come into the care of the Native Animal Trust Fund (NATF). Most of these are newly fledged chicks that have made an unsuccessful first flight and been found on the ground. If able to perch, ideally, these chicks should be placed on a tree branch where the parent birds can resume care and feeding. However, this is not well known, so that the chicks arrive in care as a result of well-intentioned human intervention.

While in care the juvenile figbirds are fed on a mixture of fruit, mince plus insectivore powder, calcium and High Protein Mix, mealworms and crickets. They remain in care until fully grown, are banded and released as a group. Time in care varies from just weeks to two months depending on size when admitted into care. It is the policy of NATF where possible to keep animals and birds of the same species together, particularly in the case of naturally flocking birds.

In such situations, it has been observed that young figbirds in care practise cooperative feeding, with the slightly older and larger birds feeding the younger ones. This is in the absence of any adult bird. While the first birds into care may need to be hand fed, as the group increases in size all feeding is done by the larger juveniles. The likelihood of birds becoming imprinted onto humans is greatly reduced as the need for human contact is eliminated.

The *Whistler* – Instructions to Authors

The *Whistler* is an occasional publication of the Hunter Bird Observers Club Inc. (HBOC), which is based in Newcastle. HBOC members are active in observing birds and monitoring bird populations in the Hunter Region. This journal-style publication is a venue for publishing these regionally significant observations and findings. The journal publishes three types of articles:

1. **Contributed Papers**
2. **Short Notes**
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Authors should consider the appropriateness of their study to this publication. The publication is suitable for studies either geographically limited to the Hunter Region or with obvious relevance to it. Papers attempting to address data and issues of a broader nature should be directed to other journals, such as *Corella*, *Australian Field Ornithology* and *Emu*. Contributed papers should include analyses of the results of detailed ecological or behavioural studies, or syntheses of the results of bird monitoring studies. These may include comprehensive annotated species lists of important bird areas and habitats. Such data would then be available for reference or further analysis in the many important issues of bird conservation facing the Hunter Region.

Communication of short notes on significant bird behaviour is also encouraged as a contribution to extending knowledge of bird habits and habitat requirements generally. Reviews of bird books are also solicited, with the intention of providing a guide for other readers on their usefulness regionally and more broadly.

General Instructions for Submission

Manuscripts should be submitted electronically; please attach your manuscript to an email as a Microsoft Word document. Charts should be submitted as an Excel file. Authors should adhere to the instructions for each type of submission:

Contributed Papers

- Manuscripts should be up to 12 pages in length (longer in exceptional circumstances) and of factual style.
- They should include a summary of approximately 250 words.
- An 'Introduction' or 'Background' section introduces the aims of and rationale for the study and cites any other work considered essential for comparison with the study.
- A section on 'Methods' describes the location of the study, citing map co-ordinates or including a map, and describing how observations were made and data were collected and analysed.
- A section on 'Results' includes description and/or analysis of data highlighting trends in the results; this may be divided into subsections if more than one body of data is presented; use of photos, drawings, graphs and tables to illustrate these is encouraged.
- A section headed 'Discussion' should attempt to set the results in a wider context, indicating their significance locally and/or regionally; comparison with national and international work is optional, as is the discussion of possible alternative conclusions and caveats; suggestions for future extension of the work are encouraged.
- A final section headed 'Conclusion[s]' gives a concise summary of findings, usually without introducing any new data or arguments.
- Appendices of raw data and annotated lists of bird species and habitats can be included in tabular form at the end of the article.
- References should be cited in brief within the text of the article, and full references should be listed at the end of the text after any Acknowledgements and before Appendices and Annotated Lists. References should be formatted as per the formatting instructions below.
- The preferred layout described above can be modified at the Editors' discretion.

Short Notes

- Should be no more than 4 pages of descriptive or prosaic style.
- Should provide an adequate description of the location of observations, a brief rationale for documenting the observations, and a cogent description of observations; similar relevant observations should be cited with references if appropriate.
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- Should be approximately 2 pages of critical assessment and/or appreciation.
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Formatting Instructions

Although not necessary, it may assist if authors format their manuscripts as follows:

1. A4 size page, portrait layout except for large tables or figures;
2. Margins 2 cm top, bottom, left and right;
3. Title in bold 16pt Arial font, centred;
4. Authors names in 12pt Arial font, centred;
5. Affiliations or addresses of authors, including email addresses, in Arial font, 10 pt size, centred;
6. Section headings capitalized in bold Arial font, 12 pt size, left justified;
7. Sub-section headings not capitalized in bold Arial font, 12 pt size, left justified;
8. First line of each paragraph should not be indented and one line should be left between paragraphs;
9. Typescript should be Times New Roman, 11 pt, except methods, acknowledgements and references which are 10 pt;
10. Figures and Tables to be included at the end of the document in Times New Roman font, 10 pt minimum size, title left justified, below figures and above tables with "**Figure x.**" or "**Table y.**" heading the title;
11. Nomenclature and classification of bird species should follow BirdLife Australia's "Working List of Australian Birds" which can be downloaded from: http://birdlife.org.au/conservation/science/taxonomy. The scientific names of all bird species should be shown in italics after the first mention of their English name in the text. Scientific names should also be included after the first mention of the bird in the summary.
12. References to be cited in the text in parenthesis as close as possible to the information taken from the paper: for one author (Smith 2000), two authors (Smith & Jones 2001b) and more than two authors (Smith *et al*. 2002) with the authors listed in the order they are listed on the original paper;
13. References should be listed in alphabetical order and secondarily by year of publication; if published in the same year then in alphabetical order with an a, b, or c after the year to indicate which paper is being cited in the text (see below); each reference should form a separate paragraph.

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