The Whistler

Bird species at Charlestown Golf Course
Varied Sittella in the Hunter
Swifts over the Hunter Region
Bird surveys at Cattai, Curracabundi and Saltwater
Red-browed Finch eats tadpoles

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

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Front cover: Varied Sittella *Daphoenositta chrysoptera* showing agonistic display - Photo: Chris Tzaros

Back cover: Red-browed Finch *Neochmia temporalis* - Photo: Bruce Hosken

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The *Whistler* - Editorial

While it is a pleasure to be directed to exactly the right site to see an unusual species, nothing is quite as exhilarating as stumbling upon unexpected birds when not specifically looking for them, or spontaneously experiencing an unexpected avian behaviour. By this we can learn something new, and we can communicate our new-found discoveries to others. Even those who live in the busy urban communities of the lower Hunter Valley are fortunate in having many opportunities to make such discoveries as they go about their daily lives, and as they enjoy activities that have little to do with bird-watching. Around Newcastle there are important pockets of rich habitat, many of them well connected with other areas able to support a variety of avian life: suitable habitat in some cases for breeding, in others for temporary residence, and in others for opportunistic feeding and foraging to break their journey. The idea of wildlife corridors may be relatively new to our deliberations, but the need for them has been felt by many bird species for much longer. *The Whistler* provides an opportunity to inform the community about the remarkable richness of the Hunter Region's bird population.

Golf courses offer green oases in close proximity to the suburbs, and though not the kind of exciting habitat that most of us crave to visit for the sake of seeing birds, they make a relatively easy area to check thoroughly for avian activity and a potential place for the golfer to experience and appreciate wildlife. Golfers have a historic association with birds dating back to 1903, with the names "birdie, eagle and albatross" reflecting the excellence of their play. While the courses they play on may not attract albatross they do provide a regular home for some species, as well as offering occasional foraging opportunities and additional connectivity for many others. This issue of *The Whistler* records the results of regular surveys at Charlestown Golf Course, which offers useful insights into the role a suburban golf course can play in supplementing the avian life of a region. Equally importantly it demonstrates how a bird project can contribute to increased community awareness of birds and the management of a shared environment. There are golf courses throughout Australia. This potential national opportunity was recognised by the Royal Australasian Ornithologists Union (now BirdLife Australia) during the 1990s in terms of initiating a 'Birds on Golf Courses' project which never eventuated. Congratulations to Grahame Feletti on demonstrating the merits of that proposal 20 years later.

This issue is unusual in having a strong focus on the north of our region, covering three sites, one coastal (Saltwater NP), one estuarial (Cattai Wetlands), and one in the foothills north-west of Gloucester (Curracabundi NP). These articles are all based on regular systematic surveys that provide a comprehensive picture of the site's avifauna over time (with occasional exceptions, such as nocturnal species). Though all these sites are valuable in their own right, it may plausibly be claimed that this is partly because of other nearby conservation areas. They are enhanced by their connectivity with other sites, and they in turn contribute to the well being of those other sites. Tellingly, all three authors discuss the connections of their sites with others in the area. The editors commend such studies of less well known sites, which are of greater scientific use than incidental sightings.

One bird that is observed less now than it once had been is the vulnerable Varied Sittella. Admittedly when one finds them they can be in quite good numbers because they have a collaborative lifestyle, but there is evidence that they have declined and even disappeared from some locations. Given their liking for drier woodland this is not wholly surprising, since many woodland birds are declining worryingly. This is therefore an appropriate time to reflect on the conservation requirements of this species and on how woodland habitat can be managed to support the ecological requirements of its unique life style.

There is also a relatively short article on swifts. Its main focus is the White-throated Needletail, including its Hunter Region distribution, though it is more difficult in this case to confine one's discussion to specific regions, or to specific habitats. Its natural habitat in Australia is the sky, but the insects it feeds on breed in the vegetation below, perhaps the ultimate extension of the concept of connectivity. The swifts visiting the Hunter Region breed elsewhere, further complicating attempts to understand changes in the status of these species. The article contains important information

for those wishing to contribute to a more complete knowledge of these species across the region. BirdLife Australia have recently stated that they consider the sub-species of White-throated Needletail which visits Australia is eligible for listing as Vulnerable under the *Environment Protection and Biodiversity Conservation Act* 1999 based on the decline exceeding 30 percent reported by Professor Tarburton in a paper published in 2014 in *Australian Field Ornithology*. This development highlights the value of community participation in data gathering and the importance of analysing and publishing the results of such studies. Congratulations to Mike and to all the swift watchers in the Hunter Region.

Regrettably, this issue has few short notes. One concerns mixed foraging flocks and is related to the Varied Sittella paper. Another concerns some unexpected delicacies on the menu of Red-browed Finches. Observations of a Noisy Miner with aberrant plumage are described. We once again urge Hunter Region observers to document unusual sightings and relatively minor contributions to ornithological knowledge by writing them up for possible publication. There is no shortage of people willing to lend a hand in the writing up of such notes, and the process should surely not prove too onerous. With the summer months upon us, and breeding behaviours and family associations to be observed, we urge readers to keep *The Whistler* in mind and to feel that they can contribute something to our knowledge of birds, and especially of birds in the Hunter Region.

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Bird species at Charlestown Golf Course NSW

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The local golf course is often overlooked as a community asset for sustaining native birdlife. This paper describes a project surveying bird communities at Charlestown Golf Club from 2012-2014. Of the 82 native species identified, 44% are either *Very Common* or *Common* species. 56% are *Uncommon* species and exhibit different patterns and timing to their visits. Neville Cayley's (1987) avian habitat model was adapted to classify the species as birds of *Freshwater, Open Forest, Forest Scrub* and *Blossoms and Outer Foliage*. Reports of species seen monthly, annual bird numbers and seasonal breeding records in different habitats are posted on the Golf Club's website. Golfers, staff and volunteers now report bird sightings and actively support bird welfare.

INTRODUCTION

Lake Macquarie is the largest permanent saltwater lake (approx. 110km^2) in the southern hemisphere - only slightly smaller than Port Stephens estuary 43km to the north-east. The Lake's southern margins are identified by BirdLife International as an Important Bird Area (IBA) because their remnant native eucalypt forests and coastal habitats support significant numbers of endangered species such as Regent Honeyeaters *Anthochaera phrygia* and Swift Parrots *Lathamus discolor* (Roderick & Stuart 2010). However, published inventories of common native birds in any local area adjacent to the Lake are surprisingly rare (Stuart 2009). This project (2012-2014) recorded bird species seen at a suburban golf course surrounded by dry sclerophyll forest on *Awabakal* land near the north-east side of the Lake. It was anticipated that this location would attract a cross-section of woodland, open forest and water-bird species, as well as those seen in blossoms and outer foliage.

Study Region and Site Description

The northern region of Lake Macquarie is mapped as supporting a range of vegetation corridors, rehabilitation corridors, remnant native vegetation and cleared areas (*Lake Macquarie Native Vegetation Corridors Map 2011*). These assist in movement of fauna, including some mammals and birds listed under the NSW *Threatened Species Conservation Act 1995* and known to occur in this area, within pockets of native vegetation.

Latest census data (2011) for suburbs adjacent to the study site show modest growth (6%) in numbers of residents and private dwellings in Warners Bay to its south-west and Charlestown to its east (http://www.censusdata.abs.gov.au). Of more concern are recent developments. Since 2009 large indoor recreational facilities, commercial warehouses and light industrial property were built up to 1km from the golf course. Access to these local facilities and cross-traffic on arterial roads surrounding the course and recreation reserve have dramatically increased traffic volume and background noise. As **Figure 1** shows, Hillsborough Road runs parallel to and only 120m from the course's northern border. Only 50-90m from its eastern side is the Inner City Bypass which links both roads with the Pacific Highway and Motorway (http://www.rms.nsw.gov.au/projects/hunter/).

Figure 1. Charlestown Golf Course aerial view showing surrounding forest, main roads and adjacent suburbs (Source: ©Google Maps. Accessed 15 October 2014.)

The study site is Charlestown Golf Club (CGC), an 18-hole public golf course (54ha) surrounded by dry sclerophyll forest (126ha) in suburban Hillsborough. The clubhouse is located at 32°57′44″S, 151°40′21″E, 67m above sea-level, and approximately 3km north-east of the Lake at Warners Bay. The land is leased from Lake Macquarie City Council (LMCC) until 2040, and is essentially open grass-land (fairways and greens) with a range of open-water sites and small areas of remnant native vegetation. Other endemic trees and native shrubs planted since 1974 include Swamp Mahogany *Eucalyptus robusta*, Tallowwood *E. microcorys*, and Turpentine *Syncarpia glomulifera*. The study area also includes a 25m wide perimeter of scrub in the surrounding forest, where birds could be seen or heard.

Recent mapping surveys indicate this whole area consists of three types of native forest (Bell, Driscoll & LMCC 2014). Each forest is defined by its dominant tree species providing a canopy, and has a unique (or *diagnostic*) set of shrubs and groundcover species underneath, as well as species in common with the other forests. The two main forest types overlapping are MU11: Coastal Sheltered Apple-Peppermint Forest and MU30j: Sugarloaf Lowlands Bloodwood-Apple-Scribbly Gum Forest; the third is MU30e: Coastal Plains Stringybark-Apple Forest. Several websites list the characteristic species for each forest type (see http://www.lakemac.com.au/). Recent flora surveys have listed well over 140 native species in the surrounding area.

To analyse the distribution of native birds recorded at this site, four avian habitats were adapted from Cayley (1987): *Freshwater* (lakes, streams and swamps), *Open Forest* (including birds of the air), *Forest Scrub* (mid-level shrubs and groundcover under canopy trees), and *Blossoms and Outer Foliage* (seasonal blooms and related food sources at tree, shrub and ground level).

Open Forest Habitat

Fairways and greens (open grasslands) are regularly fertilised, irrigated and mown (<2cm). Traversing natural slopes and gullies, each fairway is approximately 40m wide and bordered by mature trees of the open forest(s) and/or planted species. Their canopy is approximately 20-30m high, suitable for birds which hawk, forage, nest or defend territory along the fairways or course perimeter (approximately 3.8km).

Forest Scrub Habitat

The site has two areas of dense, mid-level vegetation diagnostic of the respective forest(s). One *forest scrub* area occurs 450m along its north-western perimeter, within the Apple-Peppermint Forest (MU11). This 2-6m scrub is mostly Black She-Oak *Allocasuarina littoralis,* Golden Wattle *Acacia longifolia*, Cheese Tree *Glochidion ferdinandi*, Sweet Pittosporum *Pittosporum undulatum,* Prickly–leaf Paperbark *Melaleuca stypheloides*, Egg and Bacon Pea *Dillwynia retorta* and several banksia species (Hairpin Banksia *Banksia spinulosa* var *spinulosa,* Old Man Banksia *B. serrata* and Rusty Banksia *B. oblongifolia*). The other *forest scrub* is a 1ha thin wedge along a wet gully inside the south-east corner of the Apple-Bloodwood-Scribbly Gum Forest (MU30j). Shrubs in this 2-5m tall scrub include Black She-Oak, Golden Wattle, Green Wattle *Acacia decurrens,* Hairpin Banksia and Tree Fern *Cyathea cooperi*. Dense (<1.5m) groundcover contains Bracken Fern *Pteridium esculentum,* Tussock Grass *Poa affinis,* Crofton Weed *Ageratina adenophera,* and Tall Saw-sedge *Gahnia clarkei.* Both areas offer protection, nesting sites and a range of food sources for small passerine species.

Freshwater Habitat

Club management has greatly improved the flow and use of water through the course, increasing its open-water catchment to nearly 4ha. As seen in **Figure 1** the course has a range of reliable water resources, including two main lakes (2.4ha, 0.5ha), three large dams (0.2-0.6ha), natural overflow channels, ponds, reed marshes and wet gullies – as suitable freshwater bird habitats. These come from rainfall, stormwater run-off into Winding Creek catchment and the adjacent Inner City Bypass. Heavy downpours on the course's clay and sandstone substrate can result in temporary surface water on some fairways, making them attractive to wetland birds. Sprinkler systems water fairways from lakes and dams during long, dry spells. This practice not only extends grass-growth periods but also reduces toxins in addition to exposing new foraging areas as water levels drop.

Blossoms and Outer Foliage Habitat

Remnant native vegetation of the respective forests and their understorey provide a range of blossoms and fruit for most of the year. As a general guide in this area, Tallowwood flowers from August to October; Smooth-barked Apple and Scribbly Gum

start from November; Red Bloodwood from February; and stringybark species flower from March into August. Spotted Gum *Corymbia maculata* and planted species like Swamp Mahogany may flower into early winter. Remnant native shrubs like Hairpin Banksia bloom through winter, and Golden Wattle into August (Moore & Fairley 2010). Other native shrub species that bloom prolifically during the year (*Acacia, Banksia, Callistemon, Grevillea spp*) have been planted around the course.

METHOD

Surveys involved (GF) walking a pre-set trail of 4-5 km over the course, spending similar time in nine (6ha) zones. Each survey took 2 hours between 6am and 10am, in fine weather to maximise detection of birds. The number and species, their observed location and activity were noted on a digital tape-recorder, plus comments on unusual sightings and time of day. These data were later transcribed, then became Excel files for analyses. Surveys were completed, typically 10 days apart, between 1 January 2012 and 31 December 2014. All species and the total number of each species on a given survey visit were recorded. This enabled calculations of average number (mean) and reporting rate (RR) for each species, where RR is the percentage of surveys for which each bird was observed. For this report, data from 100 surveys between 4 June 2012 and 31 December 2014 were analysed, although photographic evidence from earlier years was included (e.g. breeding records). Species' reporting rates were calculated from all 100 surveys, and for each season. Seasonal means and reporting rates were calculated for three-month periods (e.g. summer = December to February).

RESULTS AND DISCUSSION

Table 1 summarises the survey statistics. A total of 82 species were observed in the 31-month period, with the largest diversity (37 species) recorded in spring and summer, and the lowest diversity (17 species) in winter (June 2012). The maximum numbers of species recorded in winter and autumn were less than those for spring and summer; it was a similar story for average (mean) number of species per survey. More than 34,000 *bird-observations* were recorded in this period. Mean numbers per survey show a steady increase from winter to spring before peaking in summer. The maximum number of birds was greatest in summer (519 on 17 January 2013). There were abnormal peak numbers of Rainbow Lorikeet *Trichoglossus haematodus* (55), Australian Wood Duck *Chenonetta jubata* (111), Masked Lapwing *Vanellus miles* (38) and Welcome Swallow *Hirundo neoxena* (100+) that morning, compared with 7 January and 30 January 2013. The lowest number of birds seen (208 in winter 2012) coincided with the lowest number of species recorded.

The **Appendix** shows the maximum and mean number of each species recorded, grouped by their Reporting Rates (RR%). Species seen on 80% or more surveys *at this site* are described as *Most Common*. Birds in the second group, *Common* species, were observed on 20-79% of surveys, and those reported on less than 20% are *Uncommon* species. These RR% groupings are similar to the status definitions for reporting species at the (Hunter) regional level (Stuart 2014: 8).

19 species (23%) appear in the *Most Common* group; they are typically birds of Freshwater and Open Forest habitats. Species by species comparisons show their Reporting Rates at least 2-6 times higher than 16-year averages across the Hunter Region. RR% for Hardhead *Aythya australis*, Eurasian Coot *Fulica atra* and Little Corella *Cacatua sanguinea* are 10-13 times greater than regional RR% data. Noisy Miner *Manorina melanocephala* and Rainbow Lorikeet also belong in this group, perhaps due to the range of blossom available year-round, and their flexible diet. Even for this group of species seen almost every survey,

Table 1. Summary of survey statistics

	All Surveys	Winter	Spring	Summer	Autumn
Number of surveys	100	29	31	21	19
Species recorded	82	33	37	37	32
Average/survey	28.5	26.7	30.7	29.3	26.7
Minimum	17	17	22	19	21
Maximum	37	33	37	37	32
Bird observations	34,126	9,193	10,467	8,246	6,220
Average/survey	341	317	338	393	328
Minimum	208	208	223	280	229
Maximum	519	468	445	519	425

variations in their numbers suggest that some individuals are nomadic while others are *sedentary* (remain on site). Survey data also show the numbers of Australian Wood Duck and Pacific Black Duck *Anas superciliosa* peak in mid- to late summer; this may be due to birds returning to more reliable water and food sources on site at that time of season. The *Most Common* water-birds listed (except Dusky Moorhen *Gallinula tenebrosa* and Hardhead) often forage on moist fairways and greens, but these species move to larger water sites if disturbed.

Common species as a group involved similar numbers of species (17 species, 21%) as the *Most Common* group*;* they also occurred in the same two habitats. Reviews of monthly field notes suggested that the range of several *Common* species characteristic of Open Forest extended beyond the golf course (Nankeen Kestrel *Falco cenchroides*, Black-faced Cuckoo-shrike *Coracina novaehollandiae,* Pied Currawong *Strepera graculina* and Yellow-tailed Black-Cockatoo *Calyptorhynchus funereus*). Many Freshwater birds in this group may also be nomadic, moving locally between the golf course and Lake Macquarie or other wetlands in the vicinity (see e.g. Common Locations given Grid References M10 or L10 on pp. 121-22 of Stuart 2014). This behaviour may be seasonal or nomadic (i.e. unpredictable) involving both species known to reside in the Region and others known to migrate to the Hunter in summer to breed (Dollarbird *Eurystomus orientalis,* and Channel-billed Cuckoo *Scythrops novaehollandiae*).

Uncommon species form the largest group observed at the course (46 species, 56%). It includes many small passerines seen foraging or moving through Blossoms/Outer Foliage or Forest Scrub habitats around the perimeter of the course. Reviews of consecutive survey data and field notes helped differentiate whether such movements were nomadic, migratory or reflected limited observation of timid species. Up to 15 *Uncommon* (and five *Common* species) marked by * in the **Appendix** were spring-summer visitors. This group includes Latham's Snipe *Gallinago hardwickii* and Black-fronted Dotterel *Elseyornis melanops*, seen foraging on mudflats of large dams and lakes when water levels were down. Small flocks of Musk Lorikeet *Glossopsitta concinna* were seen in May 2014 actively feeding on Swamp Mahogany blossom along fairways. A number of species were seen intermittently in forest scrub on the north-west and south-east perimeters of the course. These include Eastern Yellow Robin *Eopsaltria australis*, Silvereye *Zosterops lateralis*, Striated Pardalote *Pardalotus striatus*, White-browed Scrub-wren *Sericornis frontalis* and Rufous Fantail *Rhipidura rufifrons*. More recent surveys suggest that very low reporting rates for some species may be due to low detectability of timid species (Australian King-Parrot *Alisterus scapularis,* Crimson Rosella *Platycercus elegans*, and Red-browed Finch *Neochmia temporalis*).

Plumed Whistling-Duck *Dendrocygna eytoni* was an unusual sighting, occurring as a summer *vagrant***.** It is resident in only one or two sites in the Upper Hunter (Stuart 2014). However, over consecutive summers, typically after a north-westerly storm front has passed, small mobs (12-25) suddenly appeared, loafing (warily) for 1-3 days beside the eastern lake.

Table 2 integrates two sets of bird data – the species grouped by relative frequency of occurrence (RR%) and the four avian habitats in which they were seen most often in this study. From this overview it appears that each habitat type on the golf course is used by a range of species. Only two *Most Common* species (Noisy Miner, Rainbow Lorikeet) were predominatly found in Blossoms/Outer Foliage, and the *Most Common* group was absent from Forest Scrub. Overall, almost identical numbers of species were seen in Freshwater (27) and Open Forest (28) habitats. Similar numbers of species were observed in Forest Scrub (12) and in Blossoms/Outer Foliage (15) habitats. The row for *Uncommon* species shows a number of species was observed in each of the four avian habitats.

Area surveys done 10 days apart are not ideal for determining which species were breeding, but field notes and digital photographs provide a useful basis for further observations in specific areas. Using the criteria defined in Stuart (2014, p. 1) those species showing unambiguous breeding activity or success are indicated in **Table 2** in bold type, and summarised in column and row margins. For this report Breeding Activity (BA) includes adult pairs on or emerging from a nest site, nestlings, dependent young being fed or accompanied by adult birds, and displaced fledglings. BA was recorded for 30/82 (37%) species, including all *Most Common* species except Hardhead. Pairs of Pacific Black Duck and Australian Wood Duck were recorded as 'tree-nesting' on the course, typically in hollow trunks of Scribbly Gum and Smooth-barked Apple. Some

Table 2. Species and breeding activity grouped by Reporting Rate (RR) and avian habitat type at Charlestown Golf Course 2012-2014

	Freshwater	Open Forest	Forest Scrub	Blossoms/Outer Foliage	Total
Most common RR >80%	**Australian Wood Duck** **Pacific Black Duck** **Purple Swamphen** **Dusky Moorhen** **Eurasian Coot** **Masked Lapwing** Hardhead	**Eastern Rosella** **Laughing Kookaburra** **Crested Pigeon** **Australian Magpie** **Little Corella** **Sulphur-crested Cockatoo** **Australian Raven** **Galah** **Magpie-lark** **Pied Butcherbird**		**Noisy Miner** **Rainbow Lorikeet**	19 (23%) BA=18
Common RR 20-79%	**Australasian Grebe** Little Black Cormorant Little Pied Cormorant White-faced Heron	Welcome Swallow Grey Butcherbird Pied Currawong **Black-faced Cuckoo-shrike** **Nankeen Kestrel** **Dollarbird** **Sacred Kingfisher** Yellow-tailed Black-Cockatoo Channel-billed Cuckoo Willie Wagtail	Eastern Whipbird	Yellow-faced Honeyeater **Spotted Pardalote**	17 (21%) BA=6
Uncommon RR <20%	Chestnut Teal Grey Teal Straw-necked Ibis Latham's Snipe Great Egret Royal Spoonbill Australian White Ibis **Black Swan** Australian Darter Buff-banded Rail Pied Cormorant Black-fronted Dotterel Plumed Whistling-Duck White-necked Heron Cattle Egret Little Egret	Spotted Dove **White-breasted Woodswallow** Crimson Rosella Australian King-Parrot Fork-tailed Swift Pacific Baza Swamp Harrier Peregrine Falcon	**Superb Fairy-wren** Golden Whistler Fan-tailed Cuckoo Eastern Koel **Olive-backed Oriole** Grey Fantail Variegated Fairy-wren White-browed Scrubwren **Red-browed Finch** Eastern Yellow Robin Rufous Fantail	Brown Thornbill Eastern Spinebill **Scaly-breasted Lorikeet** Red Wattlebird Silvereye Musk Lorikeet Noisy Friarbird Striated Pardalote Lewin's Honeyeater Yellow Thornbill Striated Thornbill	46 (56%) BA=6
Total	27 (33%) BA=8	28 (34%) BA=15	12 (15%) BA=3	15 (18%) BA=4	82 BA=30

Species in each category are listed in order of decreasing Reporting Rate (RR%). Breeding Activity (BA) recorded at CGC for a species is indicated in **bold type**.

ground nest sites were also recorded, but most ducklings just 'appeared' with adult birds on open grassland or freshwater. Observed at 10-day intervals their numbers seem depleted; potential predators include eels, snakes, lizards, foxes, stray dogs and other bird species.

Records since 2012 show eleven of the golf course's *Common* and *Uncommon* species bred successfully over spring-summer including: Dollarbird, Sacred Kingfisher *Todiramphus sanctus*, Channel-billed Cuckoo, White-breasted Woodswallow *Artamus leucorhynchus*, Olive-backed Oriole *Oriolus sagittatus*, and Eastern Koel *Eudynamys orientalis*. *Uncommon* species that bred successfully on site include: Superb Fairy-wren *Malurus cyaneus*, Red-browed Finch, Spotted Pardalote *Pardalotus punctatus*, Scaly-breasted Lorikeet *Trichoglossus chlorolepidotus*, and Crimson Rosella. Multiple pairs of some *Common* and *Uncommon* species (Nankeen Kestrel, Dollarbird, Sacred Kingfisher and Olive-backed Oriole) were recorded breeding in the same area each summer.

Digital photographs (©Ken Wells, a 'golfing photographer') date-stamped between 2006 and 2011 indicated breeding by a number of species recorded in this study as *Uncommon* visitors. A pair of Black Swan *Cygnus atratus* raised four cygnets on the site in 2010. While surveys record several visits from this species since then, no breeding activity has occurred.

CONCLUSIONS

Morning surveys by a single observer are effective, but preclude seeing some insectivore, raptor and other species reported later in the day, or nocturnal species heard in the local area (Masked Owl *Tyto novaehollandiae*, Tawny Frogmouth *Podargus strigoides* and Powerful Owl *Ninox strenua*). Changes to survey methods, focus areas and time of day would increase the species list. The diversity of species and numbers of birds recorded each season and year seem impressive for a suburban public golf course, especially when reporting rates are compared with Hunter Region data. However, no published lists from similar or nearby sites were found. This study shows 44% of species are in the *Common* and *Most Common* categories on the course or in adjacent forest. Previously-installed nesting boxes, and natural tree hollows by 'stagging' dead limbs have attracted not only woodland species (especially parrots, galahs, cockatoos, corellas, lorikeets and rosellas) but also tree-nesting duck species. The course's open water sites and watered fairways are also popular with species from different habitat types.

Charlestown Golf Club proactively manages this public course in a manner which is sympathetic to its wildlife and welcomes collaborative support. The surrounding dry sclerophyll forest and its diverse sub-canopy scrub is also an important community asset. One striking outcome of this study is that "green areas" like this maintain a refuge of high species diversity within the cities, thus decreasing the risk of local extinctions. Breeding activity has been recorded for many species on the course or along its perimeter. These results support Lake Macquarie Native Vegetation Corridors Map (2011) showing tracts of remnant native forest are well-used by species moving along, or breeding in, these vegetative corridors. As such, this dry sclerophyll forest with its rich annual floral harvest and protective vegetation should not be compromised by further residential or commercial development. The adverse effects of such rapid exploitation on local and migrant woodland bird populations have been documented (Rayner *et al.* 2015).

The golf course's role as a breeding site for native species, particularly smaller *Passerines* is still unfolding. More obvious is its attraction to sizeable flocks of *Psittaciformes* and *Anatidae* species. Its lakes and adjacent fairways are well-populated by both *Most Common* and *Common* species seen at this site, particularly in spring-summer. However, due to weed control and golfing requirements the Club cannot provide protected breeding sites for ground-nesting birds. This may explain why some ducks (e.g. Hardhead, Chestnut Teal *Anas castanea*) are not observed breeding on its freshwater sites.

Reporting rates on the 82 observed species were also compared with accumulated survey data (Birdata Atlas Hunter 2012-14) from the 10-minute cell (area M10), in which the golf course is located. Analyses showed only eight species had RR>19% (reflecting regular occurrence) at both the golf course and in this data cell, but the reporting rates for six of them were 2-4 times higher at this golf course than those across all other sites in M10. Such results demonstrate the importance of Charlestown Golf Club and environs in supporting the avian diversity of the area. Data from other golf courses or similar public reserves in M10 may help us better understand how to support bird populations at such sites.

One further outcome of this project is the ongoing interaction with various community members and resources, acknowledged below. Golfers and golf club staff show growing awareness of local birdlife; they often share bird sightings and ask questions. Items of interest are now posted monthly on the Club's website under Newsletter/ Birdlife (http://www.charlestowngolfclub.com/). Recently (January 2015) ground staff rescued three young Dollarbirds, fallen from separate nests on different days. Contact was made with local bird-rescue volunteers who collected them. Hunter Bird Observers Club members and local veterinarians have also provided relevant information for staff on bird welfare and handling.

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APPENDIX

Species observed during 100 surveys at Charlestown Golf Club from 2012 to 2014, presented by Common and Scientific Names, with Maximum and Mean numbers, and grouped by Reporting Rate (RR %).

Most Common species (RR >80%)

Common Name	Scientific Name	Maximum	Mean	RR (%)
Australian Wood Duck	*Chenonetta jubata*	159	69.9	100.0
Pacific Black Duck	*Anas superciliosa*	52	13.4	100.0
Purple Swamphen	*Porphyrio porphyrio*	27	12.6	100.0
Dusky Moorhen	*Gallinula tenebrosa*	53	18.5	100.0
Eurasian Coot	*Fulica atra*	44	22.4	100.0
Masked Lapwing	*Vanellus miles*	58	26.5	100.0
Eastern Rosella	*Platycercus eximius*	46	21.4	100.0
Laughing Kookaburra	*Dacelo novaeguineae*	25	9.1	100.0
Crested Pigeon	*Ocyphaps lophotes*	23	9.8	99.0
Noisy Miner	*Manorina melanocephala*	43	17.1	99.0
Australian Magpie	*Cracticus tibicen*	36	15.0	99.0
Rainbow Lorikeet	*Trichoglossus haematodus*	85	19.7	97.0
Little Corella	*Cacatua sanguinea*	158	37.9	90.0
Sulphur-crested Cockatoo	*Cacatua galerita*	40	7.3	89.0
Australian Raven	*Corvus coronoides*	18	5.0	89.0
Galah	*Eolophus roseicapillus*	18	5.4	87.0
Magpie-lark	*Grallina cyanoleuca*	10	2.9	86.0
Hardhead	*Aythya australis*	14	3.7	83.0
Pied Butcherbird	*Cracticus nigrogularis*	15	4.0	83.0

Common species (RR 20%-79%)

Common Name	Scientific Name	Maximum	Mean	RR(%)
Welcome Swallow*	*Hirundo neoxena*	100	8.2	76.0
Grey Butcherbird	*Cracticus torquatus*	8	2.8	72.0
Pied Currawong	*Strepera graculina*	5	1.8	67.0
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	6	2.3	59.0
Nankeen Kestrel	*Falco cenchroides*	6	2.0	55.0
Australasian Grebe	*Tachybaptus novaehollandiae*	5	2.0	54.0
Little Black Cormorant	*Phalacrocorax sulcirostris*	4	2.1	54.0
Little Pied Cormorant	*Microcarbo melanoleucos*	7	1.4	48.0
Eastern Whipbird	*Psophodes olivaceus*	3	1.3	32.0
Yellow-faced Honeyeater	*Lichenostomus chrysops*	15	2.7	28.0
White-faced Heron	*Egretta novaehollandiae*	9	1.6	27.0
Dollarbird*	*Eurystomus orientalis*	8	3.4	27.0
Sacred Kingfisher*	*Todiramphus sanctus*	6	2.0	24.0
Spotted Pardalote	*Pardalotus punctatus*	9	2.4	24.0
Yellow-tailed Black-Cockatoo*	*Calyptorhynchus funereus*	50	8.7	23.0
Channel-billed Cuckoo*	*Scythrops novaehollandiae*	4	2.0	22.0
Willie Wagtail	*Rhipidura leucophrys*	2	1.2	20.0

Reporting Rate (RR%) is the percentage of surveys that each species was seen. Maximum and mean indicate each species' abundance. Mean number is based only on surveys when the species was seen/recorded. Asterisk * indicates that species was a summer migrant or bird of passage on the course.

Uncommon species (RR <20%)

Common Name	Scientific Name	Maximum	Mean	RR(%)
Chestnut Teal	*Anas castanea*	2	1.7	19.0
Spotted Dove	*Streptopelia chinensis*	2	1.5	19.0
Superb Fairy-wren	*Malurus cyaneus*	5	2.5	19.0
Brown Thornbill	*Acanthiza pusilla*	6	3.0	19.0
Grey Teal	*Anas gracilis*	4	1.7	15.0
Golden Whistler*	*Pachycephala pectoralis*	4	1.5	15.0
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	4	1.5	13.0
Straw-necked Ibis	*Threskiornis spinicollis*	6	2.4	12.0
Eastern Koel*	*Eudynamys orientalis*	4	1.4	12.0
Olive-backed Oriole*	*Oriolus sagittatus*	5	2.2	12.0
Latham's Snipe*	*Gallinago hardwickii*	2	1.2	11.0
White-breasted Woodswallow*	*Artamus leucorhynchus*	6	4.0	11.0
Great Egret	*Ardea alba*	5	1.7	10.0
Eastern Spinebill	*Acanthorhynchus tenuirostris*	3	1.4	10.0
Crimson Rosella	*Platycercus elegans*	1	1.0	9.0
Grey Fantail	*Rhipidura albiscapa*	1	1.0	9.0
Royal Spoonbill*	*Platalea regia*	2	1.1	8.0
Australian King-Parrot	*Alisterus scapularis*	6	2.5	8.0
Variegated Fairy-wren	*Malarus lamberti*	6	4.3	8.0
White-browed Scrubwren*	*Sericornis frontalis*	2	1.7	7.0
Red-browed Finch	*Neochmia temporalis*	6	2.4	7.0
Australian White Ibis	*Threskiornis molucca*	9	2.8	6.0
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	5	2.2	6.0
Red Wattlebird	*Anthochaera carunculata*	5	3.7	6.0
Silvereye*	*Zosterops lateralis*	6	2.7	6.0
Black Swan	*Cygnus atratus*	3	1.8	5.0
Australian Darter*	*Anhinga novaehollandiae*	1	1.0	4.0
Pied Cormorant	*Phalacrocorax varius*	2	1.3	4.0
Black-fronted Dotterel*	*Elseyornis melanops*	3	1.8	4.0
Musk Lorikeet	*Glossopsitta concinna*	16	9.0	4.0
Noisy Friarbird	*Philemon corniculatus*	2	1.3	4.0
Eastern Yellow Robin	*Eopsaltria australis*	2	1.3	4.0
Plumed Whistling-Duck*	*Dendrocygna eytoni*	25	12.7	3.0
Fork-tailed Swift*	*Apus pacificus*	2	1.7	3.0
Pacific Baza	*Aviceda subcristata*	2	2.0	3.0
Swamp Harrier*	*Circus approximans*	1	1.0	3.0
Peregrine Falcon	*Falco peregrinus*	1	1.0	3.0
Buff-banded Rail	*Gallirallus philippensis*	1	1.0	3.0
Striated Pardalote*	*Pardalotus striatus*	6	3.3	3.0
Lewin's Honeyeater	*Meliphaga lewinii*	2	1.3	3.0
Yellow Thornbill	*Acanthiza nana*	2	2.0	2.0
White-necked Heron*	*Ardea pacifica*	1	1.0	1.0
Cattle Egret	*Ardea ibis*	1	1.0	1.0
Little Egret	*Egretta garzetta*	1	1.0	1.0
Rufous Fantail*	*Rhipidura rufifrons*	1	1.0	1.0
Striated Thornbill*	*Acanthiza lineata*	3	3.0	1.0

Reporting Rate (RR%) is the percentage of surveys that each species was seen. Maximum and mean indicate each species' abundance. Mean number is based only on surveys when the species was seen/recorded. Asterisk * indicates that species was a summer migrant or bird of passage on the course.

Varied Sittellas in the Hunter: distribution, habitat and threats

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The Varied Sittella *Daphoenositta chrysoptera* is a widely distributed but relatively uncommon species in the Hunter Region, consistent with its occurrence elsewhere. Long-term monitoring in the Paterson area of the Hunter Region has demonstrated that remnant woodland on farms and protected public lands provides important habitat for this species.

In the Paterson area studies there was evidence of a long-term decline in the status of the Varied Sittella with the frequency of occurrence decreasing by more than 50% in the last decade. A similar magnitude of decline during this period was apparent in the results of BirdLife Australia Birdata area surveys for the whole of the Hunter Region. However, this decline, which was statistically significant, was not apparent throughout the broader bio-region of the east coast of Australia.

Clearing of remnant vegetation, particularly the selective removal of the rough-barked tree species which provide food for sittellas was suspected to have contributed to the decline in the Paterson area studies. As observers primarily encounter sittellas in modified habitat, particularly near roads, habitat loss and gradual degradation provide a plausible cause of the observed decline throughout the Hunter Region.

The status of the Varied Sittella, which exclusively forages on the trunks and branches of trees, is considered to be limited by food availability. As an adaptation to these circumstances sittellas form collaborative groups and clans which occupy large territories. Any factor which decreases food availability, such as the removal of the preferred rough-barked trees, would be expected to decrease sittella numbers and increase their vulnerability to factors such as drought, which may cause short-term fluctuations in food availability.

It would be courageous for land managers to assume that the widespread distribution of the Varied Sittella provides a buffer against processes threatening the status of the species. Evidence presented in this paper suggests that the species may favour modified and even fragmented habitats when they occur adjacent to larger patches of remnant vegetation. However, if such habitat is progressively degraded across the landscape, as appears to be occurring in the Hunter Region, the level of threat to the species' viability will inevitably increase.

INTRODUCTION

The Varied Sittella *Daphoenositta chrysoptera*, which is listed as Vulnerable under the NSW *Threatened Species Conservation Act 1995* is not a common species in the Hunter Region. In north-eastern NSW Varied Sittellas occurred in sedentary groups or clans holding weakly-defended territories of 13-20ha (Noske 1998). Observations in the Hunter Region, where this species is intermittently encountered in woodland areas, are consistent with this lifestyle.

The BirdLife Australia (BLA) Atlas archive Birdata provides information on the distribution of the Varied Sittella in the Hunter Region. However, for relatively uncommon species like the sittella interpretation of temporal trends in occurrence is difficult because of a combination of inadequate survey sample sizes and variation in survey effort. Fortunately, within large data sets like BLA Birdata there are subsets of information which have been generated with rigid control of survey method and effort in areas of defined habitat. A number of such studies were conducted by the author in the Paterson area of NSW between 1996 and 2013 and these provide insights into the status and conservation requirements of the Varied Sittella.

Varied Sittellas are mostly found in eucalypt woodlands and forests where rough-barked trees and mature eucalypts with hollows and dead branches are present (Higgins & Peter 2002). Noske (1985 & 1998) suggests that group-living and philopatry in the Varied Sittella probably developed to increase foraging efficiency. Noske further suggests that large territories, feeding of the

incubating female, as well as a specialised foraging niche and cryptic prey, all suggest that food may be limiting for this species.

This paper examines the Varied Sittella's status and habitat preferences in the Hunter Region, with emphasis on studies in the Paterson area.

METHODS

The analysis presented herein is based on observations undertaken across the entire Hunter Region and includes more comprehensive long-term datasets in several locations (e.g. Green Wattle Creek, Butterwick and *Warakeila* and other sites; see **Table 5** below). Most of the survey data was submitted to the BLA Atlas and is available in their Birdata archive. All the Birdata records for the period 1998 to 2014 for the Hunter Region were obtained in 2015. Survey data was separated into two categories for analysis:

- 2ha surveys - which involved listing all bird species present in a 2ha area during a 20-minute survey.

- Area surveys - which involved listing all species present in areas bounded by a radius of either less than 500m or less than 5km. While there is no constraint on survey time in this data set, most surveys were conducted within a 24-hour period.

Other data sources containing sittella records such as the Atlas of NSW Wildlife were not considered.

Distribution

Results from both survey types were combined to determine the distribution of Varied Sittellas in the Hunter Region.

Reporting Rates

Annual reporting rates (RRs) indicating the frequency of occurrence of Varied Sittellas in the Hunter Region, were calculated as a percentage of the number of surveys conducted in 10-minute grid blocks where Varied Sittellas have been recorded at least once between 1998 and 2013 (i.e. surveys in grids where the Varied Sittella had not been recorded were ignored). RRs calculated in this manner avoid dilution from surveys conducted in unsuitable habitat. RRs were also calculated for individual survey sites.

2ha surveys generate the most consistent data because the area and duration (20 minutes) of the survey are constant. However, RRs are low for scarce species like the Varied Sittella making it difficult to draw statistically significant conclusions concerning differences between temporal changes in the frequency of occurrence and the relative importance of different survey sites without very large numbers of this type of survey.

Area surveys usually involve more effort in terms of both the area covered and the time spent searching for species. While this results in higher RRs for sparse species the survey effort is often variable, confounding comparisons between sites and temporal analysis using this source of data. However, there are some long-term data sets involving area surveys where the survey effort was constant as discussed in the next section.

During the subsequent presentation and discussion of results any percent values reflecting the frequency of occurrence of sittellas have been calculated as reporting rates.

Constant survey effort data sets

Most of the work described below involved studies in which surveys, both 2ha and area, were conducted in an identical manner. In the case of area surveys a constant route through the survey site was used, with approximately the same survey duration on every occasion. Consequently, temporal variations in the RRs at these sites were not affected by variations in survey effort. However, there were differences in the size of the area searched and survey duration between studies at different locations which compromised inter-site comparisons. Because all 2ha surveys were conducted with the same survey effort (i.e. 2ha searched for 20 minutes), between-sites comparisons were possible. For instance, a statistically significant difference in occurrence of Varied Sittellas between two 2ha survey sites may indicate a difference in the suitability of the habitat at and surrounding the sites (i.e. the survey site is a sample of the habitat at that location).

Four data sets involved a hybrid survey technique in which a number, usually four, of 2ha sites were embedded in an area survey conducted along a fixed route between the 2ha sites. These studies (Newman 2006 & 2009; Newman & Lindsey 2008) were part of the Royal Australasian Ornithologists Union (now BLA) Birds on Farms project and a fourth unpublished shorter term study used a similar design. For the hybrid survey studies the total survey data was a combination of all the species recorded at the 2ha sites and during the fixed route walk between the sites. Hence the 2ha and total survey results in the hybrid studies are not independent. In analysing the results of hybrid surveys the entire survey is treated as an area search (i.e. the combined records at 2ha sites and those made while walking between the sites) and is reported as the "hybrid" value in **Tables 2**, **3** and **4**.

Response to weed removal and fire

A sub-project was conducted at Green Wattle Creek (Newman 2014b) to determine the response of woodland birds, including the Varied Sittella, to habitat management using a combination of controlled burns and manual removal of invasive weeds (e.g. lantana). Three 2ha sites, Post-burn 1, Post-burn 2 and Post-burn 3, were subjected to both weed removal and controlled burns conducted in spring 2010 (Post-burn 3) and autumn 2011 at the other two sites. Weeds were removed at a fourth 2ha site (Rehab), but it was not burnt. The 2ha surveys were conducted in three campaigns, two in spring and one in autumn, over an 18-month period in 2012 and 2013.

RESULTS

Hunter Region

The Varied Sittella is widely distributed in the Hunter Region (**Figure 1**) with records from just over half the 151 ten-minute grids which comprise the region. However, within that range it is relatively infrequently recorded with a RR of 6.9% in area surveys (**Table 1**). Records of the Varied Sittella in the Hunter Region submitted to the BLA Birdata archive between 1998 and 2014 are summarised in **Table 1**.

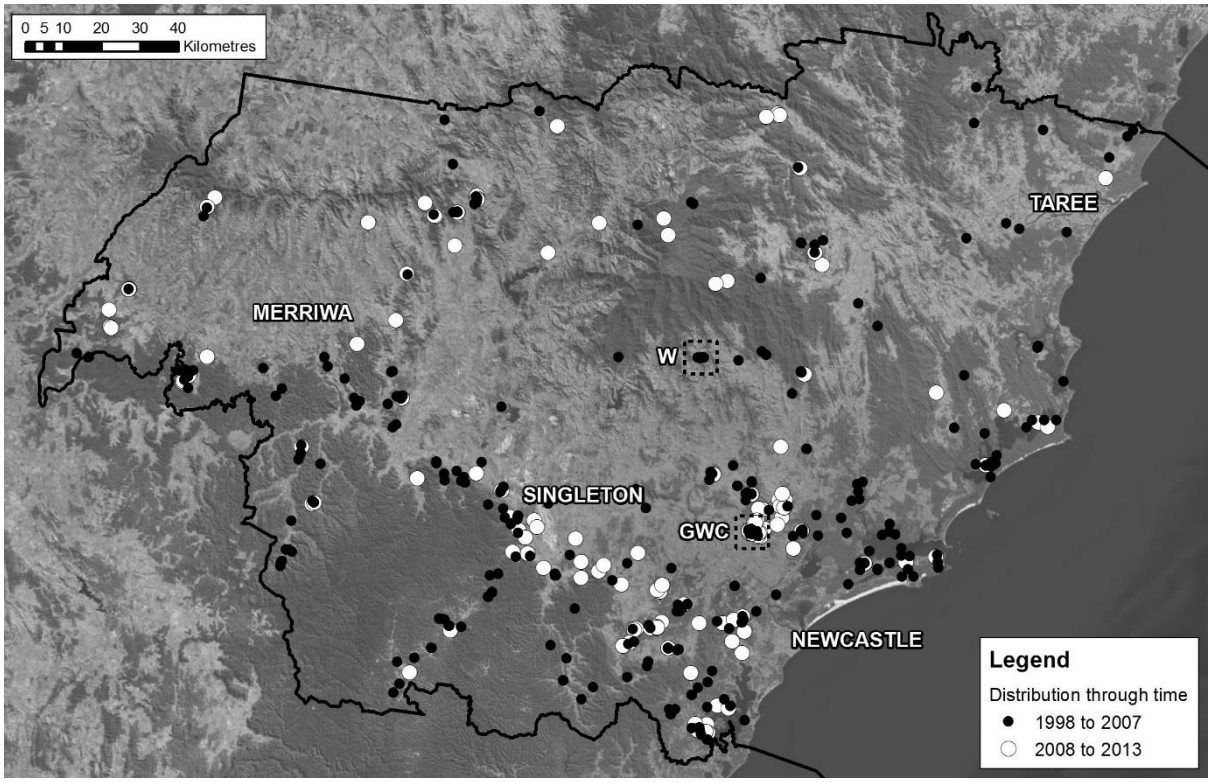

Figure 1. The distribution of Varied Sittellas in the Hunter Region of NSW. The two boxed areas indicate locations where long-term studies were conducted at Green Wattle Creek and the adjacent Butterwick cattle property (GWC) near Paterson and at *Warakeila* (W) in the Allyn River valley.

Table 1. Summary statistics of Varied Sittella records submitted to the BLA Birdata archive for the period 1998-2014.

Survey Method	Varied Sittella records	Number of surveys	Reporting Rate (%)	10-minute grids[1]	Hunter coverage (%)
Area	656	9471	6.9	79	52
2ha	108	3767	2.9	33	22
Combined	764	13238	5.8	84	56

[1] The Hunter Region comprises 151 grids of 10-minute latitude/longitude size.

There was a statistically significant decline in the occurrence of Varied Sittellas in area surveys conducted in the Hunter Region during the period 1998-2014 as shown in **Figure 2**.

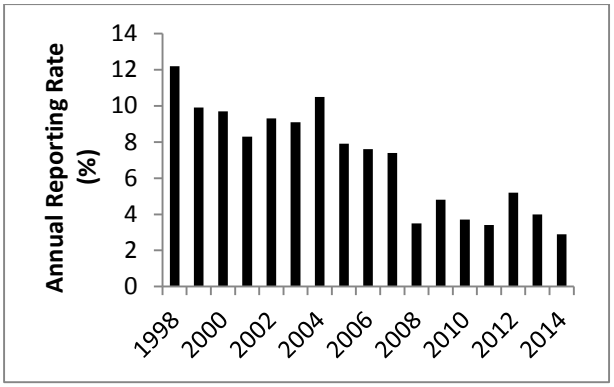

Figure 2. The variation of the annual reporting rate of Varied Sittellas in area surveys for the Hunter Region for the period 1998-2014. The mean number of surveys/annum was 525. The linear correlation factor *r* of -0.92 (n=17) was statistically highly significant ($p<0.01$).

Green Wattle Creek
(32.661°S 151.649°E)

Surveys were conducted monthly between 1996 and 2013 in remnant forest at the end of Green Wattle Creek Road, Butterwick. This land is an 81-hectare Crown Conservation Reserve (Reserve No. 1014828), which is currently reserved for the public purpose of Environmental Protection. It is currently subject to a 15-year incentive Property Vegetation Plan through the Hunter Local Land Services. The hybrid survey technique, survey sites and habitat are described in Newman (2009). The area was historically grazed and logged and there were no wildfires since at least 1992. Observations of Varied Sittellas are summarised in **Table 2**. Varied Sittellas were recorded at all four 2ha sites with an average frequency of 2.3%. They occurred most frequently at site 2 where the habitat initially involved open woodland. However, trees were progressively removed from this site up to the edge of the bordering wetter creek-zone vegetation. Five of the seven records occurred during the period 1996 – 2001 and other than two records in 2005 there were no subsequent records, suggesting that habitat modification had rendered the site unsuitable for sittellas. The majority of the records involved sittellas encountered while walking between the 2ha survey sites. Sittellas were recorded during 31.7% of the hybrid surveys, which took approximately four hours, with evidence of decline during the second half of the study (**Figure 3)**.

Table 2. Records of the Varied Sittella during 186 monthly surveys in woodland at Green Wattle Creek near Paterson, NSW between 1996 and 2011.

Site	Reports	RR (%)	Surveys
1 (2ha)	4	2.2	186
2 (2ha)	7	3.8	186
3 (2ha)	3	1.6	185
4 (2ha)	3	1.6	184
All 2ha	17	2.3	741
Hybrid	59	31.7	186

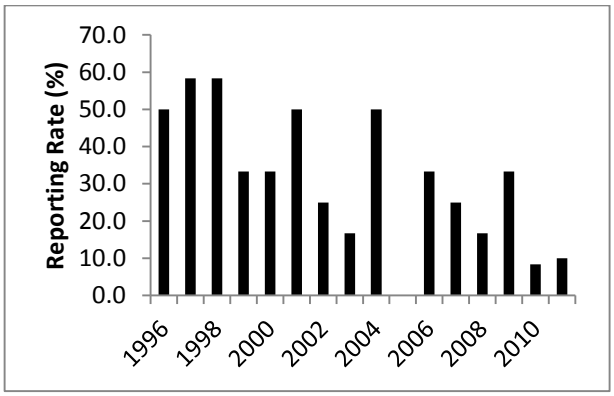

Figure 3. Variation in annual RR of Varied Sittellas during monthly fixed-route surveys of four hours' duration in woodland at Green Wattle Creek between 1996 and 2011.

Farm Studies

The three farm studies involved the hybrid survey approach using a combination of area and 2ha surveys. At *Yaraandoo* surveys were also monthly, but over a more limited period from 2010 to 2013. The Butterwick (1996 to 2013) and *Warakeila* (1996 to 2010) studies involved surveys at three-monthly intervals. Results for the Butterwick and *Warakeila* properties are discussed in the following sections. The *Yaraandoo* results are contained in the subsequent section on other large data sets.

Cattle property at Butterwick
(32.655°S 151.640°E)

Surveys were conducted quarterly between 1996 and 2011 on a property at Butterwick adjacent to Green Wattle Creek Road and the Green Wattle Creek Crown Reserve. The hybrid survey technique, survey sites and habitat are described in Newman (2006). The Varied Sittella records are summarised in **Table 3**.

Table 3. Records of the Varied Sittella during 64 quarterly surveys on a cattle property at Butterwick near Paterson, NSW between 1996 and 2011.

Site	Records	RR (%)	Surveys
1 (2ha)	5	7.9	63
2 (2ha)	1	1.6	64
3 (2ha)	4	6.3	64
4 (2ha)	6	9.4	64
Combined 2ha	16	6.3	255
Hybrid	18	28.1	64

The property has about 15% remnant vegetation in which the four 2ha sites were located. Sittellas were recorded at all four 2ha sites at an average RR of 6.3%. Occurrence at site 2, which predominantly involved creek-side vegetation, was lower (1.6%) than at the other three sites (6.3% to 9.4%), which involved copses of trees. Sittellas were seen at the 2ha sites and walking between the sites, during 28.1% of the 64 surveys.

Warakeila
(32.247°S 151.513°E)

Surveys were conducted quarterly between 1996 and 2010 on *Warakeila*, a cattle property in the Allyn River valley, NSW. The survey technique, survey sites and habitat are described in Newman & Lindsey (2008). Observations of Varied Sittellas are summarised in **Table 4**.

Table 4. Records of Varied Sittellas during 59 quarterly surveys between 1996 and 2010 at *Warakeila*, a cattle property in the Allyn River valley, NSW.

Site	Reports	RR (%)	Surveys
1 (2ha)	0	0.0	59
2 (2ha)	3	5.1	59
3 (2ha)	0	0.0	58
4 (2ha)	3	5.1	59
Combined 2ha	6	2.6	235
Hybrid	11	18.6	59

The property had about 15% remnant vegetation. The four 2ha sites were located in this vegetation. Sittellas were recorded at sites 2 and 4 with a frequency of 5.1% in both instances. Both these sites featured numerous trees and had good connectivity to other woodland. There were no sittella records at site 1, which involved creek-side vegetation, or at site 3 which was an isolated copse. Sittellas were recorded, either at the 2ha sites or walking between them, during 11 of the 59 surveys (18.6%), which typically took at least four hours. Approximately half the sittella observations were made while moving between the 2ha sites.

Other studies with large survey sets

The results in **Table 5** were drawn from the literature and the author's unpublished records. In each case the data was collected in a standard manner at individual sites. However, there were differences in survey effort between studies as indicated in **Table 5**.

Table 5. Summary of results of other studies with large data sets involving constant survey effort.

Location	Surveys	Area	Duration	Records	RR (%)	Period
Forest Road, Duns Creek[7]	74	500m	90min	0	0	2005-2014
Black Rock, Martins Creek[1]	104	5km	135min	22	21.2	1999-2013
Columbey South Trail[8]	6	500m	40min	2	33.3	2013
Blue Gum Hills Regional Park[5]	44	500m	200 min	2	4.5	2012-2015
Wirrumbirra, Laguna[2]	296	5km	Monthly	23	7.8	1979-2012
Yaraandoo[6]	45	5km	180 min	10	22.2	2010-2013
Yaraandoo[6]	140	2ha	20 min	1	0.7	2010-2013
GWC Rehab[3]	49	2ha	20min	4	8.2	2011-13
GWC Post-burn 1	47	2ha	20min	2	4.1	2011-13
GWC Post-burn 2	44	2ha	20min	1	2.0	2011-13
GWC Post-burn 3	42	2ha	20min	1	2.0	2011-13
Curracabundi National Park[4]	190	2ha	20min	3	1.6	2010-13

[1] Newman (2014a); [2] Raine (2014), (32.984°S 151.102°E); [3]Newman (2014b); [4]Drake-Brockman (2015), (31.667°S 151.750°E); [5]Greg Little unpublished results (32.891°S 151.622°E); [6,7,8]Newman unpublished results [6](32.635°S 151.659°E), [7](32.631°S 151.513°E), [8](32.600°S 151.739°E).

Comparison of Hunter studies

Results for the Hunter studies were compared with values for the entire Hunter Region over the period 1998 to 2014 (**Figure 4**).

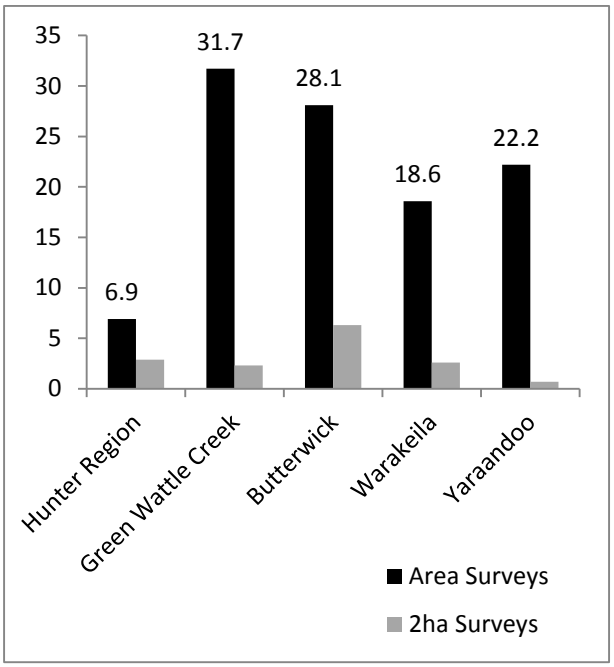

Figure 4. Comparison of reporting rates for Varied Sittellas during the farm and Green Wattle Creek studies with the rates for the entire Hunter Region for the period 1998 - 2014. Durations of individual area (hybrid) surveys were 3 hours at Butterwick and *Yaraandoo*; 4 hours at Green Wattle Creek and *Warakeila*. The mean duration of area surveys for the entire Hunter Region is unknown, but expected to be considerably less than 3 hours.

East Coast Bioregion trend

The State of Australia's Birds Project has established dynamic trends for the occurrence of a number of bird species using Birdata based on methodology described in the recent report of headline trends for terrestrial birds (Ehmke *et al.* 2015). The trend for the Varied Sittella in the East Coast Bioregion, which includes the Hunter Region, is shown in **Figure 5**.

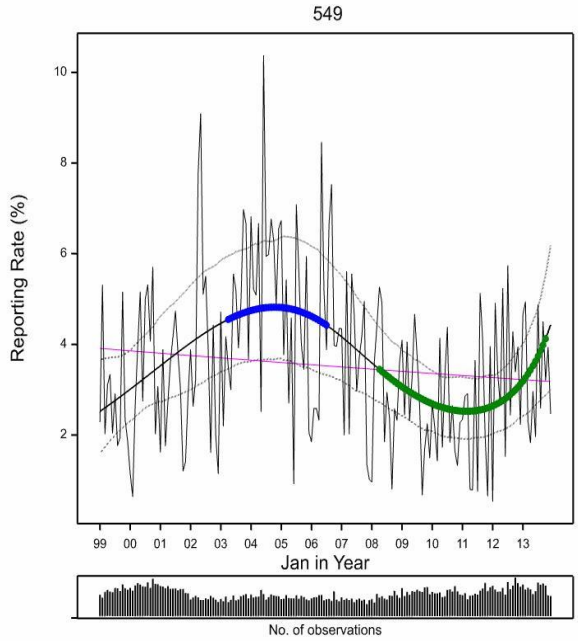

Figure 5. Dynamic variation in the occurrence of the Varied Sittella in the East Coast Bioregion of Australia, indicating a peak RR(%) about 2005 followed by a decline and the start of a recovery in 2011. Ehmke *et al.* (2015) provides a detailed explanation of the observed trend. Area surveys were used for this analysis.

DISCUSSION

In the Hunter Region Varied Sittellas are recorded in only 1 in 14 area surveys compared with a ratio of 1 in 2 for common species like the Superb Fairy-wren *Malurus cyaneus*. As Varied Sittellas are encountered as active, noisy family groups in open woodland they are easily detected and their infrequent recording is a genuine indication of scarcity rather than difficulties in detection. It has been suggested that sittellas, which are obligate trunk and branch feeders, have larger territories than foliage-feeding species like thornbills (*Acanthiza* species*)* because their food availability is limited (Noske 1985 & 1998); hence their relatively sparse occurrence.

Varied Sittellas were more frequently recorded in the south and west of the Hunter Region (**Figure 1**). However, this conclusion should be treated with caution because the unstructured nature of the surveys (i.e. variable survey areas and time spent surveying), together with low survey sample sizes in the remoter western and northern areas, compromise comparisons between sub-regions.

Fortunately the long-term studies (e.g. on farms and at Green Wattle Creek) described above generated quantitative information on the occurrence of Varied Sittellas at RRs above the mean level for the Hunter Region (**Figure 4**) and for the East Coast Bioregion of Australia (**Figure 5**). As will be discussed in the following section, these studies set bench-mark RR levels for areas which support Varied Sittellas and provide some insights into the habitat requirements of the species.

In each of the studies involving farms with remnant vegetation and the remnant woodland at Green Wattle Creek the Varied Sittella area survey RR was more than twice the mean level for the Hunter Region (**Figure 3**). This provided compelling evidence that the Paterson and Allyn River areas provided important habitat for Varied Sittellas. The extent to which these locations provided superior sittella habitat was uncertain because these studies involved more comprehensive survey effort than was the norm for the Birdata citizen science data set for the Hunter Region. However, the difference in the frequency of occurrence is sufficiently large (e.g. 1:3 surveys at Green Wattle Creek compared with 1:20 surveys for the entire Hunter Region or 1:14 for grids where the Varied Sittella has been recorded) to suggest the inference that these locations provide important habitat is justified.

Green Wattle Creek

At Green Wattle Creek where surveys were conducted at monthly intervals, Varied Sittellas were usually encountered as a single flock with continuous presence for a number of months, including breeding, interspersed by prolonged periods of absence. Hence, the impression was gained of a species which is locally nomadic rather than holding fixed territory indefinitely (see Newman 2010b), which is consistent with Noske's finding in north-eastern NSW (Noske 1998).

In the first half of the Green Wattle Creek study, which involved monthly hybrid surveys between 1996 and 2013, the annual RR was 50% or greater in five out of nine years (**Figure 3**). Potential explanations of the cause of the subsequent decline after 2004 (**Figure 3**) include a regional decline in the species and deterioration in the suitability of the woodland at Green Wattle Creek for Varied Sittellas. There is evidence supporting both these possibilities as discussed below.

There was a corresponding decline in the RRs for area surveys throughout the Hunter Region (compare **Figures 2** and **3**), although in **Figure 2** the trend may be influenced by variations in survey effort associated with the unstructured nature of the surveys. Across the broader East Coast Bioregion there was no evidence of a long-term decline over the same period (**Figure 5**). However, fluctuations occurred with a peak in 2005 followed by a prolonged period of decline through to 2011. The post-2011 recovery across the broader East Coast Bioregion (**Figure 5**) is not apparent in the Hunter Region data (**Figure 2**) suggesting any decline involving the Hunter Region is of limited geographic extent. Fluctuations like that shown in **Figure 5** are an expected feature of stable populations, whereas extended declines of the type shown in **Figures 2** and **3** may suggest a species is experiencing a longer-term decline in status. There is limited information on the longevity of Varied Sittellas (Higgins & Peter 2002), but based on the estimate of five years for the generation time (Debus & Soderquist 2008) the long-term decline evident in **Figure 2** would appear to exceed two generation times.

In 1996 when the study commenced Green Wattle Creek was a lightly grazed woodland and, other than near the creek at the northern end, involved open woodland with very little understorey. Cattle grazing ceased soon after the start of the study, and understorey vegetation progressively increased to the detriment of ground-foraging species such as the Speckled Warbler *Chthonicola sagittata* (Newman 2010a). It is not obvious why this vegetation change should have impacted on the Varied Sittella which forages on the trunks and limbs of trees as opposed to the ground (Higgins & Peter 2002). However, during this period a considerable number of trees, particularly mature ironbark species, were illegally removed for firewood and fencing. These mature trees, particularly rough-barked trees, are important features of sittella habitat (Higgins & Peter 2002). Any decrease in rough-barked tree numbers would decrease the availability of food, which is scarce in the specialised niche exploited by sittellas (Noske 1998). Consequently selective removal of rough-barked trees may have contributed to the Varied Sittella's apparent decline at Green Wattle Creek. For instance Noske (1998) suggests that the densities and sizes of territories of sittellas may be determined by the abundance of rough-barked eucalypts at a site. Periods of drought may also have contributed to both local and regional decline

of insectivorous species like sittellas, as has been suggested in relation to fluctuations in the occurrence of Grey Fantails *Rhipidura fuliginosa* at Green Wattle Creek (Newman 2012). A long-term decline in aerial insectivores was described in the recently published State of Australia's Birds 2015 report (Ehmke *et al*. 2015).

The four 2ha survey sites were selected to sample different vegetation sites representative of the total study area. Varied Sittellas were recorded at all four sites with a mean RR of 2.3% (**Table 2**). Assuming that the frequency sittellas were encountered was proportional to the survey time the mean RR for a four-hour total survey time would be 27.6%, which is in reasonable agreement with the observed value of 31.7% in the hybrid survey (**Table 2**). The total area surveyed during the four hours was estimated to be approximately 15ha of suitable continuous woodland, which is of the magnitude required to support a sittella clan (Noske 1998), consistent with the high RRs in the initial years of the study (**Figure 2**). Decreased occurrence since 2005 suggests that the survey area no longer permanently supports a sittella clan and is now visited intermittently as part of an extended sittella territory.

The 3.8% RR for 2ha site 2 was more than double the mean rate for the other three sites. This site was initially selected because it involved an area of open woodland with scattered mature trees and grassy understorey. This area was subsequently cleared to establish an equestrian centre requiring the survey site to be shifted closer to the less open habitat adjacent to the creek. The possibility that the open nature of this site when initially established might provide optimum sittella habitat is supported by the high 2ha RR of 11.8% during the first six years of the study. Occurrence was also at a similar level (8.2%) during a short-term project at the GWC 2ha Rehab site (**Table 5**), where the habitat was superficially similar to site 2 at the start of the study in 1996. In a contemporaneous set of surveys at Post-burn sites 1-3 (**Figure 6**) adjacent to the unburnt Rehab site the mean RR was 2.7% (**Table 5**). At all four of these sites the shrub layer had been largely removed by a combination of manual removal of lantana and burning at the post-burn sites. The burn was carefully controlled in order to leave the canopy intact, but may have affected the viability of the tree trunks as a food resource for sittellas. This would explain the higher RRs at the unburnt rehab site. The net impact of the rehabilitation effort at the rehab and post-burn sites was to restore the habitat to a structure which was similar to that at the start of the long-term study when the shrub layer was controlled by grazing. However, as indicated by **Figure 6,** there was more groundcover in the absence of grazing. The rehabilitation temporarily benefitted the Speckled Warbler and the Eastern Yellow Robin *Eopsaltria australis* (Newman 2014b). It is possible that the Varied Sittella was similarly advantaged as the mean RR for these post-burn sites of 2.7% was greater than the long-term mean of 2.3% for the four 2ha sites (**Table 2**) during a period in which the Varied Sittella was declining. It must be stressed that the post-burn and rehab sites are different survey sites to those in the long-term Green Wattle Creek study.

While the above results demonstrate that carefully controlled cool burns have limited adverse impact, an extensive hot wildfire impacting on trunks, branches and the canopy would be expected to render an area unsuitable for sittellas, at least in the short term.

Figure 6. Habitat at the GWC Post-burn survey site 1, which had been restored to a condition structurally similar to that which existed throughout much of the Green Wattle Creek study area when the project commenced in 1996. However, following the burn in autumn 2011 and in the absence of cattle there was extensive grass groundcover.

Farm studies

The range of 2ha RRs for Varied Sittellas in the farm studies varied from 0.7% at *Yaraandoo* to 6.3% at Butterwick, straddling the mean value of 2.9% for all 2ha sites in the Hunter Region between 1998 and 2014. A key reason for this general correspondence of the farm study RR

magnitudes with other data is that the farm study data sets form a large proportion of the 2ha data set for the Hunter Region. This bias is much less pronounced for the area search data where the ratio of farms to other surveys is more than five times lower.

The farm studies (Butterwick, *Warakeila* and *Yaraandoo*) all involved properties which were grazed by cattle throughout the survey period. In each case extensive clearing had occurred with only about 15% vegetation retained. The 2ha sites were located in these fragmented woodland remnants which, even collectively, were of insufficient size to support a sittella clan. The magnitudes of the long-term hybrid survey RRs were in the range 18 to 28% (**Figure 4**) suggesting these areas are regularly visited by sittellas, even if they do not support a resident clan. However, at each study location there were extensive areas of bush in close proximity to the farms capable of providing extended territories.

At Butterwick and the adjacent woodland at Green Wattle Creek, the long-term hybrid survey RRs were similar at 28.1% and 31.2% respectively (**Figure 4**). The mean RR (7.9%) for the three 2ha sites at Butterwick (**Table 3**), which involved copses of trees with limited shrub layer, was higher than the 2.6% found at the nearby Green Wattle Creek 2ha sites over the period 1996-2011. However, the RR is very similar to the 8.2% found at the Green Wattle Creek rehabilitation site (**Table 5**). The highest Butterwick 2ha RR was 9.4% at site 4, where the species has bred. Structurally the vegetation at Butterwick site 4 (**Figure 7**) was similar to nearby Green Wattle Creek site 2 before cattle grazing ceased and trees were removed when the equestrian centre was established (Newman 2006 & 2009) and to the GWC Rehab site (Newman 2012). Collectively these observations suggest that open woodland with limited shrub layer suits Varied Sittellas and that light grazing may help maintain these conditions. In contrast, in dense creek-side vegetation at Butterwick site 2, sittellas were only present occasionally (1.6%), primarily in a small copse of trees near the creek.

Figure 7. Habitat at Site 4 on the Butterwick property, where Varied Sittellas have bred, showing the presence of rough-barked trees and the open structure of the woodland. Cattle grazing has removed the understorey and groundcover vegetation.

At *Yaraandoo*, a lightly grazed property about 5km from Green Wattle Creek, the RR for Varied Sittellas during monthly hybrid surveys was 22.2% between 2010 and 2013 (**Table 5**). Most of the records were in lightly grazed open woodland with grassy understorey, with only one record at the 2ha survey sites which sampled dense creek-side vegetation, a rainforest gully and an olive grove, all of limited suitability to Varied Sittellas. The hybrid survey reporting rate of 18.6% (**Table 4**, **Figure 4**) at *Warakeila*, a property in the Allyn River valley surveyed between 1996 and 2010, was slightly lower than at the other farms. No sittellas were recorded at *Warakeila* 2ha site 1 which involved creek-side vegetation, a finding which was consistent with the result at Butterwick. Perhaps more surprisingly was the absence of sittellas at *Warakeila* site 3, an isolated copse of trees, although progressive ringbarking of trees severely degraded it over the period of the study. Sittellas were recorded at 2ha sites 2 and 4 with RRs of 5.1% in both instances. These sites involved very different types of woodland habitat. *Warakeila* site 2 was on a track perpendicular to a gully supporting rainforest vegetation, whereas site 4 was on flats adjacent to the Allyn River where mature casuarinas were the dominant trees used by the sittellas. At both these sites extensive vegetation clearing occurred during the study, apparently rendering them less suitable for sittellas.

Other studies

Varied Sittellas were frequently recorded (21.2%) at Black Rock, Martins Creek during fixed-route area surveys between 1999 and 2013 (**Table 5**) with evidence of a progressive decline from the 31% recorded during the first three years of the study. They were absent during a period of drought (Newman 2014a). The Black Rock study was mainly conducted along roads in a rural landscape involving patches of remnant woodland. A feature of this study was the occurrence of sittellas in roadside vegetation along fence lines through cleared land. Ongoing clearing, including along fence lines, may have contributed to the apparent decline of sittellas in the study area.

At Forest Road, Duns Creek the Varied Sittella was not recorded during 74 surveys sampling roadside vegetation through an area containing a combination of acreage properties and grazed paddocks. The absence of Varied Sittellas was surprising as superficially the habitat and survey effort was similar to that at Black Rock, Martins Creek.

Sittellas were frequently recorded (33.3%) along the South Trail at Columbey National Park in 2013 (**Table 5**). Unfortunately the sample size was small and the results are merely indicative that this small area of open woodland with shrubby understorey could be important habitat.

The other studies summarised in **Table 5** were included to provide benchmark data for occurrence of sittellas in different areas and habitats of the Hunter Region. Varied Sittellas were located at only three of 21 2ha survey sites (1.6%) during a three-year study at Curracabundi National Park in the north of the Hunter Region (Drake-Brockman 2015). They occurred less frequently during 2ha surveys than for the farms in the Paterson area. At Blue Gum Hills Regional Park in the greater Newcastle area the RR for Varied Sittellas was 4.5% in area surveys involving similar observer effort to those at Green Wattle Creek and the other farm studies where the range was 19 to 32% (**Figure 4**). The results of both these studies highlight the extent to which remnant vegetation studied in the Paterson area appears to provide superior habitat for Varied Sittellas. At Curracabundi many of the survey sites were in wetter heavily wooded mountainous habitat with steep gullies, which seemed to be less suitable. In contrast the Ironbark-Spotted Gum woodland at Blue Gum Hills Regional Park would seem suitable habitat and it is perhaps surprising that Varied Sittellas were seldom recorded. However, at Blue Gum Hills Regional Park, which is located midway between Green Wattle Creek and the coast, the vegetation tends to be denser and wetter, probably because of its proximity (15km) to the coast.

Habitat requirements

Area surveys do not precisely define where surveys were conducted making it difficult to identify the habitat types favoured by sittellas. This issue was overcome when 2ha surveys with precisely defined locations were used, but the sparse occurrence of Varied Sittellas (2.9%, **Table 1**) in this type of survey necessitates large data sets to identify preferred 2ha survey sites and hence habitat. This is not surprising because sittella territories are typically 13 to 20ha (Noske 1998) which is much larger than 2ha survey sites. Within the Hunter Region the intensive studies at Green Wattle Creek and farms in the Paterson region address these requirements, but involved habitat which was highly modified and, except for Green Wattle Creek, is fragmented into small remnants. Even the continuous woodland at Green Wattle Creek involved regrowth with limited numbers of mature trees. However, the high frequency of occurrence of Varied Sittellas in the area survey data demonstrates that all these locations regularly support Varied Sittellas. None of the farms studied appeared to have sufficient habitat to support a sittella clan permanently. At Green Wattle Creek, habitat and related ecological changes occurred during the study resulting in a decline in the sittella's occurrence to magnitudes similar to those on the farms, suggesting that the area of woodland surveyed was no longer capable of permanently supporting a resident sittella clan. A number of potential causes of decline have been identified, including changes in vegetation structure following cessation of grazing. However, degradation by selective removal of mature rough-barked trees is considered to have been a key factor in rendering the Green Wattle Creek woodland less suitable for sittellas.

It may be courageous to conclude that the habitat in these studies, which primarily involved remnant and highly modified vegetation, is optimal for the Varied Sittella, even though the species is recorded more frequently than in other areas of the Hunter Region. The inference is based on the results of survey data sets which on average involved more survey effort than in other areas. In addition, they sampled a limited set of habitat types. In other sub-regions of the Hunter the sittella occurrence rates

will have been diluted by surveys in unsuitable habitat (e.g. heathland and rainforest). Consequently, it is recommended that research is conducted into the habitat requirements of the Varied Sittella across other sub-regions and habitat types using standard approaches with constant survey effort. A focus of the proposed study should be to determine whether sittellas favour more open woodland at forest edges with limited understorey as was found at Green Wattle Creek. It is possible that high survival rates are important for sparse species like the Varied Sittella. For instance their breeding productivity may be lower than for other passerine species because of their specialised foraging requirements. Noske (1998) suggests that the sittella's cooperative lifestyle not only ensures food supply to nestlings is sufficiently high, but also reduces vulnerability to predators. When a member of a sittella clan identifies a threat they become highly vocal and have developed spectacular agonistic group displays (Newman 2007). Survival rates may be higher in more open habitat and in the absence of understorey. During the 1990s Varied Sittellas were observed in mixed foraging flocks, which formed in open areas at Green Wattle Creek outside the spring breeding season (Newman 2015). Buff-rumped Thornbills *Acanthiza reguloides* are nuclear species attracting other species including the Varied Sittella (Bell 1985). The progressive development of understorey at Green Wattle Creek removed the ground-foraging niche essential to the Buff-rumped Thornbills and they declined, as did the occurrence of mixed foraging flocks. This is another example of the potential advantage to sittellas of living in open habitat in terms of strategies which decrease predation and increase survival.

Threats

The final determination by the NSW Scientific Committee (2010) with respect to listing the Varied Sittella as a Threatened Species highlighted decreased habitat quality as being a key factor driving long-term decline. It suggested that because sittellas are sedentary their populations are sensitive to habitat isolation. Although aggression by Noisy Miners *Manorina melanocephala* (Olsen *et al.* 2005) was cited as a threatening process impacting on Varied Sittellas, this was not noted during these studies. The final determination lists the following factors: small-scale clearing for fence lines and road verges, rural tree decline, loss of paddock trees and connectivity, 'tidying up' on farms and firewood collection as current threats to the viability of sittella populations. Relevant Key Threatening Processes listed in NSW under the *Threatened Species Conservation Act 1995* include: 'Clearing of native vegetation', 'Loss of hollow-bearing trees' and 'Removal of dead wood and trees'.

Status Overview

Varied Sittellas are considered to be a species whose population is limited by food availability; hence any action or event which decreases food availability decreases their population viability and makes them more susceptible to the short-term impacts of factors like drought and fire. Recently Green Wattle Creek has been managed by Crown Lands, a division of the NSW Department of Trade and Investment and the area is now known as the Butterwick Crown Lands Reserve. Management protocols have been introduced which should prevent further degradation of the area and should sustain the sittella population at current levels by preventing continuing removal of trees, removing weed growth and managing fire by a series of cool burns conducted infrequently across a mosaic of habitat patches. Of course it is not possible to rectify the losses of mature trees, which are irreversible in the short to medium term.

Community education is required to highlight the factors which cause insidious degradation of habitat. This includes increasing the awareness of local government administrators and front-line staff, who are responsible for the management of the rural landscape. In addition to the aforementioned factors the importance of dead branches and trees to sittellas is an example of a counter-intuitive habitat requirement, which would not usually be appreciated as important. For example, historically, dead timber was allowed to be harvested for fire wood on Crown Land. It is essential for breeding as well as a prime foraging niche. This is classic example of an uninformed decision.

It is of obvious concern that the area survey results (**Figure 2**) suggest a widespread decline of the Varied Sittella across the Hunter Region. It is tentatively suggested that observers primarily survey areas which are easily accessed near roads and vehicular tracks and that these areas tend be modified, at the edges of continuous woodland and often involve fragmented vegetation. In this case the observed decline may be associated with the progressive fragmentation and clearing of this habitat. If the degradation continues a point may be reached at which food availability falls below the critical limit necessary to sustain sittellas. As

pointed out by Noske (1998) the relationship between food availability and sittella territory size is unknown. There may be limits to territory size and the distance breeding sittellas can range to successfully feed their nestlings.

CONCLUSIONS

Long-term studies in the Paterson area of the Hunter Region provide benchmark RRs for the occurrence of Varied Sittellas in standardised surveys. Comparison with other survey data in the Hunter Region suggests that the Paterson area supports important populations of this scarce species which is widespread in the area, although only intermittently present at any specific location. Varied Sittellas appear to favour drier open woodland where they forage on the trunks and branches of trees. Remnant vegetation on farms and road sides provides important habitat. Rough-barked trees are especially favoured. There is evidence of sustained local decline in the Paterson area and throughout the Hunter Region. However, sustained decline is not apparent across the broader scale of the east coast of Australia during the same period. Possible causes of decline include habitat loss by clearing and degradation by the removal of mature trees, with rough-barked species selectively removed, often illegally. Where trees have been excessively thinned, especially at roadsides, there are continual losses when trees are up-rooted during storms. These ongoing habitat losses are permanent as there is no replacement, unless appropriate conservation management actions are undertaken. There is also data to suggest that drought and burning may also have an adverse impact on populations within the region in the short to medium term.

There is an urgent need to halt the decline of Varied Sittellas in the Paterson district and other areas known to be important to the species. Community education is urgently required to ensure that the ecological requirements of the Varied Sittella are widely appreciated. Engagement with land owners, land managers and local government regulators to ensure their awareness of the management actions necessary to protect the Varied Sittella and halt the ongoing degradation of their habitat is a priority.

As discussed previously although the highest known rates of occurrence of the Varied Sittella are in the Paterson area, the highly modified landscape in which these studies were conducted may not be optimal habitat for the species. It is recommended that a research program is initiated to compare sittella occurrence in other regions of the Hunter and in other habitats. Standardised survey approaches should be used which allow comparison with the baseline levels established in this paper.

It would be courageous for land managers to assume that the widespread distribution of the Varied Sittella provides a buffer against processes threatening the status of the species. Evidence presented in this paper suggests that the species may favour modified and even fragmented habitat, but if such habitat is progressively degraded across the landscape, as appears to be occurring in the Hunter Region, the level of threat to the species' viability will inevitably increase.

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Swifts over the Hunter Region

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Because swifts spend all day and at least part of the night in flight, observers need to develop different habits to those used to record numbers and behaviour of birds in trees or in swamps. When we remember to look up high over forests and ridges we can be rewarded by seeing unusual behaviour. In the Hunter Region the largest flock of White-throated Needletails *Hirundapus caudacutus* recorded was 6,000 birds, while the largest Fork-tailed Swift *Apus pacificus* flock was of 3,000 birds. This might be deceptive as the Needletail is now in decline, while the Fork-tailed Swift population appears to be more stable. These population assessments are based on estimates and counts of flock sizes recorded by observers.

INTRODUCTION

Most of what David Lack wrote on the first page of his introduction to his book "Swifts in a Tower" in 1956, still applies. He said "the swift's dependence on the air brings many benefits but also a great danger. Its magnificent flight enables it to take all its food and nesting material from the air and [in some species] to spend the night on the wing, while except when weakened or surprised it can outfly birds of prey. But the air-borne insects upon which it relies for food become extremely scarce in bad weather, and the danger of starvation can be overcome only by unusual behaviour and other adaptations."

Lack was primarily referring to the Common Swift *Apus apus*, but most of those strengths and weaknesses apply to the swifts that part the air over the Hunter Valley. In fact the Fork-tailed Swift *Apus pacificus* being in the same genus as the Common Swift may have all of those abilities. When food is scarce both the Fork-tailed Swift and the White-throated Needletail *Hirundapus caudacutus* will travel to the windward side of mountains, hilly ridges, or a belt of trees, where the rising air not only reduces the energy needed to stay afloat, but also uplifts a smorgasbord of aerial prey to their upstairs dining room. They will also use rising air thermals on hot days for the same two purposes, or to gain height beyond normal human vision, then glide off to a distant feeding ground, while expending very little energy. You need your binoculars or scope to witness the latter events.

METHODS

Data were initially collected from observations where dates and numbers of birds were recorded when published in national and regional bird journals. These were added to my own observations and those from bird and naturalist club newsletters, data from the three BirdLife Australia (BLA) Bird Atlas phases, and those published on the internet. From the Hunter Region many reports came from the Hunter Region Annual Bird Reports, from e-mails direct from the observers, and observations in the Hunter Bird Observers Club (HBOC) Hunterbirding on-line forum.

RESULTS

I have spent about 30 years gleaning as many sightings of swifts from all parts of Australia, from as many sources as possible. These data show that the Needletail is much more common in the Hunter Region (with 1936 sightings) than the Fork-tailed Swift (with 278 sightings). The Hunter Region distributions of these species based on records submitted to the BLA Birdata archive are shown in **Figure 1**.

White-throated Needletail

The largest flock of Needletails in the Hunter Region was about 6,000 birds recorded by John Hobbs, at Maitland on 9 December 1959. A flock of 2,000 was seen at Mungo Brush on 5 January 2014 by Alan Curry. Flocks of 1,000 were recorded south of Newcastle on 16 December 1967 by Glenn Holmes; at Sandy Hollow, west of Newcastle on 16 February 1997 by Peter Mackie;

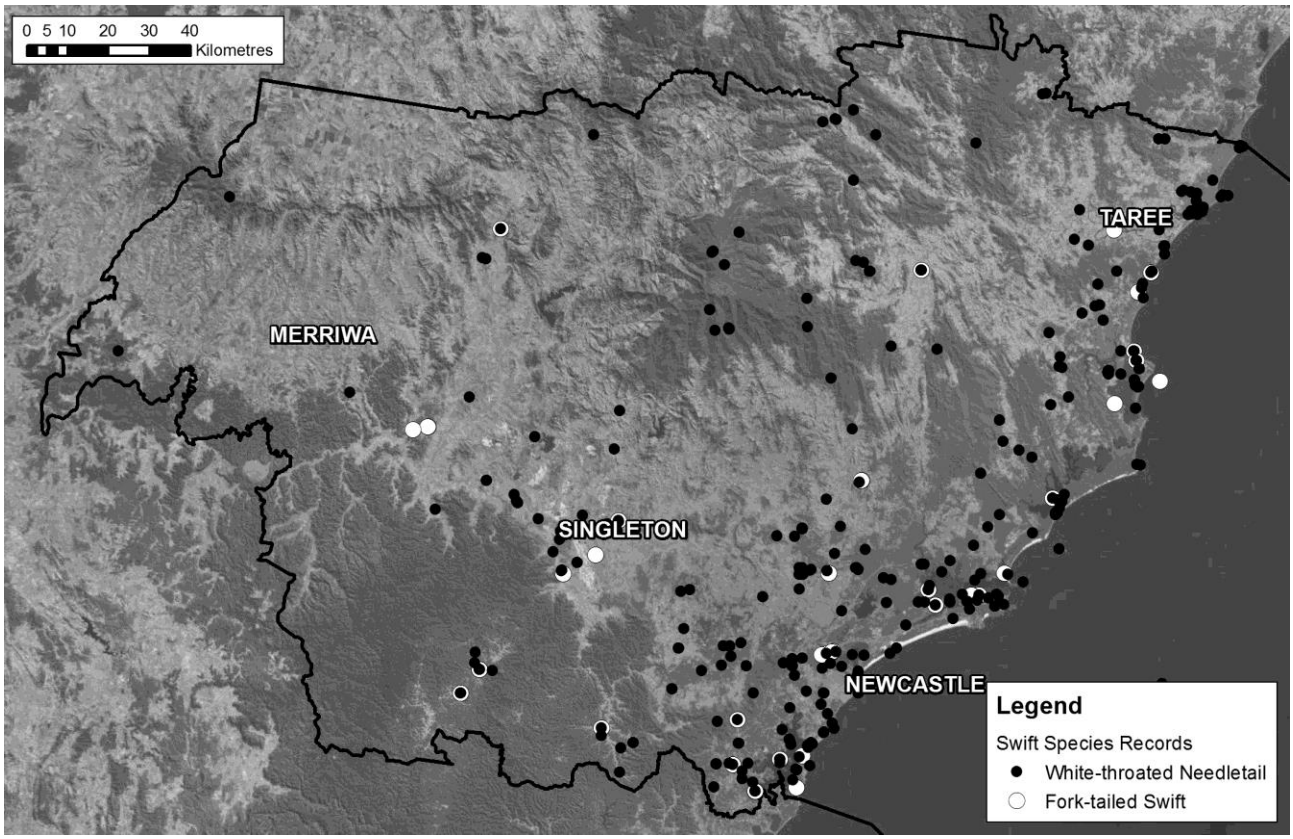

Figure 1. Distribution of White-throated Needletail and Fork-tailed Swift records in the Hunter Region based on BLA Birdata archive for the period 1998-2013.

above the Pacific Highway at Belmont on 19 November 2009 by Martin Cachard and on 28 November 2010 by Craig Anderson; at Limeburners Creek Road on 28 December 2012 by Joshua Bergmark; and above Cabbage Tree Island off Hawks Nest on 10 December 2013 by Chris Lloyd.

That four of these flocks were seen in the last five years is misleading if it makes us think that these birds are increasing in numbers. With more observers than ever many more small flocks are also being seen. So assuming that decreased flock sizes imply less swifts we need to average the flock size over periods of time to determine the trend of the population – if indeed there is any. When we group the data as in **Table 1**, it is clear that in the Hunter Region there is a decline in Needletails, as has been shown for the Australia-wide wintering population (Tarburton 2014). Unfortunately the pre-1990 counts are too few to give the statistically significant results that we get from the more numerous national data. But by grouping all the pre-1970 data and the 1971-1990 data, the downward trend in the mean size of the flocks can be seen.

Table 1. Flock Size statistics for White-throated Needletails in the Hunter Region.

Period[1]	<1970	1971-1990	1991-2000	2001-2010	>2010
Mean	134	121	51	46	47
n	87	18	95	483	667
SD	649	129	112	90	116
SE	70	30	11	4	4

[1] For each time period the flock statistics are described by the mean (average) size of the flock, *n* the number of flocks reported, SD the standard deviation from the mean value, and SE the standard error of the mean.

Fork-tailed Swift

What about the less common visitor: the Fork-tailed Swift? My earliest record from the Hunter with numbers reported is of 50 birds seen on 24 February 1969. This is a lot more recent than my earliest record for Needletails which was 27 November 1928. Does this mean Fork-tailed Swifts never used to come to the Hunter Region or that earlier observers were less confident at identifying them, or maybe they never noticed they were not Needletails, particularly when in mixed flocks? One possibility is that the drier Hunter in

recent decades is more attractive to this species or that the even drier interior is forcing them to coastal regions. Several of these factors might be working together – but we need more observations to try and tease that out. Even nationally, observations from the three atlases as well as eBird show most observations are from the east coast, where most observers live. Higgins (1999) states that in Australia the Fork-tailed Swift is mostly found over the inland plains, and even though I live in southern Victoria, where they are most often reported for all of Australia, I see them more often and in larger flocks when travelling through the drier parts of Australia. These two factors suggest that the frequency of reporting is influenced by observer distribution rather than the distribution of the birds. Further evidence comes from Western Australia, where Simon Davies and Ric Elsel reported flocks of 3,000 and 5,000 swifts in October 2012 and November 2013 near the Broome Bird Observatory. No one else reported flocks of that size in 2012 and the 2013 flock was not reported again until March when Nigel Jacket reported them on several days along the NW Coastal Highway. In most years I believe large flocks tour outback Australia, but go unreported, because observers tend to visit those areas when the swifts are in the Northern Hemisphere.

The data in **Table 2** do not support a decline, but because the sample sizes are small and the flock size range so large, the differences lack statistical significance. The national data also fails to support the notion of a decline in this species.

Table 2. Flock Size for Fork-tailed Swifts in the Hunter Region.

Period[1]	<1990	1991-2000	2001-2010	>2010
Mean	16	39	68	43
n	13	24	70	56
SD	17	57	361	150
SE	5	12	43	20

[1] For each time period the flock statistics are described by the mean (average) size of the flock, *n* the number of flocks reported, SD the standard deviation from the mean value, and SE the standard error of the mean.

DISCUSSION

Has clearing and mining the Hunter Region reduced the local swift population? It probably has when we consider that uncleared areas such as Bulahdelah produce so many sightings. Paul Osborne sent me 94 Needletail sightings from the Bulahdelah area between October 2006 and January 2011. I have 144 observations in total from Bulahdelah. Even Newcastle with so many observers has provided only 137 sightings of Needletails in total.

Improve your observational skills by just remembering to periodically lift your eyes above the waterbodies and tree canopy, which will enable you to see swifts more often. In some forest areas, looking upwards through your binoculars will increase the number of sightings you make. This season I have watched a lot of Needletail flocks that were too high to be seen by normal vision for all or most of the time they were being observed. This has been up to 2.5 hours, when birds were at 900 – 1,800m directly above me. Observing high-flying swifts through your binoculars will mean you are more likely to see pairs engaging in co-ordinated display flights, where they maintain a fixed distance between each other (usually 20cm to 2m) while doing loops, rolls, twists, turns and power dives. When performing the latter they easily reach speeds in excess of 200kph, making for exciting birding.

Assuming we can apply the knowledge about Common Swifts in Europe to the Needletails, then one advantage of maintaining their pair bond through the non-breeding season is that these birds are usually the first ready to breed each season. The first birds returning to the breeding ground with their mate, get to use the safest nests located in areas with the best food supply, and so raise larger broods than the unpaired late-comers.

Swifts are designed to fly at high altitudes. Palomeque *et al.* (1980) showed that their blood's ability to take oxygen from the air in the three species tested was equal to birds that live above 2500m. Some of the other implications of their high haematocrit readings and body design as they relate to their high-flying altitudes during migration are discussed in Tarburton (2009). The year after that paper was published Andrew Bell, a pilot flying regularly into Darwin, reported that he often saw Fork-tailed Swifts at around 1000m both north and south of Darwin Airport, particularly late in the Austral season for non-breeding visitors.

Early in the Austral swift season you may pick moulting birds and can document the progress of their moult, as it proceeds from the inner primaries to the outer (10 each side), and the rectrices (tail feathers), innermost to the outer (5 each side). Sometimes this is easier from photographs than in real life. You might also recognise birds hatched that season by the dark striations on the white

under-tail coverts as shown in **Figure 2** compared with adult plumage in **Figure 3**.

Figure 2. White-throated Needletail, first-year bird. Photo © Paul Walbridge.

Figure 3. White-throated Needletail, Adult bird. Photo © Paul Walbridge.

Enjoy the Needletails while you are able as they are in a steady decline. Tarburton (2014) demonstrates they have been in decline every decade since 1950. BirdLife Australia have recently stated that they consider the sub-species of White-throated Needletail which visits Australia is eligible for listing as Vulnerable under the *Environment Protection and Biodiversity Conservation Act* 1999 based on the decline exceeding 30 percent reported by Tarburton (2014). The major cause appears to be the excessive logging of their roosting trees in Siberia; however, Australia is no longer blameless. Needletails and Short-tailed Shearwaters are the most commonly killed birds at two wind farms in Tasmania (Hull *et al*. 2013). Keep this in context as 80-83% of the bird species using the air space occupied by these two wind farms are not being killed by the turbines. The maximum velocity of the turbine blade tips is 185kph, a speed that Needletails can exceed, but somehow they are being fooled. As far as I know no other state is studying the bird mortality on their windfarms, but just last week I picked out six recent records of dead Needletails from the biocache database (Atlas of Living Australia) on the internet, whose grid co-ordinates show they were collected from the Woodlawn Wind Farm in southern NSW.

Fork-tailed Swifts do not appear to be in decline, and there is no apparent evidence that the rock faces, cave entrances and rocky islets they nest on in Mongolia, China, Siberia and off shore are being mined or quarried in any extensive way. Their true numbers are difficult to determine because they do not all winter in Australia and those that do move around in the outback, where they are rarely reported. Sometimes large numbers are reported, historically from South Australia, Victoria and NSW, but the largest and most recent report was in Queensland, 30km SE of Townsville. Len Ezzy (2012) and three car-loads of bird observers contributed to an estimate of 215,000 Fork-tailed Swifts seen on 21 January 2012. This

estimate alone indicates this species is abundant, though it may take an individual observer many years to see any. Keeping an eye on the sky will help reduce that time. **Figure 4** shows the features that you should be looking for to record Fork-tailed Swifts. Early in the season Fork-tailed Swifts are moulting, and when the outer tail feathers are moulting, instead of the forked-tail becoming pointed when closed it looks blunt, unlike the broader tail of the Needletail. This leads some observers to report House Swifts *Apus affinis*, but it is best to look for the scalloped markings on the flanks and bellies of the Fork-tailed Swift, or if other birds are with them compare their lengths. Fork-tailed Swifts are 17-18 cm long while House Swifts are 15 cm long.

Figure 4. Fork-tailed Swift NE Qld 5 February 2005. Photo © Ian Montgomery birdway.com.au.

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Bird Surveys at Curracabundi National Park (2010-2013)

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Between January 2010 and February 2013 ten survey campaigns were conducted involving 21 survey sites. A total of 126 bird species were recorded for the area. 111 of these species occurred at the survey sites. Five species listed as Threatened and Endangered under the New South Wales *Threatened Species Conservation Act 1995* were present, and all migratory movements observed were noted. The range of species recorded demonstrates the importance of Curracabundi National Park as a reserve for eastern Australian woodland birds, many of which are in decline as urbanisation and land clearing continues to eat away at their habitat. The presence of five threatened species further supports the gazetting of the area as Wilderness and National Park. The results of this study highlight its value as a vital link in the Great Eastern Ranges Corridor.

INTRODUCTION

Following discussions in 2009 with Terry Evans, then Manager of the Gloucester office of the National Parks and Wildlife Service (NPWS) and Penny Drake-Brockman of the Gloucester Environment Group (GEG), and agreement between NPWS Head Office Sydney and the GEG, a three-year project was agreed to assess the presence and numbers of avian species on the property *Karamea* (31° 39′ 57″ S 151° 44′ 54″ E), a newly gazetted section of Curracabundi National Park. The area to be surveyed included the Homestead on the northern bank of the Barnard River, and the catchments of Curricabark and Mernot Creeks beyond the steep ridge behind the Homestead to the west and south-west. In addition Terry Evans requested that all avian migratory observations be recorded.

The eastern section of Curracabundi National Park, comprising the property *Karamea* is 340 km north of Sydney (**Figure 1**). It is located in a rain shadow with on average a lower rainfall than the surrounding Gloucester-Nowendoc area, with cold winters and hot summers. The area surveyed is characterised by extremely steep forested slopes and almost impassable pinches created by the Barnard River and its tributary creeks, with sections of pasture land in the valleys and along water courses. Other than cedar extraction and some larger tree felling, much of the original timber remains with only one large section of partially cleared land in the Curricabark valley behind the steep ridge at the rear of the Homestead and cattle yards, small clearings on summits along the trails, and the land surrounding the house and on the flats either side of the Barnard River. The remote areas are currently being allowed to regenerate (Ian Jack Heritage Consulting 2007).

Karamea's 2,640 hectares were gazetted in September 2006 into Curracabundi National Park along with the properties of *Rock Glen*, *Lea Hurst* and *Watchimbark*, and Bretti, Camels Hump, Mernot and Monkeycot nature reserves, which connect to Woko National Park to the south-east, and will form a section of the Great Eastern Ranges Corridor. A large section of the park (19,914 hectares) was gazetted Wilderness in 2011. Access is via Giro on the original (pre-1959) Gloucester/Nowendoc dirt road through private land and at the time of writing this report, access remained subject to agreement with the Giro landowners (NPWS 2014).

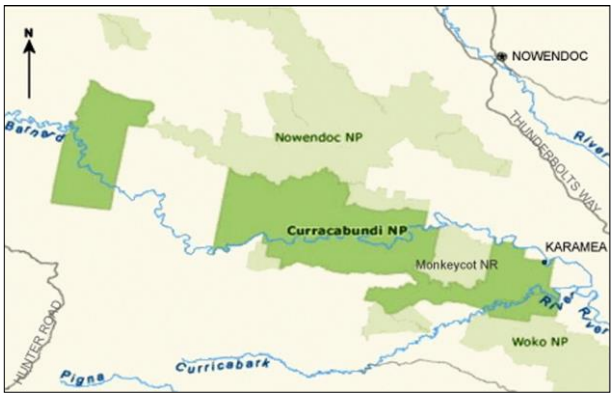

Figure 1. Map showing Curracabundi National Park and *Karamea* homestead.

Previous avian studies conducted to the west of *Karamea* include the following:

- E. L. Hyem's (1979) work on owls in areas adjoining Mernot and Monkeycot and his publication "Observations on Owls in the Upper Manning River District, NSW" was the culmination of 30 years observing Sooty Owl *Tyto tenebricosa*, Masked Owl *Tyto novaehollandiae*, Eastern Barn Owl *Tyto alba delicatula,* Powerful Owl *Ninox strenua,* and Southern Boobook *Ninox novaeseelandiae.*

- NPWS bird census, 5-9 May 2004 led by Trish Waters, NPWS ranger, and Tod Sonderquist, at Watchimbark Nature Reserve, when 54 species were recorded.

- The National Parks Association three-day survey of birds, plants, mammals and spiders, 12-15 April 2007, based at Glen Rock, with Stephen Debus leading a group of birdwatchers, when over 70 species were recorded, including Southern Boobook, Masked and Powerful owls.

METHODS

Owing to the extreme steepness of access tracks, thickly vegetated slopes and creek crossings at the back of the Homestead, 15 transects were initially selected along the vehicle tracks bordering Mernot and Curricabark Creeks, with a further two at the Homestead and Barnard River, covering as wide a variety of habitat/vegetation types as possible. An additional three sites were selected following NPWS track clearance at the far end of the Mernot track and one site on Curricabark when flooding prevented access to the three far sites, making a total of 21 sites. Sites were to be surveyed four times a year for three years starting from January 2010, and star pickets were set up with GPS WGS84 co-ordinates taken. Sites were registered with Birds Australia, now BirdLife Australia (BLA), and Atlas forms submitted to the BLA Birdata archive following each survey event. Sites could only be accessed in robust 4WD vehicles due to the ford crossings and steep, stony and often slippery trails. The **Appendix** contains details of the survey site locations, habitat at each site and BLA Birdata site ID numbers. Unfortunately the intensive short duration survey method used in this study did not provide time for detailed assessment of bird behaviour and consequently breeding behaviour was under-reported.

The data acquisition design used the standard BLA 2ha survey method which involves sampling bird populations at fixed sites of 2ha size for a period of 20 minutes. The principle underlying this design is that competent observers will locate most (>80%) bird species present in a 2ha area during 20-minute surveys conducted when birds are active. Surveys were conducted as early in the day as possible to ensure high levels of bird activity, with species present being recorded as well as an estimate of the number of each species. Collecting records in this systematic manner facilitates inter-site comparisons of bird populations as well as variations at sites between seasons and years. At each site 20-minute surveys were conducted on foot by two or more participants, walking 100 metres along the track both sides of a centre point, recording species both visually and by call 50 metres either side of the track, including fly-overs together with an estimate of the number of each species present. Significant bird activity was noted, in particular the presence of vulnerable or endangered species, breeding, foraging, and migration.

One brief night-time survey for owls was carried out in November 2011 when a Southern Boobook responded to call-back at Mernot Site 3. During all visits night-birds heard from the Homestead area and all species seen or heard outside of survey sites and time limits were recorded, providing a more complete species list for the park. However, since these additional records were not acquired in a systematic manner, their use in data analysis is limited.

Out of the projected 12 survey events, only 10 were completed due to extreme wet weather conditions outlined below. On some occasions 2ha sites were surveyed more than once at different times of day, but in each case only one of these duplicate surveys, held early morning and with the highest number of recorded species, was used for data analysis.

In particular, surveys were impacted by weather conditions at Barnard River, when heavy rain on several occasions in 2011 and 2012 caused delay or abandonment of surveys when the river flooded the causeway leading to the Homestead. In 2012 flooding dumped tons of gravel on the southern side of the causeway, sweeping the flats at Site 17 clear of weedy vegetation and a large dead tree, thus changing the habitat. Moreover, at Curricabark Creek flooding caused the creek ford to Site 12 and beyond to be inaccessible during the first survey visit. Site 12A was added on the second survey visit when it was not possible to cross the second ford, and this new site was surveyed eight times. Sites 13, 14 and 15 beyond the second ford could not be surveyed during the first three visits due to flooding and washout of the track, and were therefore surveyed seven times. Site 9 was missed in May 2010 and surveyed nine times. At Mernot Creek three new sites were created (MT1, MT2 and MT3) in September 2010 after the track beyond the ford at Site 7 was cleared by NPWS staff, and these sites were surveyed eight times.

RESULTS

A total of 126 species was recorded overall as detailed in **Tables 1A** and **1B**. This number included 111 species recorded during surveys at the 21 designated sites (**Table 1A**), and a further 15 species (**Table 1B**) recorded outside of the 20-minute survey time limit at the sites or in other areas of the park. Five species listed as threatened and vulnerable under the New South Wales *Threatened Species Conservation Act 1995*, were recorded at the 2ha survey sites or elsewhere in the park (**Table 2**).

Migratory movements

Migratory activity of species was noted as detailed in **Table 3**. It was observed that birds used the Barnard River as a route connecting the park to the Manning River, leading to the coastal belt. Migrating groups were observed in spring flying over the Homestead and the ridge behind to access the Curricabark valley and areas beyond, and vice versa in autumn. There is a high, thickly forested ridge on the east side of the Barnard River which would appear to force the birds to take a south-easterly route before they can turn north-east into the Manning valley.

Nocturnal species

Although night-time call-back was not carried out systematically, all sightings made or calls heard were recorded (**Table 4**).

Raptor species

Table 5 details all records of raptors. It was apparent that the pair of Wedge-tailed Eagles *Aquila audax*, regularly observed from the Homestead Site 17 and in the Curricabark valley, was resident in this section of the park. Sightings of Wedge-tailed Eagles over the ridge near Drovers Gate and beyond the Curricabark valley leading into Watchimbark, may have involved another territory. Two Nankeen Kestrels *Falco cenchroides* recorded in 2010 were not reported subsequently. The Black Falcon *Falco subniger* is fairly often recorded in the Hunter Valley (Stuart 1994-2014), but to the author's knowledge has not previously been recorded in the Gloucester area.

Reporting rates, abundance and distribution of species

The relative frequency of occurrence of the 111 bird species recorded during the 2ha surveys is indicated in **Table 1A**, in which the reporting rates (RR, which is the percent frequency of occurrence of a species in all 2ha surveys across the 21 survey sites) and the total number of each species seen in all the surveys gives an indication of relative abundance. The spread of the distribution of each species is indicated by the number of 2ha sites in which each species was recorded (e.g. the White-throated Treecreeper *Cormobates leucophaea* was widespread being recorded at 18 of the 21 2ha survey sites; see **Table 1A**).

Table 1A. Summary statistics for species recorded during 2ha surveys of 20 minutes duration in Curracabundi National Park between 2010 and 2013.

Common Name	Scientific Name	Number of survey sites recorded[1]	Maximum number in one survey	Total birds in all surveys	Reporting rate of all surveys[2] (%)
Brown Quail	*Coturnix ypsilophora*	8	13	48	6.7
Pacific Black Duck	*Anas superciliosa*	4	11	36	6.2
Australasian Grebe	*Tachybaptus novaehollandiae*	1	1	1	1.4
Brown Cuckoo-Dove	*Macropygia amboinensis*	4	2	5	2.9
Bar-shouldered Dove	*Geopelia humeralis*	2	6	12	1.4
Wonga Pigeon	*Leucosarcia picata*	12	2	23	9.6
Wompoo Fruit-Dove	*Ptilinopus magnificus*	1	4	4	0.5
Topknot Pigeon	*Lopholaimus antarcticus*	3	13	20	2.9
Tawny Frogmouth	*Podargus strigoides*	1	1	1	0.5
White-throated Nightjar	*Eurostopodus mystacalis*	1	2	2	0.5
White-throated Needletail	*Hirundapus caudacutus*	2	25	33	1.0
Little Pied Cormorant	*Microcarbo melanoleucos*	2	2	7	1.4
Great Cormorant	*Phalacrocorax carbo*	1	1	1	0.5
Little Black Cormorant	*Phalacrocorax sulcirostris*	1	23	26	1.9

[1] Surveys conducted at 21 sites.
[2] A total of 209 surveys were conducted.

Table 1A. Summary statistics for species recorded during 2ha surveys of 20 minutes duration in Curracabundi National Park between 2010 and 2013 (cont.)

Common Name	Scientific Name	Number of survey sites recorded[1]	Maximum number in one survey	Total birds in all surveys	Reporting rate of all surveys[2] (%)
White-faced Heron	*Egretta novaehollandiae*	2	1	2	1.0
Black-shouldered Kite	*Elanus axillaris*	3	1	3	1.4
Brown Goshawk	*Accipiter fasciatus*	5	1	2	2.4
Grey Goshawk	*Accipiter novaehollandiae*	2	1	2	1.0
Wedge-tailed Eagle	*Aquila audax*	13	3	27	10.5
Nankeen Kestrel	*Falco cenchroides*	1	1	2	0.5
Brown Falcon	*Falco berigora*	3	1	4	1.9
Black Falcon	*Falco subniger*	1	1	1	0.5
Dusky Moorhen	*Gallinula tenebrosa*	2	1	2	1.0
Masked Lapwing	*Vanellus miles*	4	2	8	3.3
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	7	11	32	5.3
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	5	5	12	1.9
Musk Lorikeet	*Glossopsitta concinna*	1	4	4	0.5
Australian King-Parrot	*Alisterus scapularis*	7	8	31	5.7
Crimson Rosella	*Platycercus elegans*	15	17	127	20.1
Eastern Rosella	*Platycercus eximius*	1	2	2	0.5
Pheasant Coucal	*Centropus phasianinus*	1	1	1	0.5
Eastern Koel	*Eudynamys orientalis*	8	2	10	3.8
Channel-billed Cuckoo	*Scythrops novaehollandiae*	2	3	6	1.4
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	2	2	3	1.0
Shining Bronze-Cuckoo	*Chalcites lucidus*	6	2	6	1.9
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	17	2	35	15.3
Brush Cuckoo	*Cacomantis variolosus*	12	2	13	5.7
Azure Kingfisher	*Ceyx azureus*	1	2	4	1.4
Laughing Kookaburra	*Dacelo novaeguineae*	10	4	22	7.7
Sacred Kingfisher	*Todiramphus sanctus*	3	1	3	1.9
Dollarbird	*Eurystomus orientalis*	2	1	3	1.9
Superb Lyrebird	*Menura novaehollandiae*	3	1	3	1.4
White-throated Treecreeper	*Cormobates leucophaea*	18	3	55	25.4
Red-browed Treecreeper	*Climacteris erythrops*	1	1	1	0.5
Green Catbird	*Ailuroedus crassirostris*	4	3	7	2.4
Satin Bowerbird	*Ptilonorhynchus violaceus*	9	15	43	11.0
Superb Fairy-wren	*Malurus cyaneus*	20	30	540	46.4
Red-backed Fairy-wren	*Malurus melanocephalus*	8	6	39	4.8
Variegated Fairy-wren	*Malurus lamberti*	10	5	51	7.2
Southern Emu-wren	*Stipiturus malachurus*	1	4	5	1.0
Yellow-throated Scrubwren	*Sericornis citreogularis*	2	1	2	1.4
White-browed Scrubwren	*Sericornis frontalis*	16	6	91	27.8
Large-billed Scrubwren	*Sericornis magnirostra*	7	3	12	3.8
Speckled Warbler	*Chthonicola sagittata*	4	2	8	3.8
Brown Gerygone	*Gerygone mouki*	15	10	131	18.2
White-throated Gerygone	*Gerygone olivacea*	10	6	30	8.1
Striated Thornbill	*Acanthiza lineata*	18	27	293	18.7
Yellow Thornbill	*Acanthiza nana*	16	10	123	17.2
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	4	11	38	3.8
Buff-rumped Thornbill	*Acanthiza reguloides*	9	6	40	5.7
Brown Thornbill	*Acanthiza pusilla*	18	6	127	34.4
Spotted Pardalote	*Pardalotus punctatus*	21	15	19	46.4
Striated Pardalote	*Pardalotus striatus*	2	2	3	5.7
Eastern Spinebill	*Acanthorhynchus tenuirostris*	18	3	64	23.4
Lewin's Honeyeater	*Meliphaga lewinii*	21	13	290	70.3
Yellow-faced Honeyeater	*Lichenostomus chrysops*	21	40	389	50.7

[1] Surveys conducted at 21 sites.
[2] A total of 209 surveys were conducted.

Table 1A. Summary statistics for species recorded during 2ha surveys of 20 minutes duration in Curracabundi National Park between 2010 and 2013 (cont.)

Common Name	Scientific Name	Number of survey sites recorded[1]	Maximum number in one survey	Total birds in all surveys	Reporting rate of all surveys[2] (%)
White-plumed Honeyeater	*Lichenostomus penicillatus*	1	1	1	0.5
Bell Miner	*Manorina melanophrys*	13	50	598	31.1
Noisy Miner	*Manorina melanocephala*	5	8	34	5.7
Red Wattlebird	*Anthochaera carunculata*	5	1	7	3.8
Scarlet Honeyeater	*Myzomela sanguinolenta*	19	7	62	16.7
Brown-headed Honeyeater	*Melithreptus brevirostris*	1	2	2	0.5
White-naped Honeyeater	*Melithreptus lunatus*	12	20	112	14.8
Noisy Friarbird	*Philemon corniculatus*	20	12	111	23.4
Spotted Quail-thrush	*Cinclosoma punctatum*	3	2	9	2.9
Eastern Whipbird	*Psophodes olivaceus*	16	6	110	29.7
Varied Sittella	*Daphoenositta chrysoptera*	3	3	9	1.4
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	7	5	22	45.3
Cicadabird	*Coracina tenuirostris*	14	2	19	9.1
White-winged Triller	*Lalage tricolour*	1	1	1	0.5
Crested Shrike-tit	*Falcunculus frontatus*	2	1	2	1.0
Golden Whistler	*Pachycephala pectoralis*	21	2	102	42.6
Rufous Whistler	*Pachycephala rufiventris*	16	5	28	11.0
Grey Shrike-thrush	*Colluricincla harmonica*	21	3	117	45.0
Australasian Figbird	*Sphecotheres vieilloti*	2	2	3	1.0
Olive-backed Oriole	*Oriolus sagittatus*	10	3	20	7.2
Dusky Woodswallow	*Artamus cyanopterus*	1	3	6	1.4
Grey Butcherbird	*Cracticus torquatus*	12	2	25	10.5
Pied Butcherbird	*Cracticus nigrogularis*	5	2	11	3.8
Australian Magpie	*Cracticus tibicen*	12	5	46	16.3
Pied Currawong	*Strepera graculina*	21	26	300	44.0
Rufous Fantail	*Rhipidura rufifrons*	2	1	2	1.0
Grey Fantail	*Rhipidura albiscapa*	21	6	201	50.7
Willie Wagtail	*Rhipidura leucophrys*	10	6	61	17.7
Australian Raven	*Corvus coronoides*	5	3	13	4.3
Little Raven	*Corvus mellori*	6	7	18	4.3
Leaden Flycatcher	*Myiagra rubecula*	10	4	20	6.2
Restless Flycatcher	*Myiagra inquieta*	1	1	1	0.5
Black-faced Monarch	*Monarcha melanopsis*	8	3	20	5.3
Magpie-lark	*Grallina cyanoleuca*	4	2	15	5.3
Jacky Winter	*Microeca fascinans*	6	3	31	8.6
Scarlet Robin	*Petroica boodang*	1	1	1	1.0
Rose Robin	*Petroica rosea*	9	1	10	5.7
Eastern Yellow Robin	*Eopsaltria australis*	21	3	86	35.9
Rufous Songlark	*Cincloramphus mathewsi*	1	2	2	1.4
Silvereye	*Zosterops lateralis*	18	15	220	27.8
Welcome Swallow	*Hirundo neoxena*	5	10	36	7.2
Tree Martin	*Petrochelidon nigricans*	2	12	43	2.9
Mistletoebird	*Dicaeum hirundinaceum*	8	5	19	6.7
Double-barred Finch	*Taeniopygia bichenovii*	2	9	18	1.9
Red-browed Finch	*Neochmia temporalis*	20	40	394	28.7

[1] Surveys conducted at 21 sites.
[2] A total of 209 surveys were conducted.

Table 1B. Fifteen species recorded outside of survey time limits or in other areas of the park

Common name	**Scientific name**	**Details**
Australian Brush-turkey	*Alectura lathami*	One bird on the Mernot track between Sites 3 and 4 in April 2012.
White-headed Pigeon	*Columba leucomela*	One or more birds feeding in fig trees overhanging the Barnard River Site, 16 February 2013.
Common Bronzewing	*Phaps chalcoptera*	Single birds foraging on the track at Mernot Sites 4 and 7, in May 2010 and November 2011.
Australian Owlet-Nightjar	*Aegotheles cristatus*	Heard from Homestead Site 17, January 2010.
Pied Cormorant	*Phalacrocorax varius*	One bird flying up the Barnard River at Site 16, July 2013.
White-necked Heron	*Ardea pacifica*	One bird flying up the Barnard River at Site 17, November 2011.
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	Single birds over the Barnard River in September 2010 and April 2012.
Australian Hobby	*Falco longipennis*	Observed from the Homestead Site 17 in January 2010 and February 2013.
Buff-banded Rail	*Gallirallus philippensis*	One bird foraging in the Homestead garden Site 17, January 2010.
Galah	*Eolophus roseicapillus*	Single birds recorded from the Homestead Site 17, flying towards Giro Station, January and May 2010.
Southern Boobook	*Ninox novaeseelandiae*	Heard from Homestead Site 17 several times and at Site 3, November 2011.
Regent Bowerbird	*Sericulus chrysocephalus*	Seen after time at Site 3, 31 January 2010 and at ruined cottage site on 30 January 2010.
Fairy Martin	*Petrochelidon ariel*	Several birds observed at Curricabark Site 10, February 2013.
Bassian Thrush	*Zoothera lunulata*	Single bird flushed on the track near Mernot Site 5, September 2010.
Common Myna	*Sturnus tristis*	Two birds observed from Homestead Site 17 in January and May 2010.

Table 2. Species listed as Vulnerable under the NSW *Threatened Species Conservation Act 1995*

Common name	**Scientific name**	**Details**
Wompoo Fruit-Dove	*Ptilinopus magnificus*	Four recorded Site 16 August 2011 foraging in fig trees flanking river.
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	Present in steep woodland, usually in groups of two or three, where *Allocasuraina sp.* present and once at Barnard River Site 16. Maximum number at one time, 11 perched in dead tree at Site 7 August 2011.
Speckled Warbler	*Chthonicola sagittata*	Recorded seven times in open woodland with good shrub layer and thick grass at Sites 9, 16, 17, MT1 and MT2. Site 16 was deserted after floods mid 2011 when most small birds moved up hill to Site 17, including the warblers.
Varied Sittella	*Daphoenositta chrysoptera*	Groups of three recorded at Site 8 May 2010, Site 9 February 2011 and Site MT1 May 2011.
Scarlet Robin	*Petroica boodang*	One recorded at Site 17 July 2012 and a pair April/July 2012 at Site 16.

Table 3. Spring and autumn migration movements

Month / year	Observations
May 2010	Parties of Noisy Friarbirds, Australasian Figbirds, Yellow-faced Honeyeaters and Silvereyes flying over the Homestead Site 17 from the ridge behind, down to and following the Barnard River.
September 2010	Parties of Spotted Pardalotes and Yellow-faced Honeyeaters flying over the Homestead Site 17 and ridge behind, north and west into Mernot and Curricabark Creek valleys.
August 2011	Yellow-faced and White-naped Honeyeaters and Silvereyes migrating in small groups, flying up the Barnard River valley and over the Homestead into Mernot and Curricabark Creek valleys. Many Scarlet Honeyeaters present.
April 2012	Small parties of Yellow-faced Honeyeaters passing over the Homestead south to the Barnard River, some stopping to feed in flowering grevillea in the garden.
February 2013	Noisy Friarbirds at Site 4 exhibiting pre-migratory behaviour, calling and assembling.

Table 4. Observations and calls recorded of nocturnal species

Species	Observations
Tawny Frogmouth *Podargus strigoides*	Recorded during survey at Site 17 January 2010.
White-throated Nightjar *Eurostopodus mystacalis*	Heard at night calling from the hillside behind the Homestead in January 2010 and two flushed during survey at Site 3 November 2011.
Australian Owlet-nightjar *Aegotheles cristatus*	Heard once at the Homestead in January 2010.
Southern Boobook *Ninox novaeseelandiae*	Heard at night on several occasions from the Homestead Site 17 and once at Site 3 November 2011.

Table 5. Sightings recorded of raptor species

Species	Observations
Black-shouldered Kite *Elanus axillaris*	A pair seen from the Homestead Site 17, February 2013 and recorded at Sites 10, 11 and 12A in the Curricabark Valley.
White-bellied Sea-Eagle *Haliaeetus leucogaster*	Single adult and an immature observed flying over the Barnard River in September 2010 and April 2012 respectively.
Brown Goshawk *Accipiter fasciatus*	Recorded at Site 17 and Sites 7 and MT2 Mernot Track and Sites 11, 12 and 12A Curricabark Track.
Grey Goshawk *Accipiter novaehollandiae*	Recorded November 2011 at Sites 14 and 15 Curricabark Track. Second sighting possibly the same bird or mate of one at Site 14.
Wedge-tailed Eagle *Aquila audax*	A pair usually seen from the Homestead Site 17 and in the Curricabark and Mernot Creek valleys. Two adults observed May 2010 harassing two immature eagles at Site 17. Recorded all visits.
Nankeen Kestrel *Falco cenchroides*	A pair recorded at the Homestead Site 17 in January, May and September 2010, but not since.
Brown Falcon *Falco berigora*	One or two recorded in open areas of the Curricabark Valley at Sites 10, 11 and 12.
Australian Hobby *Falco longipennis*	Recorded at Homestead Site 17 in January 2010 and February 2013.
Black Falcon *Falco subniger*	An unusual record of one at Site 10 Curricabark valley in February 2013.

DISCUSSION

The intention of this initial paper is to place on record the inventory of bird species present in the areas of Curracabundi National Park surveyed during the period 2010-2013 and to draw general conclusions related to the objectives of this study. A subsequent paper will provide more detailed discussion of the distribution of species between the survey sites with a focus on the importance of different habitat types.

While the statistics presented in **Tables 1A** and **1B** are considered to provide a comprehensive inventory of the birds of Curracabundi National Park and their relative abundance, there are some caveats. Recording birds during surveys depends heavily on detection by call. Certain species advertise their presence loudly in response to the disturbance caused during a survey and are easily detectable. The most frequently recorded species, the Lewin's Honeyeater *Meliphaga lewinii* (RR 70.3%; 21 survey sites) being a typical example. Others like the Eastern Yellow Robin *Eopsaltria australis* (RR 35.9%) and Grey Shrike-thrush *Colluricincla harmonica* (RR 45.0%) were also recorded at every site, although both were only present in small numbers. Seasonal variations in the intensity of calling may impact on the detectability of some species. Other species present in small numbers may be under-reported because of their cryptic nature, while migratory species are only present seasonally.

Numbers of migratory species in particular increased when passing through the study area during spring and late summer, examples being Spotted Pardalote *Pardalotus punctatus*, Yellow-faced Honeyeater *Lichenostomus chrysops* and White-naped Honeyeater *Melithreptus lunatus*. The effectiveness of mid-summer surveys in woodland sites was adversely affected by the presence of large noisy Bell Miner *Manorina melanophrys* colonies and by loud cicada calls which masked other bird calls.

Superb Fairy-wrens *Malurus cyaneus* (RR 46.4%; 20 survey sites), usually absent from woodland sites, were often present in large family groups in open grassy areas and track edges. Pied Currawongs *Strepera graculina* (RR 44.0%; 21 survey sites) formed large flocks in winter, particularly around fruiting fig trees lining the Barnard River Site 16. Crimson Rosellas *Platycercus elegans* formed flocks in winter, particularly near the Homestead Site 17, and feeding parties of smaller species were recorded at woodland sites.

The 15 species recorded outside of survey time limits (**Table 1B**) tended to be those that are normally present in small numbers. The small flock of Fairy Martins *Petrochelidon ariel* noted in February 2013 could have been passing through as no other sightings were made and no signs of breeding observed.

Cryptic species resident year round might reveal themselves more openly depending on weather conditions or time of year, such as a spike in Spotted Quail-thrush *Cinclosoma punctatum* and Brown Quail *Coturnix ypsilophora* sightings in May 2011.

There was a marked difference in species variety and numbers between steep dry north and north-west facing woodland, wet rainforest gullies facing south and south-east, and open grassy riverine sites edged with forest, such as the latter surrounding the Homestead and Barnard River Sites 16 and 17 and the open grassy valley around Curricabark Creek Sites 10 and 11. In addition it was more difficult to locate birds when large colonies of Bell Miners were present, particularly along the Mernot Creek track between Sites 4 and 7, making it difficult to hear other bird calls and because they are known to exclude congeners.

The least number of species were recorded at the most distant sites, Curricabark Creek Sites 13, 14 and 15 and Mernot Site MT3 (between 7 and 10km from the Homestead). Although the former were only surveyed seven times and the latter eight times, the nature of these sites is such that they are considered unlikely to show much increase in bird abundance if surveyed more frequently, although it could result in an increase in species diversity. Bird presence decreased the higher one penetrated the creek beds as they became narrower, darker and more densely edged with casuarinas and vines.

Over the three years of surveys, shrub and tree regrowth in the cleared grassy areas at Sites 1, 9, 10, 11, 12, 13 and 14, was beginning to change the nature of these sites, and may in time alter species composition unless fire limits regrowth. However, regrowth of rainforest vegetation in the gully Sites 5 and 6 on Mernot Track may take many years to markedly change the habitat, partly due to heavy vine growth strangling young rainforest trees. Their present more open character should continue to attract the same species in the near future.

Taking into account the wide range of weather conditions that Australia is noted for and which were experienced during the three years of this project, field surveys conducted over a limited time will not record every species likely to be present. Weather conditions in the study area and the east coast of Australia generally are unpredictable and in this instance impacted on several occasions on this study's results. For instance heavy rainfall higher up the catchment made creeks unfordable in May 2010 and September 2010 and flooding of the Barnard River causeway in 2012 forced the cancellation of two survey visits. These variations in conditions may impact both short-term and longer-term changes in the diversity of bird populations. Consequently, it is anticipated that further survey effort in this section of Curracabundi National Park would increase the species list for the study area. Unfortunately the intensive short duration survey method used in this study did not provide time for detailed assessment of bird behaviour and consequently breeding behaviour was under-reported.

CONCLUSIONS

The range of species recorded in this study (**Tables 1A** and **1B**), clearly shows that Curracabundi National Park is an important reserve for eastern Australian woodland birds, many of which are in decline as urbanisation and land clearing continues to eat away at their habitat. The presence of five threatened species strongly supports the gazetting of the area as Wilderness and National Park and its value as a vital migration link in the Great Eastern Ranges Corridor.

This study provides a baseline against which the impact of the ongoing management of the Park on its bird populations can be assessed.

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APPENDIX

Survey site locations and basic habitat descriptions

Site 1 Homestead Track – 10 Surveys (31° 40′ 07″ S, 151° 44′ 40″ E) BLA Birdata Site ID 20125. Track behind Homestead rising steeply through cleared woodland with grass, weeds and regrowth of *Acacia* sp., facing south-east over the Barnard River valley.
Site 2 Homestead Track – 10 Surveys (31° 40′ 14″ S 151° 43′ 56″ E) BLA Birdata Site ID 20126. Track through regrowth woodland, mainly *Acacia* sp., on steep dry stony hillside with shrubs, vines, lantana and *Xanthorrhoea* sp. in drainage line.
Site 3 Homestead Track – 10 Surveys (31° 40′ 18″ S 151° 43′ 56″ E) BLA Birdata Site ID 20127. A clearing at top of steep-sided ridge with dry dam; view through acacia/eucalypt woodland into Curricabark and Barnard valleys.
Site 4 Mernot Track – 10 Surveys (31° 40′ 21″ S 151° 43′ 23″ E) BLA Birdata Site ID 20128. Steep closed canopy, grassy eucalypt/allocasuarina woodland on sharp bend in track with one small fig and sparse understorey shrubs.
Site 5 Mernot Track – 10 Surveys (31° 40′ 23″ S 151° 43′ 00″ E) BLA Birdata Site ID 20129. Rainforest over deep drainage line with regrowth, thick grass, dense creepers and introduced weeds, and dry eucalypt/acacia open forest above the track.
Site 6 Mernot Track – 10 Surveys (31° 40′ 35″ S 151° 42′ 46″ E). BLA Birdata Site ID 20130. Steep track with remnant rainforest below and dry eucalypt/acacia open woodland above.
Site 7 Mernot Track – 10 Surveys (31° 40′ 45″ S 151° 42′ 18″ E) BLA Birdata Site ID 20131. Ford over Mernot Creek in deep gully, lined with casuarinas *Casuarina cunninghamiana*, lilly pillies and other rainforest shrubs.
Site 8 Curricabark Track – 10 Surveys (31°40′ 25″ S 151° 44′ 10″) BLA Birdata Site ID 20132. Steep mixed dry woodland with rainforest gully falling to valley below.
Site 9 Curricabark Track – 9 Surveys (31° 40′ 36″ E 151° 44′ 21″ E) BLA Birdata Site ID 20133. Steep mixed dry woodland with rainforest gully giving way to grassland with regrowth encroaching, overlooking the valley.
Site 10 Curricabark Track – 10 Surveys (31° 40′ 54″ S 151° 44′ 31″ E) BLA Birdata Site ID 20134. Drainage gully in open grassland with some large casuarinas and remnant rainforest shrubs/trees and weeds, including false tobacco.
Site 11 Curricabark Track – 10 surveys (31° 41′ 03″ S 151° 44′ 34″ E) BLA Birdata Site ID 20135. Woodland edging Curricabark Creek, with casuarinas, remnant rainforest and regrowth, and cattle yards in open grassland with remnant forest eucalypts. Evidence of feral bulls present at most survey visits.
Site 12 Curricabark Track – 8 Surveys (31° 41′ 24″ S 151° 44′ 25″ E) BLA Birdata Site ID 20136. Cleared grassy ridge with two large eucalypts surrounded by lantana and weeds, falling steeply down into rainforest creek gully. By February 2013 advancing regrowth of acacia and *Dodonea* sp. and introduced weeds was starting to change the habitat.
Site 12A Curricabark Track – 8 Surveys (31° 41′ 24″ S 151° 44′ 15″ E) BLA Birdata Site ID 20169. Curricabark Creek with grassy banks, lantana and other weeds, edged with rainforest and eucalypt woodland. Evidence of feral bulls at most surveys.
Site 13 Curricabark Track – 7 Surveys (31° 41′ 40″ S 151° 43′ 28″ E) BLA Birdata Site ID 20137. Cleared grassy ridge surrounded by dry eucalypt woodland sloping steeply to Curricabark Creek. Regrowth starting to encroach.
Site 14 Curricabark Track – 7 Surveys (31° 41′ 40″ S 151° 43′ 09″) BLA Birdata Site ID 20138. Steep grassy ridge and track surrounded by dry eucalypt woodland with regrowth encroaching from the edges.
Site 15 Curricabark Track – 7 Surveys (31° 41′ 54″ S 151° 47′ 35″ E) BLA Birdata Site ID 20139. This deep gully is the final site on the Curricabark track, the old track beyond the creek being overgrown and impassable. Large *Casuarina cunninghamiana* trees line the grassy creek bed with rainforest trees, shrubs and a few weeds, and open woodland above.
Site 16 Barnard River – 10 Surveys (31° 40′ 05″ S 151° 45′ 05″ E) BLA Birdata Site ID 20140. River flats with White Cedars *Melia azedarach*, a large dead eucalypt and shrubs looking across the river to a cliff face with massed fig trees at base, grass trees, lantana and other trees/shrubs on almost vertical stony slope with eucalypts on the ridge above. Several severe floods in mid-2011 cleared the river flats of most vegetation and removed the dead tree, leaving a deep layer of gravel.
Site 17 Karamea Homestead – 10 surveys (31° 39′ 57″ S 151° 44′ 54″ E) BLA Birdata Site ID 20141. Homestead with fenced garden containing exotic and native trees, shrubs and fruit trees, backed by an overgrown vegetable garden on the west, cleared drainage line with exotic pines on the east, areas of mown grass in front leading to weedy steep river bank facing south-east over the Barnard River and down the valley.
Site MT1 Mernot Track – 8 Surveys (31° 40′ 50″ S 151° 42′ 15″ E) BLA Birdata Site ID 20170. Steep dry ridge of grassy woodland with allocasuarinas, angophoras and shrubs, edged by rainforest and eucalypt woodland. Eight surveys were carried out following clearance of the track by NPWS staff.
Site MT2 Mernot Track – 8 Surveys (31° 41′ 05″ S 151° 42′ 08″ E) BLA Birdata Site ID 20171. Grassy promontory surrounded on three sides by Mernot Creek, with eucalypts, rainforest and understorey shrubs, and weedy scrub and false tobacco encroaching from the edges. Eight surveys were carried following clearance of the track by NPWS staff.
Site MT3 Mernot Track – 8 Surveys (31° 41′ 09″ S 151° 41′ 57″) BLA Birdata Site ID 20172. Narrow stony rainforest gully formed by the creek and lined with *Casuarina cunninghamiana,* vines and scrub. Eight surveys were carried out following clearance of the track by NPWS staff.

Bird surveys of Cattai Wetlands (2006 to 2014) on the mid-north coast of New South Wales

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Avifaunal surveys were undertaken by members of Manning Great Lakes Birdwatchers at Cattai Wetlands, ~20km northeast of Taree in New South Wales, between July 2006 and June 2014. 178 species were recorded from 63 surveys with an additional seven species recorded by others during unscheduled visits and a single species observed in farmland immediately adjacent. Of these, ten species are listed as either vulnerable or endangered under the *Threatened Species Conservation Act 1995* (NSW). 38 species were recorded as breeding, of which one, the Comb-crested Jacana *Irediparra gallinacea*, is a listed species.

The initial purchase of the land, incorporating Cattai Wetlands, by Greater Taree City Council was to remediate land affected by acid sulphate soil. Sections of land surrounding the affected areas include examples of seven vegetation communities listed under the *Threatened Species Conservation Act 1995* (NSW), within which some of the surveys were conducted. This variety of habitats also supported several over-wintering species typically considered to be partly or fully migratory within the Hunter Region. Revegetation works and ongoing weed control will enhance the areas surveyed into the future.

INTRODUCTION

A parcel of land (~450 ha), containing Cattai Wetlands (**Figure 1**), was purchased by Greater Taree City Council (GTCC) in 2003. Whilst remediation of land affected by acid sulphate soil, which ultimately discharges into the Manning River, was the principal reason for the purchase, additional benefits of a wildlife corridor linking Crowdy Bay National Park in the east with Coopernook State Forest to the west and providing an educational centre for wetland management for GTCC, were also identified.

During an ecological assessment of the property by Graham (2004), 72 bird species were identified during three days of field survey in the month of December. Realising an opportunity to contribute ongoing avifaunal data through systematic surveys, Win Filewood (LWF) contacted GTCC in early 2006, on behalf of Manning Valley Birdwatchers (now Manning Great Lakes Birdwatchers Inc. MGLBW), regarding access to Cattai Wetlands to undertake regular bird surveys.

Site Description

Cattai Wetlands (31°50'S, 152°38'E) are located ~20 km north-east of Taree, on the mid-north coast of New South Wales (NSW). The site is ~10 km west and ~6 km northwest of the coastal villages of Crowdy Head and Harrington respectively. Land portions around Cattai Wetlands were alienated from the crown in 1876 (B. Crisp pers. comm.). A compilation of portion plans from that time indicates that Cattai Wetland was a 'Tea Tree swamp heavily timbered', the area either side of the 'Saltwater channel' (Coopernook Creek) being 'dry ferny land' and the northern bank of Coopernook Creek, west of Cattai Wetland, was a 'Tea tree swamp' (Smith *et al*. 2006, p. 40). Atkinson *et al*. (2003) suggest that as recently as 2000 years ago (late Holocene period), Cattai Wetlands was an open-water coastal lagoon. Sedimentation of the Manning River delta over the ensuing years has resulted in the formation of the surrounding coastal floodplain area.

From the original purchase by GTCC, four 10 ha lots in the central western section were subdivided and sold off. Of the remaining parcel, surveys were undertaken in the lower portion covering ~84 ha and were divided into five distinct areas (**Figure 2**) with vegetation types, as described by Graham (2004), as follows:

Giants Footprint (GF) is the main perched freshwater wetland (Cattai Wetland) with fringing swamp sclerophyll forest, dominated by Broad-leaved Paperbark *Melaleuca quinquenervia* and

Figure 1. Location of areas surveyed (hatched) within the whole Cattai Wetlands parcel (black outline). Aerial image courtesy of Greater Taree City Council.

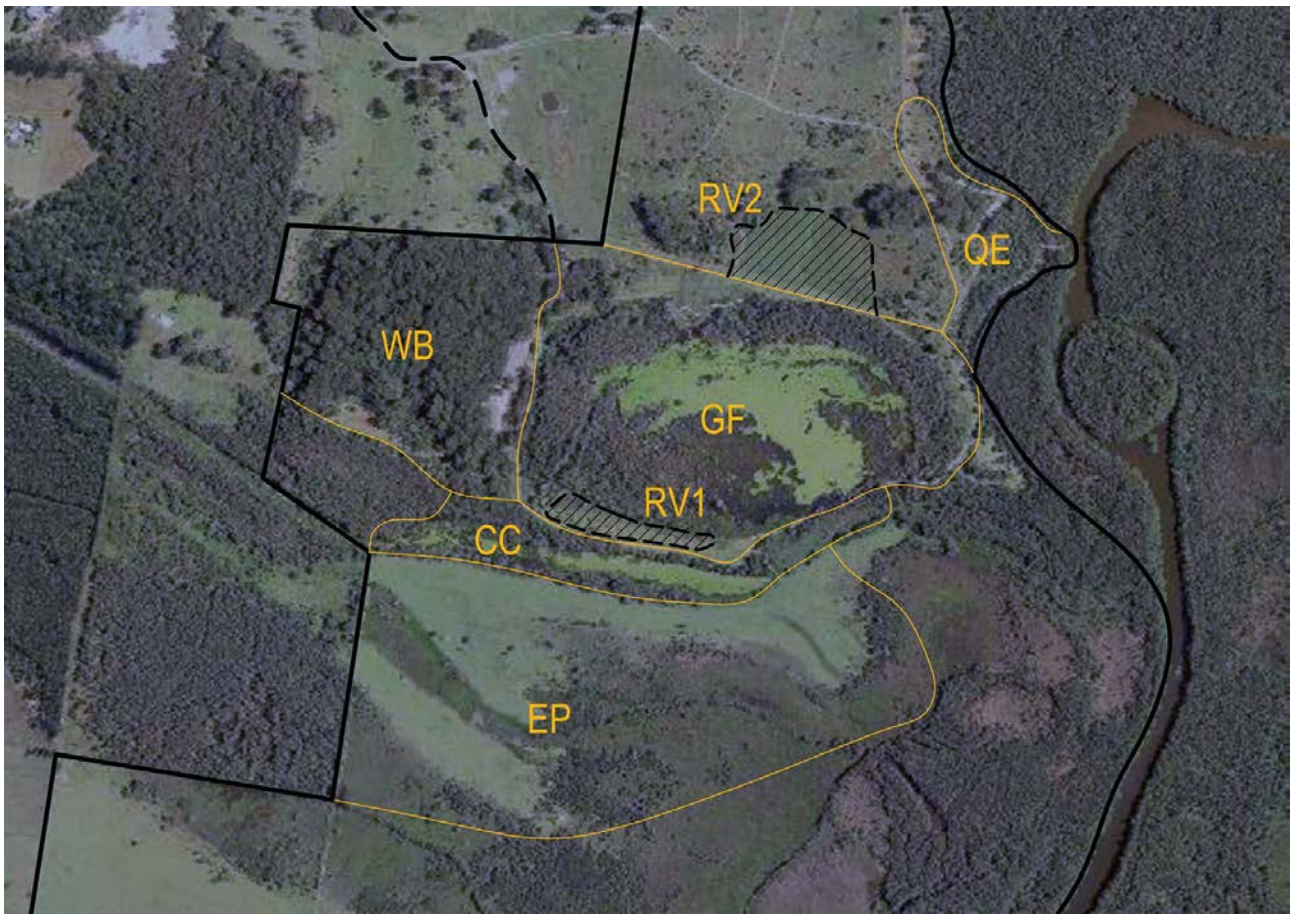

Figure 2. Location of individual survey areas at Cattai Wetlands. GF = Giants Footprint; CC = Coopernook Creek; QE = Quarry Extension; WB = Western Block; EP = Electric Paddock; RV1& RV2 = Revegetation Areas 1 and 2 (refer to text for descriptions). Aerial image courtesy of Greater Taree City Council.

Swamp Oak *Casuarina glauca*. Covering an area of ~17 ha, the wetland has a maximum depth of 0.8 m. The open water is fringed by a diverse range of sedges and rushes (e.g. *Elaeocharis* and *Triglochin spp*.) and approximately half the open water area is covered by flowering Cape Waterlily *Nymphaea sp*. during the warmer months. Numerous emergent Swamp Oaks are scattered throughout the open water and provide roosting areas at their bases for aquatic birds. When purchased by GTCC the wetland water level was controlled by a natural earth bank overflow, which was often soft and boggy and which discharges into Coopernook Creek. In March 2008 GTCC constructed a concrete causeway, with a small low-flow channel, which deliberately raised the water level by approximately 200mm.

Coopernook Creek (CC) flows along the southern side of the GF and enters Cattai Creek, which forms the eastern boundary of the site. Once known as Saltwater Creek, CC is now predominantly a freshwater lagoon which overtops a redundant floodgate during rainfall events. Riparian vegetation along CC is classed as floodplain rainforest and characterised by emergent sclerophyll eucalypts mixed with fig trees *Ficus spp*., palms, Cheese Tree *Glochidion ferdinandii* and a dense ground layer of *Lomandra spp*. A previously cleared strip of land between CC and GF has been revegetated (RV1; planted in 2006) with floodplain rainforest species.

Quarry Extension (QE) forms the northeastern section of the survey area and contains the remains of a gravel pit. The elevated ridge in this vicinity contains dry sclerophyll forest species of Blackbutt *Eucalyptus pilularis*, Tallowwood *E. microcorys*, Flooded Gum *E. grandis*, Northern Grey Ironbark *E. siderophloia*, Grey Gum *E. punctata* and White Bottlebrush *Callistemon salignus*. Downslope to the south, towards GF, is a stand of Brush Box *Lophostemon confertus* while on the eastern slopes is the mangrove forest and woodland complex of riparian vegetation along Cattai Creek dominated by Grey *Avicennia marina* and River Mangroves *Aegiceras corniculatum* and Swamp Oak.

Western Block (WB) is an elevated knoll on the western end of the survey area and is bordered on the north (cleared) and west (heavily vegetated) by private property and to the south by Coopernook Creek. The knoll is covered by mature closed dry sclerophyll forest consisting of the same species as those listed in QE above. A small section of Brush Box wet sclerophyll forest is also present on the southern foot slopes which grade to CC.

Electric Paddock (EP) is located on the southern side of Coopernook Creek and was previously used for grazing. With stock removed, the land now consists of tall rank mixed grass species. Several remnant paddock trees suggest that this area was previously covered by Floodplain Rainforest species. Saltmarsh is located to the southeast of this area and was not included in the surveys.

Many of these vegetation types are listed as ecologically endangered communities (EEC), under the NSW *Threatened Species Conservation Act 1995* (*TSC Act*):

- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions
- Freshwater Wetlands on Coastal Floodplains on the NSW North Coast, Sydney Basin and South East Corner Bioregions
- Lowland Rainforest on Floodplain in the NSW North Coast Bioregion
- Subtropical Coastal Floodplain Forest of the NSW North Coast Bioregion
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions
- River-Flat Eucalypt Forest on Coastal Floodplains in the NSW North Coast, Sydney Basin and South East Corner Bioregions

Additional to the revegetation area (RV1) between CC and GF, a second area, located centrally to the north of GF, has also been revegetated (RV2; planted in 2010) with a mixture of wet and dry sclerophyll species.

METHODS

Between July 2006 and June 2009, surveys were undertaken monthly. From July 2009 to June 2014, surveys were programmed to alternate between every second and third month, which over five years resulted in an additional two surveys for each month and a total of five surveys per month over the eight year duration. Although five distinct areas were recognised within the site, not all of these were surveyed each time due to numbers of observers available on any given survey day. When there was a minimum number of observers, priority was given to surveying GF. Although recorded separately, surveys of the adjacent CC were undertaken at the same time, with analysis combining both areas. Surveys of the QE did not begin until January 2009, and, from that time on, they were usually included as an addition while surveying GF. LWF undertook two additional surveys, one in November 2007 and another in July 2012, which have been included in the analyses covering those areas surveyed. Unfortunately, following LWF's death in January 2014, it became apparent that the results of five surveys from July 2010 to May 2011 had been lost.

Surveys generally started within an hour of sunrise and lasted ~3 hours. Observers recorded both species and numbers of individuals sighted in each distinct area. Movement by birds between areas was noted so that they could be recorded for each site in which they were observed but only counted once for the entire area. Additionally, some observers tracked across the same areas, at different times, to commence or return from their specific survey areas (e.g. around GF and along CC to get to EP). At the completion of surveys, estimates were made of any overlaps in counts, and the total figures reduced accordingly. Occasionally, birds were observed in another area (not being properly surveyed) and recorded against that area. Therefore, areas that recorded fewer than 5 species were not counted as a survey for analysis purposes, but the observations were included in any overall analysis. Birds were recorded either visually or audibly by survey teams consisting mostly of two observers, occasionally three, and rarely a single observer. Abilities varied considerably amongst observers, for both visual and audio detection and identification, from relative beginners to experienced. Beginners were paired with experienced observers.

For seasonal comparisons, the following months have been combined: winter (June, July and August), spring (September, October and November), summer (December, January and February) and autumn (March, April and May). Due to the variation in months surveyed during the winter and summer periods, calculations for winter and summer visitors compared the percentage of surveys that the species was present during both these seasons. For inclusion, a species needed to be recorded a minimum of four times during either winter or summer and at least five times more frequently during summer than winter or vice-versa.

A comparison of aquatic species, recorded in more than ten surveys within GF only, has also been made between numbers before and after construction of the

concrete causeway. Both the percentage of surveys observed in and average number of individuals recorded have been compared in this calculation.

Breeding records were based on the following criteria: active visible nest, feeding of dependent juvenile, observing a recently fledged juvenile, downy (runner) aquatic species or repeated visits to a nest (e.g. termitarium by a kingfisher or bank hole by pardalote) or small patch of vegetation (e.g. clump of grass by a fairy-wren) with food.

Supplementary records have also been sourced from observations published on the local Hunterbirding network (https://au.groups.yahoo.com/neo/groups/hunterbirding/info), a campout held by the Hunter Bird Observers Club (HBOC) from 1-5 October 2010 and observations by members of the MGLBW during non-scheduled visits.

RESULTS

In total, 63 surveys were completed. With the loss of five data sets, **Table 1** lists 58 counts, which includes two additional surveys undertaken by LWF and also correlates with the number of surveys undertaken around GF and CC. Surveys undertaken in individual months varied from 4 to 7, with an average of 4.8 surveys per month over the 8-year period. For the other individual areas, QE, WB and EP, counts are 25, 54 and 44 respectively. Excluding the two additional surveys, there was an average of 6.8 (n = 56; range 3-11) observers present for each of the surveys.

From these surveys, 178 species of birds were recorded within the survey area, one additional species, Restless Flycatcher *Myiagra inquieta*, was recorded within the farmland immediately adjacent and 38 species were recorded breeding (see species list in the **Appendix**). A further seven species have been recorded by observers supplementally to these surveys and are also shown in the **Appendix**. Ten of these species are listed as either vulnerable or endangered under the *TSC Act*. Numbers of bird species and total number of birds observed on a seasonal basis for all and individual survey areas are summarised in **Table 2**.

Species recorded in more than 75% of surveys of individual areas have been considered as resident within this data set (refer **Appendix**). Of these 30 species, only four, namely Superb Fairy-wren *Malurus cyaneus*, Brown Thornbill *Acanthiza pusilla*, Lewin's Honeyeater *Meliphaga lewinii* and Grey Fantail *Rhipidura fuliginosa*, were present during all surveys (n = 58) of the combined GF and CC areas, while Striped Honeyeater *Plectorhyncha lanceolata* and Red-browed Finch *Neochmia temporalis* were absent from one survey (n = 57) in these same areas. Within QE, both Brown Gerygone *Gerygone mouki* and Lewin's Honeyeater were recorded in all but one survey (n = 24) while the most recorded species in WB was Grey Fantail, which was absent from two surveys (n = 52).

35 species were classed as either a winter or a summer visitor to Cattai Wetlands as indicated in the **Appendix**. Winter visitors include Cattle Egret *Ardea ibis* (EP), Striated Pardalote *Pardalotus striatus* (GF/CC and WB), Scarlet Honeyeater *Myzomela sanguinolenta* (EP), Olive-backed Oriole *Oriolus sagittatus* (EP) and White-breasted Woodswallow *Artamus leucorynchus* (EP). Summer visitors include Swamp Harrier *Circus approximans* (EP), Red-backed Fairy-wren *Malurus melanocephalus* (GF/CC) and Crested Shrike-tit *Falcunculus frontatus* (WB).

Excluding GF and CC, the following eight species of birds were recorded in single areas only, with the number of times recorded shown in brackets: Lewin's Rail *Lewinia pectoralis* (1 immature specimen found dead tangled in fence wire) in QE; Square-tailed Kite *Lophoictinia isura* (5), Crimson Rosella *Platycercus elegans* (6) and Bassian Thrush *Zoothera lunulata* (1) in WB; and Rock Dove *Columba livia* (1), Australasian Bittern *Botaurus poiciloptilus* (1), Jacky Winter *Microeca fascinans* (1) and Double-barred Finch *Taeniopygia bichenovii* (1) in EP.

Recording rates and average numbers of individuals of aquatic species before and after construction of the concrete causeway are shown in **Table 3**. Beneficiaries of the resultant increased water levels include the dominant Anseriforme and Gruiforme species as well as Australasian Grebe *Tachybaptus novaehollandiae*. Conversely, several of the wading Ciconiiforme species were impacted negatively. Of the 17 compared, four species showed an increase in recording rates and only a single species a decrease, being Straw-necked Ibis *Threskiornis spinicollis*. However when comparing the average number of individuals, eight species showed an increase with three reflecting a decrease.

Table 1. Number of surveys within and months of surveys undertaken at Cattai Wetlands between July 2006 and June 2014. x = months where data was lost (refer to comments in Methods)

Month	2006	2007	2008	2009	2010	2011	2012	2013	2014	Monthly Totals
January		1	1	1					1	4
February		1	1	1	1	x		1		5
March		1	1	1			1			4
April		1	1	1	1			1	1	6
May		1	1	1		x	1			4
June		1	1	1					1	4
July	1	1	1		x	1	1 [a]	1		6
August	1	1	1				1	1		5
September	1	1	1	1	x					4
October	1	1	1			1				4
November	1	2[a]	1	1			1	1		7
December	1	1	1	1	x	1				5

[a] - Additional survey undertaken by Win Filewood

Table 2. Summary of seasonal numbers of bird species and individuals recorded during surveys at Cattai Wetlands between July 2006 and June 2014

Survey Areas		Overall	Winter	Spring	Summer	Autumn
All surveys combined						
Bird Species	Count (*n*)	58	15	15	14	14
	Average	69.9	62.5	76.5	75.1	65.8
	Minimum	41	48	61	57	41
	Maximum	94	81	86	94	79
Number of Birds	Average	720.1	733.1	714.1	683.6	748.9
	Minimum	232	265	272	291	232
	Maximum	1192	1042	1192	810	1100
Cattai Wetland and Coopernook Creek						
Bird Species	Count (*n*)	58	15	15	14	14
	Average	57.2	51.8	63.0	60.8	53.0
	Minimum	26	41	52	45	26
	Maximum	80	67	73	80	65
Number of Birds	Average	454.6	471.8	452.8	427.5	465.3
	Minimum	90	214	186	165	90
	Maximum	915	727	915	581	788
Quarry Extension						
Bird Species	Count (*n*)	25	7	4	7	7
	Average	20.7	20.7	21.5	20.6	20.4
	Minimum	9	11	9	14	13
	Maximum	31	28	31	29	24

Table 2. Summary of seasonal numbers of bird species and individuals recorded during surveys at Cattai Wetlands between July 2006 and June 2014 (cont.)

Survey Areas		Overall	Winter	Spring	Summer	Autumn
Quarry Extension cont.						
Number of Birds	Average	67.4	66.6	84.8	66.7	59.1
	Minimum	16	16	5	49	25
	Maximum	118	107	118	101	82
Western Block						
Bird Species	Count (*n*)	54	12	15	14	13
	Average	32.1	28.7	33.5	31.4	34.3
	Minimum	16	17	16	18	25
	Maximum	53	37	44	40	53
Number of Birds	Average	161.6	180.2	138.3	132	203.2
	Minimum	38	38	45	49	123
	Maximum	476	476	262	259	346
Electric Paddock						
Bird Species	Count (*n*)	44	9	13	11	11
	Average	22.3	22.6	22.5	24.5	19.6
	Minimum	7	10	7	14	8
	Maximum	41	36	41	37	31
Number of Birds	Average	91.3	106.4	91.0	92.4	78.4
	Minimum	9	31	9	46	14
	Maximum	208	188	208	151	135

Table 3. Summary of aquatic bird species and individuals recorded before and after construction of the concrete causeway during surveys at Cattai Wetlands between July 2006 and June 2014. Ratio values greater than 1.5 are considered to be an increase (**bolded**) and values less than 0.7 a decrease (*italicised*).

Common Name	Scientific Name	Percentage of Surveys Recorded (%)			Average Number of Individuals Recorded		
		Pre	Post	Ratio	Pre	Post	Ratio
Black Swan	*Cygnus atratus*	81.8	88.6	1.1	7.1	10.0	1.4
Grey Teal	*Anas gracilis*	54.5	68.6	1.3	15.7	13.8	0.9
Chestnut Teal	*Anas castanea*	77.3	68.6	0.9	7.9	17.6	**2.2**
Pacific Black Duck	*Anas superciliosa*	90.9	100.0	1.1	20.9	57.1	**2.7**
Hardhead	*Aythya australis*	18.2	57.1	**3.1**	4.5	15.3	**3.4**
Australasian Grebe	*Tachybaptus novaehollandiae*	77.3	62.9	0.8	3.4	6.0	**1.8**
Little Pied Cormorant	*Microcarbo melanoleucos*	13.6	68.6	**5.0**	2.0	2.8	1.4
Little Black Cormorant	*Phalacrocorax sulcirostris*	36.4	48.6	1.3	5.9	6.6	1.1
Australian Pelican	*Pelecanus conspicillatus*	45.5	48.6	1.1	4.6	2.4	*0.5*
White-necked Heron	*Ardea pacifica*	22.7	17.1	0.8	3.4	1.5	*0.4*
Intermediate Egret	*Ardea intermedia*	18.2	20.0	1.1	1.5	1.6	1.0
White-faced Heron	*Egretta novaehollandiae*	50.0	48.6	1.0	3.4	4.0	1.2
Straw-necked Ibis	*Threskiornis spinicollis*	27.3	14.3	*0.5*	19.0	11.4	*0.6*
Purple Swamphen	*Porphyrio porphyrio*	63.6	68.6	1.1	4.2	17.2	**4.1**
Dusky Moorhen	*Gallinula tenebrosa*	18.2	57.1	**3.1**	1.3	3.7	**2.9**
Eurasian Coot	*Fulica atra*	9.1	54.3	**6.0**	3.0	29.5	**9.8**
Masked Lapwing	*Vanellus miles*	45.5	34.3	0.8	3.5	2.8	0.8

DISCUSSION

The following paragraphs provide some commentary on the observations of the various orders / family groups of birds recorded during the survey period July 2006 to June 2014.

Quails (Galliformes): Brown Quail *Coturnix ypsilophora* is the sole representative of this group observed during the surveys, with low to moderate recording rates. Observed in small family groups (range 1-9; average 3.3) predominantly within or adjacent to rank grasslands, this species could be considered resident. Revegetation of the previously cleared areas both south and north of the wetland may have a negative impact on the Brown Quail. Although not recorded during these surveys, King Quail *Excalfactoria chinensis* has been recorded within the GF/CC areas on two occasions (Kearns 2013; Stuart 2015a), the latter a confirmed record.

Ducks (Anseriformes): Well represented with ten species recorded, of which four have been observed breeding (refer **Appendix**). This figure also includes three species considered dispersive (Marchant & Higgins 1990), being Wandering Whistling-Duck *Dendrocygna arcuate* (four times with up to 21 birds present), Pink-eared Duck *Malacorhynchus membranaceus* (single bird; Stuart 2015b) and Australasian Shoveler *Anas rhynochotis* (13 times with up to 16 birds present). However within the Hunter Region, Stuart (2014) lists both Wandering Whistling-Duck and Australasian Shoveler as 'resident'. 20 Plumed Whistling-Duck *Dendrocygna eytoni*, a migratory species (Marchant & Higgins 1990), have also been observed (McKay 2015) outside these surveys. Five Anseriforme species were compared before and after causeway construction. Only Hardhead *Aythya australis* recorded an increased observation ratio, being 3.1. However, three species recorded increased average individuals ratios of 2.2, 2.7 and 3.4, being Chestnut Teal *Anas castanea* and Pacific Black Duck *Anas superciliosa* and Hardhead respectively. The preferred habitat of Hardheads is large, deep water, terrestrial wetlands with abundant aquatic vegetation where most food is obtained from diving (Marchant & Higgins 1990). The increase in water levels by only 200mm appears to have improved the wetland favourably for this species. Both Chestnut Teal and Pacific Black Duck feed predominantly by surface dabbling and up-ending (Marchant & Higgins 1990). It is suggested that the increased surface area, as a result of the higher water level, is now capable of supporting a greater number of individuals.

Grebes (Podicipediformes): Two of the three Australian species have been recorded, with Australasian Grebe being reasonably common at GF. Its congener, the Hoary-headed Grebe *Poliocephalus poliocephalus* was only recorded on two occasions, also within GF, conforming to Stuart's (2014) noted status of a 'bird of passage' within the Hunter Region. The Australasian Grebe was also compared before and after causeway construction recording a neutral, but slightly decreased, observation ratio of 0.8 but an increased average individuals ratio of 1.8. Similar to the Hardhead above, Australasian Grebes feed by diving, but also take food from the water's surface (Marchant & Higgins 1990), and appear to have benefited from the higher water level.

Pigeons & Doves (Columbiformes): Although well represented with 11 species observed, most were recorded in low numbers, being less than 10 birds and averaging 2-4. The most common species recorded was the Bar-shouldered Dove *Geopelia humeralis* which averaged 8.4 individuals per survey ($n = 56$). With this species also being one of the most vocal, this may have resulted in the increased recording rates and individuals. Another species with a higher average number of individuals ($n = 9$; 14.9) recorded was the flocking Topknot Pigeon *Lopholaimus antarcticus*. This species and two others, White-headed Pigeon *Columba leucomela* and Brown Cuckoo-Dove *Macropygia amboinensis*, which were both recorded moderately often, may also benefit from the revegetation works both north and south of GF.

Nightbirds (Caprimulgiformes): During the surveys, only the Tawny Frogmouth *Podargus strigoides* was observed. Although only recorded on two occasions, roosting near the entry gate of the wetlands, they are more than likely a permanent resident. During a campout at the wetlands, two additional species, White-throated Nightjar *Eurostopodus mystacalis*, a 'summer migrant' (Stuart 2014), and Australian Owlet-nightjar *Aegotheles cristatus*, were observed or heard (HBOC 2010).

Swifts (Apodiformes): Recorded regularly as a summer migrant, the White-throated Needletail *Hirundapus caudacutus* was the only species observed from this order.

Cormorants (Phalacrocoraciformes): All four local species of cormorant, as well as the Australasian Darter *Anhinga melanogaster* have been observed, mostly within GF. Both Little Cormorant species, Pied *Microcarbo melanoleucos* and Black *Phalacrocorax sulcirostris*, were compared before and after causeway construction, with both recording a neutral to slightly increased average individuals recording ratio. However the Little Pied was observed five times more often post construction. Although both these species utilise terrestrial wetlands for feeding by pursuit diving (Marchant & Higgins 1990), the Little Pied hunts alone while Little Black Cormorants often hunt co-operatively, which is also reflected in the average individuals observed post construction, being 2.8 and 6.6 respectively.

Egrets & Ibis (Ciconiiformes): Both families of egrets and ibis have been represented well with nine and four species recorded respectively, which includes two species, Black-necked Stork *Ephippiorhynchus asiaticus* and Australasian Bittern, both listed as endangered under the *TSC Act*. Four of the five Ciconiiforme species compared before and after causeway construction recorded neutral observation ratios with Straw-necked Ibis recording a decreased ratio of 0.5. Three species, however, recorded decreased average individuals ratios, namely Australian Pelican *Pelecanus conspicillatus* (0.5), White-necked Heron *Ardea pacifica* (0.4) and Straw-necked Ibis (0.6). Both White-necked Heron and Straw-necked Ibis utilise soft substrate habitats for foraging, including shallow water (Marchant & Higgins 1990), however required depths are <70mm and <250mm, respectively. The increased water level has reduced the opportunity for drying and exposure of shallow / muddy edges for these two species.

Eagles, Hawks & Falcons (Accipitriformes & Falconiformes): 16 species have been recorded within these two orders, with one, the Grey Goshawk *Accipiter novaehollandiae*, recorded breeding. This group also includes two species listed as vulnerable under the *TSC Act*, being Square-tailed Kite and Little Eagle *Hieraaetus morphnoides*. A pair of Square-tailed Kites has been regularly breeding in the Coopernook State Forest for many years (R. Langdown pers. comm.), and these may be the same birds to appear during surveys.

Crakes & Rails (Gruiformes): Three of the five species have been recorded regularly. However both Lewin's and Buff-banded Rails *Gallirallus philippensis* have been observed only once each. Unfortunately the observation of the Lewin's Rail was that of a juvenile's carcass caught in a fence. This suggests that there is breeding occurring within the vicinity of the wetlands. Both being cryptic species, their presence in the area may be substantially understated. The three regularly recorded species, Purple Swamphen *Porphyrio porphyrio*, Dusky Moorhen *Gallinula tenebrosa* and Eurasian Coot *Fulica atra*, were also compared before and after causeway construction with all three recording increased average individuals ratios of 4.1, 2.9 and 9.8 respectively. The Moorhen and Coot also recorded increased observation ratios of 3.1 and 6.0 respectively. Although only the Swamphen and Coot tend to utilise aquatic growth for feeding (Marchant & Higgins 1993) it is suggested that all three species have benefited from the taller marginal vegetation, resulting from elevated water level, for breeding.

Plovers & Waders (Charadriiformes): A poorly represented order with nine species observed, the most commonly recorded species being the Masked Lapwing *Vanellus miles*. Many of these species require shallow water or exposed mud, which is only present, mainly in the CC lagoon, following a prolonged dry period. The species of note within this group is the Comb-crested Jacana *Irediparra gallinacea*, which is listed as vulnerable under the *TSC Act* and is a breeding resident. Of four migratory (East Asian – Australasian Flyway) wader species observed during the surveys and the single supplementary species, Marsh Sandpiper *Tringa stagnatilis* (B. McCauley pers. comm.), only Latham's Snipe *Gallinago hardwickii* was recorded as a regular summer migrant. The last species compared between before and after causeway construction is the Masked Lapwing, which recorded neutral ratios for both observations and average individuals.

Cockatoos & Parrots (Psittaciformes): Represented by nine species and dominated by Rainbow *Trichoglossus haematodus* and Scaly-breasted Lorikeets *T. chlorolepidotus* and Eastern Rosella. Observed on four occasions, the Little Lorikeet *Glossopsitta pusilla* is listed as vulnerable under the *TSC Act*.

Cuckoos (Cuculiformes): Of the eight species observed during surveys, three species have been recorded breeding. A Little Wattlebird *Anthochaera chrysoptera* was recorded feeding an Eastern Koel *Eudynamys orientalis* fledgling while young juveniles of both Fan-tailed *Cacomantis flabelliformis* and Brush Cuckoos *C. variolosus*

were observed. Fan-tailed Cuckoos were recorded all year round and were a dominant call heard throughout winter.

Owls (Strigiformes): The only species recorded was the Eastern Barn Owl *Tyto alba delicatula* during one survey, which was suggested (LWF pers. comm.) to be a transient individual.

Kingfishers (Coraciiformes): Of the six species observed in this order, three have been recorded breeding, which includes a Forest Kingfisher *Todiramphus macleayii* at the southern end of its range (Higgins 1999, Barrett *et al*. 2003). Although not observed breeding, Dollarbird *Eurystomus orientalis* is a regular summer migrant.

Passeriformes

Treecreepers (Climacteridae): Only the one species likely to be observed in this environment, being the White-throated Treecreeper *Cormobates leucophaea*, was observed in low numbers across all survey areas.

Bowerbirds (Ptilonorhynchidae): Both local bowerbirds, Regent *Sericulus chrysocephalus* and Satin *Ptilonorhynchus violaceus* were observed in low numbers across most survey areas.

Fairy-wrens (Maluridae): Well represented with four species observed, of which three species were recorded breeding. One species of particular interest is the Red-backed Fairy-wren, which is towards the southern limit of its range (Higgins *et al*. 2001) and was recorded breeding. Within the GF/CC area, Red-backed Fairy-wrens are considered a summer migrant, with Higgins *et al*. (2001) indicating that some non-breeding season movement occurs away from breeding territories. Two suggestions for the summer visitor status are 1) that birds vocalise or are more visible generally during the breeding season and are hence located more readily and/or 2) that small localised movements occur during the year to and from this particular site.

Scrubwrens, Gerygones & Thornbills (Acanthizidae): Two, Brown Thornbill and Brown Gerygone, of the eight species in this group were the most regularly observed species within two survey areas, being GF/CC and QE respectively. Along with the Brown Gerygone, Yellow Thornbill *Acanthiza nana* was recorded breeding during the surveys.

Pardalotes (Pardalotidae): The two commonly recorded species along the east Australian coast, Spotted *Pardalotus punctatus* and Striated, were observed during the surveys. Comparisons between winter and summer counts indicated Striated Pardalotes predominantly occurred as winter visitors, yet they were also recorded breeding during spring. Stuart (2014) notes Striated Pardalotes as 'usual residents' within the Hunter Region, Higgins & Peter (2002) indicate that they can be 'resident, migratory or dispersive' while Griffioen & Clarke (2002) had strong evidence for the movement classification of this species as 'Towards north inland and coast'. This could suggest the replacement of spring/summer breeding individuals with southern individuals during autumn/winter rather than a full-time resident population.

Honeyeaters (Meliphagidae): Another well represented family with 15 species observed. Six of these species were recorded in more than 75% of surveys and five species were recorded as breeding. Lewin's Honeyeater was one of the most observed species in both GF/CC and QE survey areas while Striped Honeyeater also featured in the top GF/CC observed species. Of particular interest was the observation of a Painted Honeyeater *Grantiella picta* by Rudder (2014), which is listed as vulnerable under the *TSC Act*. Generally found west of the Great Dividing Range, there are only scattered records of this species east of the divide (Higgins *et al*. 2001).

Quail-thrushes & Whipbirds (Psophodidae): Only the Eastern Whipbird *Psophodes olivaceus* was observed within this family.

Sittella (Neosittidae): Represented by a single species, Varied Sittella *Daphoenositta chrysoptera* is listed as vulnerable under the *TSC Act* and had low observation rates across all survey areas.

Cuckoo-shrikes & Trillers (Campephagidae): Well represented with five species observed at low to moderate rates across most sites. Cicadabird *Coracina tenuirostris* was a summer migrant in both the GF/CC and WB survey areas. Several other species may indeed be summer migrants to the Manning Region, but were insufficiently recorded to be calculated as such.

Whistlers & Shrike-thrushes (Pachycephalidae): Crested Shrike-tit was recorded in low numbers within three of the survey areas. Both Golden Whistler *Pachycephala pectoralis* and Grey Shrike-thrush *Colluricincla harmonica* are considered resident.

Orioles & Figbird (Oriolidae): Based on the summer/winter ratio, Olive-backed Orioles are not considered a visitor in the GF/CC area, where they have been recorded breeding during spring and into summer (Carlson 2014). Orioles are considered partially migratory (Marchant 1992; Griffioen & Clarke 2002; Newman 2007 & 2014; Walther & Jones 2008; AJC pers. obs.) with birds dispersing primarily in search of food sources (Walther & Jones 2008). The presence of a fruiting fig tree within EP would support the winter visitor status to this area and with fig trees also present within GF/CC the decreased winter/summer ratio negated the summer visitor status for this survey area.

Woodswallows, Butcherbirds & Currawongs (Artamidae): Three of the six species observed within this family have been recorded breeding. Within the GF/CC area, White-breasted Woodswallows have been recorded in most months of the year, with sightings within the EP only occurring during late winter and spring. In Forster, ~40km south of Cattai Wetlands, White-breasted Woodswallows generally arrive in early/mid spring and depart in mid/late autumn (AJC per. obs.). Moreover, Stuart (2014) lists them as a 'common summer migrant' for the Hunter Region. This suggests that the combined areas provide sufficient food resources to partially sustain an over-wintering population. Generally known as open area foragers, revegetation of previously cleared grazing areas may result in a reduction of both Grey Butcherbird *Cracticus torquatus* and Australian Magpie *Cracticus tibicen* observations within the GF/CC survey area.

Drongo (Dicruridae): Another single species family, Spangled Drongos *Dicrurus bracteatus* were recorded in low numbers across most survey areas, however the autumn count (n = 9) was generally three to four times greater than the other three seasons (n = 2-3). Analysis of Drongo movements by Wood (2012) recognises two distinct patterns for sub-species within NSW. Firstly, a southward movement in autumn from 32°S (Forster) to the far south coast of NSW and a return northward movement in spring and secondly, an altitudinal eastward movement following breeding from the Great Dividing Range to the lower coastal areas with a corresponding westward movement in spring. This altitudinal movement was evident between 21°S (Mackay, Qld) and 31°S (Nambucca Heads). Although Cattai Wetlands are located at the northern end of the north/south movement pattern (31°50'S), altitudinal movements may also be influencing population at this site. Again in Forster, Spangled Drongos were recorded in 77 of 106 survey months in an urban environment, with seasonal percentages (%) being Winter 100, Spring 68, Summer 38 and Autumn 89 (AJC *unpub. data*).

Fantails (Rhipiduridae): Two, Grey Fantail and Willie Wagtail *Rhipidura leucophrys*, of the three species observed are considered resident with both also recorded breeding. Grey Fantail was also one of the most common species in both GF/CC and WB survey areas. The third fantail species, the Rufous Fantail *R. rufifrons*, was recorded as a summer migrant at both GF/CC and WB.

Corvids (Corvidae): Recording rates of the three corvid species observed are lower (low to moderate across all survey areas) than their actual site presence due to the ability, or inability, of observers to differentiate calls if and when they were made. A separate record of Corvid *sp*. was not made.

Flycatchers & Monarchs (Monarchidae): Of the five species observed, only the Magpie-lark *Grallina cyanoleuca* was recorded breeding. While observations of both Leaden Flycatcher *Myiagra rubecula* and Black-faced Monarch *Monarcha melanopsis* were sufficient to calculate their migratory status as a summer visitor, the two Spectacled Monarch *Symposiarchus trivirgatus* and single Restless Flycatcher sightings were in summer also.

Robins (Petroicidae): In contrast to the single observations of a Jacky Winter in the EP and Pale-yellow Robin *Tregellasia capito* at GF/CC, Eastern Yellow Robin was recorded in 98% of all surveys with breeding recorded in several different locations. Considered an 'altitudinal migrant' by Stuart (2014), a pair of Rose Robins *Petroica rosea*, were observed during two separate winter seasons.

Cisticolas (Cisticolidae): Golden-headed Cisticola *Cisticola exilis* was observed at low rates across most survey areas, with more than 50% of records occurring during spring months. This correlates with the propensity for males of the species to call from prominent perches during the breeding season (Higgins *et al*. 2006). As females remain cryptic and do not sing (Higgins *et al*. 2006), numbers observed are most likely underestimated.

Reed-Warblers (Acrocephalidae): The Australian Reed-Warbler *Acrocephalus australis* was recorded throughout the year, but half of these

observations, similar to the Cisticola above, were during spring and another quarter during summer months. Griffioen & Clarke (2002) suggest there is strong evidence for a 'north-west slope line' migration pattern, while Higgins *et al*. (2006) suggests that the species is partly migratory, but that the full range of movements is not clear. Observations throughout the year here suggest that at least some individuals remain all year.

Grassbirds (Megaluridae): Two species of the rank grassland and aquatic vegetation, Australian Tawny *Megalurus timoriensis* and Little Grassbirds *M. gramineus* were recorded in moderate and low rates respectively.

White-eyes (Timaliidae): Although Silvereyes were recorded in more than 75% of surveys and thus assigned a resident status, migratory patterns of sub-species are not well understood (Higgins *et al*. 2006). Observations of the nominate sub-species *lateralis*, commonly referred to as the Tasmanian form, during winter months, supports Griffioen & Clarke's (2002) suggestion of a 'south Y' migration pattern of southern individuals. Therefore the resident population may in fact be a compilation of several transient sub-species rather than a year-round population of individuals.

Swallows & Martins (Hirundinidae): Represented by three species with Welcome Swallow *Hirundo neoxena* recorded breeding under the viewing platform. Observed all year round, average numbers of individuals were three times greater during winter (n = 11; 14.6) than summer (n = 9; 4.9). Griffioen & Clarke (2002) suggest that all three Hirundinidae species observed have strong evidence to support a 'mid line north' migration pattern. As with the White-breasted Woodswallows, the wetland complex appears to support over-wintering swallows that would otherwise migrate further north. Both Fairy *Petrochelidon ariel* and Tree Martins *P. nigricans* were recorded in low numbers in both GF/CC and EP survey areas.

Thrushes (Turdidae): A lone Bassian Thrush was observed at WB during one survey (April 2013) only. Seasonal movement of both ground thrush species is not well understood in the Hunter Region (Williams 2013). The presence of this individual may superficially support the hope of GTCC for the area to act as a conduit for movement of species from the coastal areas into the hinterland.

Starlings (Sturnidae): Common Mynas *Sturnus tristis* were only observed during eight survey months. Stock removal from and revegetation of previous open grazing areas should further reduce the presence of this introduced species from the wetland complex. This species was not recorded after the April 2010 survey.

Mistletoebird (Nectariniidae): Mistletoebirds *Dicaeum hirundinaceum* were recorded consistently throughout the year, but overall average numbers were higher during winter (n = 15; 15.7) than summer (n = 12; 6.5).

Finches (Estrildidae): Red-browed Finch was recorded in all surveys and breeding. As noted earlier, Double-barred Finch was observed only once, as a flock of six. A species favouring the seed heads of rank grasses, Chestnut-breasted Mannikins *Lonchura castaneothorax* were only observed on six occasions. Again, the revegetation works undertaken may impact adversely on this species.

CONCLUSION

The various habitats and communities, many of which are listed under the *TSC Act*, of Cattai Wetlands provide either a home or refuge for a great diversity of bird species. As indicated above, the area may also be partially supporting year-round populations of species that are generally considered migratory. It may also be acting as a conduit for transient species between the coastal reserve of Crowdy Bay National Park and the hinterland area of Coopernook and Lansdowne State Forests, one of the intended outcomes for GTCC. However, the evidence for this is superficial at this stage. Of particular importance is the recording of ten species scheduled under the *TSC Act*, with one, the Comb-crested Jacana, breeding.

Construction of the concrete causeway by GTCC to replace the existing earth bank raised the water level by approximately 200mm which appears to have impacted on the avifaunal composition of species utilising the wetland. This higher level requires longer dry spells to create the muddy margins required for wading species, like egrets and herons, whose observation rates and average numbers have decreased post construction. Not only has the aquatic vegetation surrounding the wetland appeared to have changed in composition

but also the health of the casuarinas standing within the wetland. With the prolonged wetting of their root system combined with an increased impact by birds roosting at their bases, the health of these trees may be in permanent decline. Wet and dry periods are still occurring in the adjacent CC.

Over the duration of the survey period, GTCC has slowly developed small areas surrounding the wetland with the construction of a parking area, walking tracks, information boards, toilets and a large covered seating area. It has also been opened up to the public on weekends and public/school holidays (daylight hours only). This low-key development has helped facilitate GTCC's commitment to use the area as an environmental education centre. Revegetation on previously cleared grazing land and ongoing weed control works will ultimately enhance the area. In the light of these plans, ongoing periodic surveys would be beneficial so that changes over time can be monitored, particularly as the revegetation areas mature, but also to note any impacts that may result from an increase in the visiting public. Nocturnal surveys may also confirm the presence of additional species or clarify the status of bittern species, particularly during spring when they call. The overall results would be instructive for public bodies planning similar rehabilitation of wetlands in the future.

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APPENDIX

Avifaunal list for Cattai Wetlands: List of birds and percentage (%) of times recorded during surveys of Cattai Wetlands between July 2006 and June 2014 and supplementary observations. GF = Giants Footprint, CC = Coopernook Creek, QE = Quarry Extension, WB = Western Block, EP = Electric Paddock (refer to text for descriptions). Birds recorded breeding are shown in bold and supplementary observations are indented. Birds considered as either a winter (W) or a summer (S) visitor have their status shown in the respective survey area column. For species with a visitor status shown in the GF column, the status has been calculated in combination with CC survey area.

Common Name	**Scientific Name**	**GF**	**CC**	**QE**	**WB**	**EP**
Brown Quail	*Coturnix ypsilophora*	29	7	16	4	5
King Quail	*Excalfactoria chinensis*					
Plumed Whistling-Duck	*Dendrocygna eytoni*					
Wandering Whistling-Duck	*Dendrocygna arcuata*	5				
Black Swan	***Cygnus atratus***	84	47	4	2	16
Australian Wood Duck	*Chenonetta jubata*	9	5			
Pink-eared Duck	*Malacorhynchus membranaceus*					
Australasian Shoveler	*Anas rhynchotis*	17	9			
Grey Teal	***Anas gracilis***	62	30	4		5
Chestnut Teal	***Anas castanea***	71	53	4		7
Mallard / Pacific Black Hybrid	*Anas hybrid*	2				
Pacific Black Duck	***Anas superciliosa***	95	82	16	11	43
Hardhead	*Aythya australis*	41	9			

Common Name	Scientific Name	GF	CC	QE	WB	EP
Australasian Grebe	*Tachybaptus novaehollandiae*	67	9			
Hoary-headed Grebe	*Poliocephalus poliocephalus*	3				
Rock Dove	*Columba livia*					2
White-headed Pigeon	*Columba leucomela*	21	18	12	28	16
Spotted Dove	*Streptopelia chinensis*	3			2	
Brown Cuckoo-Dove	*Macropygia amboinensis*	29	18	20	35	5
Emerald Dove	*Chalcophaps indica*	3	2		4	
Common Bronzewing	*Phaps chalcoptera*	2			7	
Crested Pigeon	*Ocyphaps lophotes*	5	18		4	23
Peaceful Dove	*Geopelia striata*	3				
Bar-shouldered Dove	*Geopelia humeralis*	79	63	64	67	50
Wonga Pigeon	*Leucosarcia melanoleuca*		2			
Topknot Pigeon	*Lopholaimus antarcticus*	10	2		9	5
Tawny Frogmouth	*Podargus strigoides*	2				2
White-throated Nightjar	*Eurostopodus mystacalis*					
Australian Owlet-nightjar	*Aegotheles cristatus*					
White-throated Needletail	*Hirundapus caudacutus*	10 S		8	11 S	2
Australasian Darter	*Anhinga melanogaster*	14 S	7			
Little Pied Cormorant	*Microcarbo melanoleucos*	47	18	12	4	7
Great Cormorant	*Phalacrocorax carbo*	16 S	2		4	2
Little Black Cormorant	*Phalacrocorax sulcirostris*	43	18		2	2
Pied Cormorant	*Phalacrocorax varius*	10	2	4	2	
Australian Pelican	*Pelecanus conspicillatus*	47	14		19	32 S
Black-necked Stork [E]	*Ephippiorhynchus asiaticus*	10 W	7			7
Australasian Bittern [E]	*Botaurus poiciloptilus*					2
White-necked Heron	*Ardea pacifica*	19	16			18
Great Egret	*Ardea alba*	14	14		2	11
Intermediate Egret	*Ardea intermedia*	19	4		4	5
Cattle Egret	*Ardea ibis*	9	9		2	16 W
Striated Heron	*Butorides striatus*		2			
White-faced Heron	*Egretta novaehollandiae*	48	39	8		48
Little Egret	*Egretta garzetta*	3				
Nankeen Night-Heron	*Nycticorax caledonicus*	5	2			
Glossy Ibis	*Plegadis falcinellus*	2				2
Australian White Ibis	*Threskiornis molucca*	16	12		6	18
Straw-necked Ibis	*Threskiornis spinicollis*	19	11	12	7	27 W
Royal Spoonbill	*Platalea regia*	9	2			7
Osprey [V]	*Pandion haliaetus*	7	2			2
Black-shouldered Kite	*Elanus axillaris*	10	4			9
Square-tailed Kite [V]	*Lophoictinia isura*				7	
Pacific Baza	*Aviceda subcristata*		2		2	
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	40	9	4	9	5
Whistling Kite	*Haliastur sphenurus*	48	28	8	15	27

[V] - Vulnerable under *Threatened Species Conservation Act 1995* (NSW)
[E] - Endangered under *Threatened Species Conservation Act 1995* (NSW)

Common Name	Scientific Name	GF	CC	QE	WB	EP
Brahminy Kite	*Haliastur indus*	9	2		2	5
Brown Goshawk	*Accipiter fasciatus*	7	9	4	9	5
Collared Sparrowhawk	*Accipiter cirrocephalus*	3	2	4		
Grey Goshawk	***Accipiter novaehollandiae***	9	2	8	11	7
Swamp Harrier	*Circus approximans*	29	16	4	4	25 S
Wedge-tailed Eagle	*Aquila audax*	3			2	11
Little Eagle [V]	*Hieraaetus morphnoides*	5			2	
Nankeen Kestrel	*Falco cenchroides*	3	4			7
Brown Falcon	*Falco berigora*	3	2	4		5
Australian Hobby	*Falco longipennis*	3		4		5
Purple Swamphen	***Porphyrio porphyrio***	66	74			14
Lewin's Rail	*Lewinia pectoralis*			4		
Buff-banded Rail	*Gallirallus philippensis*	2				
Dusky Moorhen	***Gallinula tenebrosa***	41	11			2
Eurasian Coot	*Fulica atra*	36	9			
Black-winged Stilt	*Himantopus leucocephalus*	7				
Black-fronted Dotterel	*Elseyornis melanops*		5			
Masked Lapwing	*Vanellus miles*	38	26		6	57
Comb-crested Jacana [V]	***Irediparra gallinacea***	28	2			
Latham's Snipe	*Gallinago hardwickii*	17 S	18		2	11
Black-tailed Godwit [V]	*Limosa limosa*	2				
Eastern Curlew	*Numenius madagascariensis*	2				
Marsh Sandpiper	*Tringa stagnatilis*					
Sharp-tailed Sandpiper	*Calidris acuminata*	3				
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	14	7	4	11	5
Galah	*Eolophus roseicapillus*	3	2		6	5
Rainbow Lorikeet	***Trichoglossus haematodus***	36	16	28 W	41	9
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	55	26	24	39	14
Musk Lorikeet	*Glossopsitta concinna*	3	2	8	7	2
Little Lorikeet [V]	*Glossopsitta pusilla*	2		4	6	
Australian King-Parrot	*Alisterus scapularis*	7	4		4	7
Crimson Rosella	*Platycercus elegans*				9	
Eastern Rosella	*Platycercus eximius*	81	70	16	63	91
Pheasant Coucal	*Centropus phasianinus*	26 S			19 S	5
Eastern Koel	***Eudynamys orientalis***		2		2	2
Channel-billed Cuckoo	*Scythrops novaehollandiae*	12 S	9		15 S	
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	12	11		7	7
Shining Bronze-Cuckoo	*Chalcites lucidus*	31	19		26 S	7
Fan-tailed Cuckoo	***Cacomantis flabelliformis***	64	53	36	63	25
Brush Cuckoo	***Cacomantis variolosus***	21 S	23	4	24 S	11
Pallid Cuckoo	*Cacomantis pallidus*	3	4		6	
Barn Owl	*Tyto alba*	2				
Azure Kingfisher	*Ceyx azureus*	34	14	4		
Laughing Kookaburra	***Dacelo novaeguineae***	84	47	36	78	66

[V] - Vulnerable under *Threatened Species Conservation Act 1995* (NSW)

Common Name	Scientific Name	GF	CC	QE	WB	EP
Forest Kingfisher	***Todiramphus macleayii***	7	5	4		
Sacred Kingfisher	***Todiramphus sanctus***	40 S	33	4	41 S	23 S
Rainbow Bee-eater	*Merops ornatus*	3	4			2
Dollarbird	*Eurystomus orientalis*	16 S	9	16	13 S	7
White-throated Treecreeper	*Cormobates leucophaea*	36	32	32	63	7
Regent Bowerbird	*Sericulus chrysocephalus*	14	11		11	
Satin Bowerbird	*Ptilonorhynchus violaceus*	14 S	14	16	28	5
Superb Fairy-wren	***Malurus cyaneus***	100	86	68	89	77
Red-backed Fairy-wren	***Malurus melanocephalus***	21 S	4	16	22	
Variegated Fairy-wren	***Malurus lamberti***	71	49	44	61	18
Southern Emu-wren	*Stipiturus malachurus*	41	33	12	28	39
White-browed Scrubwren	*Sericornis frontalis*	55	18	20	33	7
Large-billed Scrubwren	*Sericornis magnirostris*	3			7	
Brown Gerygone	***Gerygone mouki***	81	51	96	85	
White-throated Gerygone	*Gerygone olivacea*	21 S	30	12	39 S	9
Striated Thornbill	*Acanthiza lineata*	2	2	4	6	7
Yellow Thornbill	***Acanthiza nana***	93	61	44	35	27
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	2	7		6	5
Brown Thornbill	*Acanthiza pusilla*	97	82	84	85	41
Spotted Pardalote	*Pardalotus punctatus*	14	9	16	30	2
Striated Pardalote	***Pardalotus striatus***	9 W	11	12	24 W	
Eastern Spinebill	*Acanthorhynchus tenuirostris*	66	68	48	69	27 W
Lewin's Honeyeater	*Meliphaga lewinii*	100	70	96	94	34
Yellow-faced Honeyeater	***Lichenostomus chrysops***	67	56	48	70	34
White-eared Honeyeater	*Lichenostomus leucotis*	2				
Noisy Miner	*Manorina melanocephala*	74	26	28 S	80	16
Little Wattlebird	***Anthochaera chrysoptera***	28	26		19	9
Red Wattlebird	*Anthochaera carunculata*	12	4		2	2
Scarlet Honeyeater	***Myzomela sanguinolenta***	69	63	40	69	18 W
Brown Honeyeater	*Lichmera indistincta*	41	54	12	9	7
New Holland Honeyeater	*Phylidonyris novaehollandiae*	2			4	
White-cheeked Honeyeater	***Phylidonyris niger***	41	21	20	57	7
White-naped Honeyeater	*Melithreptus lunatus*	2	2		13 W	
Noisy Friarbird	*Philemon corniculatus*	43	37	28	52	23
Little Friarbird	*Philemon citreogularis*	2				
Striped Honeyeater	***Plectorhyncha lanceolata***	79	84	44	37	80
Painted Honeyeater [V]	*Grantiella picta*					
Eastern Whipbird	*Psophodes olivaceus*	84	37	72	85	11
Varied Sittella [V]	*Daphoenositta chrysoptera*	2	5	4	13	2
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	45	40	8	46	34
White-bellied Cuckoo-shrike	*Coracina papuensis*	16	7		22	2
Cicadabird	*Coracina tenuirostris*	16 S	16	12	30 S	5
White-winged Triller	*Lalage tricolor*	3				
Varied Triller	*Lalage leucomela*		2		2	

[V] - Vulnerable under *Threatened Species Conservation Act 1995* (NSW)

Common Name	**Scientific Name**	**GF**	**CC**	**QE**	**WB**	**EP**
Crested Shrike-tit	*Falcunculus frontatus*	3	7		20 S	
Golden Whistler	*Pachycephala pectoralis*	79	53	64	74	11
Rufous Whistler	*Pachycephala rufiventris*	45 S	35	28	31	27
Grey Shrike-thrush	*Colluricincla harmonica*	84	68	52	69	45
Australasian Figbird	*Sphecotheres vieilloti*	14 S	23	12	9	5
Olive-backed Oriole	***Oriolus sagittatus***	38	37	12	33	16 W
White-breasted Woodswallow	***Artamus leucorynchus***	48	33	4	9	14 W
Dusky Woodswallow	*Artamus cyanopterus*	5			2	5
Grey Butcherbird	***Cracticus torquatus***	72	58	36	80	61
Pied Butcherbird	***Cracticus nigrogularis***	57	40	28	41	66
Australian Magpie	*Cracticus tibicen*	76	51	16	70	77
Pied Currawong	*Strepera graculina*	5	4		19	2
Spangled Drongo	*Dicrurus bracteatus*	16	9	12	15	
Rufous Fantail	*Rhipidura rufifrons*	14 S	11	12	24 S	2
Grey Fantail	***Rhipidura fuliginosa***	100	84	88	96	48
Willie Wagtail	***Rhipidura leucophrys***	81	77	20	13	57
Australian Raven	*Corvus coronoides*	26	33	8	26	36
Forest Raven	*Corvus tasmanicus*	17	11	24	17	14
Torresian Crow	*Corvus orru*	45	25	12	26	27
Leaden Flycatcher	*Myiagra rubecula*	5	4		17 S	2
Restless Flycatcher[a]	*Myiagra inquieta*					
Black-faced Monarch	*Monarcha melanopsis*	10 S	7	4	24 S	
Spectacled Monarch	*Symposiarchus trivirgatus*		2		2	
Magpie-lark	***Grallina cyanoleuca***	33	32	4	7	48
Jacky Winter	*Microeca fascinans*					2
Rose Robin	*Petroica rosea*	2	2		2	
Pale-yellow Robin	*Tregellasia capito*	2			2	
Eastern Yellow Robin	***Eopsaltria australis***	91	54	88	93	14
Golden-headed Cisticola	*Cisticola exilis*	7	5		2	9
Australian Reed-Warbler	*Acrocephalus australis*	9	30		2	5
Tawny Grassbird	*Megalurus timoriensis*	40	28	16	7	41
Little Grassbird	*Megalurus gramineus*	7	21			7
Silvereye	***Zosterops lateralis***	78	63	52	61	23 S
Welcome Swallow	***Hirundo neoxena***	55	39		4	23
Fairy Martin	*Petrochelidon ariel*	7	7			7
Tree Martin	*Petrochelidon nigricans*	12	9			5
Bassian Thrush	*Zoothera lunulata*				2	
Common Myna	*Sturnus tristis*	2	4			16 S
Mistletoebird	***Dicaeum hirundinaceum***	69	72	40	15	50
Double-barred Finch	*Taeniopygia bichenovii*					2
Red-browed Finch	***Neochmia temporalis***	98	70	80	85	41
Chestnut-breasted Mannikin	*Lonchura castaneothorax*	5	4		2	
Totals	186	163	142	85	125	122

[a] - Recorded in farmland immediately adjacent

Bird Surveys in Saltwater National Park

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Surveys at Saltwater National Park in northern New South Wales over 2009-2015 have recorded 123 species. Only ten species had Reporting Rates above 70%; mostly these were birds that favour rainforest understorey habitat, which is abundant in the National Park. Frugivorous species were often present, in particular Regent Bowerbird *Sericulus chrysocephalus*, Australasian Figbird *Sphecotheres vieilloti* and Wonga Pigeon *Leucosarcia picata*. Nine species classified as threatened in NSW were recorded, notably Australian Pied Oystercatcher *Haematopus longirostris* and Wompoo Fruit-Dove *Ptilinopus magnificus* several times.

INTRODUCTION

Saltwater National Park (NP) lies at the mouth of Khappinghat Creek, in the Manning Valley near Wallabi Point, approximately 10km south of Old Bar in New South Wales. The Park, which is centred at 32˚0′30″ S 152˚33′54″ E, has habitats which include littoral rainforest, an estuary, a rocky cape, and open areas used for picnics and camping. Saltwater NP also has important local indigenous significance (Anon. 2012). The 33 ha Park is managed separately from the much larger (3,514 ha) Khappinghat NP which adjoins it (see **Figure 1**).

At the time of writing, 66 surveys have been conducted since 2009. The surveys are ongoing, but it seemed timely to review the initial results.

METHODS

The surveys have been conducted at approximately monthly intervals, except for January each year (when the Park is used by many indigenous campers). The starting time was variable, because the timing of each visit has been fitted between visits to nearby high-tide roost sites to survey them for shorebirds (Stuart 2014b). The visits to Saltwater NP have occurred mostly in the morning, although sometimes late morning and less frequently in the afternoon.

All species detected (either seen or heard) were recorded, including any birds flying over or occurring to within ~100m offshore, and the numbers for each species present were estimated. The overall survey, which took about 90 minutes on average to carry out, encompassed an area of approximately 500m radius. The results from each survey have been entered into BirdLife Australia's Atlas database (Birdata) as a "500m area survey" (with site ID 253616).

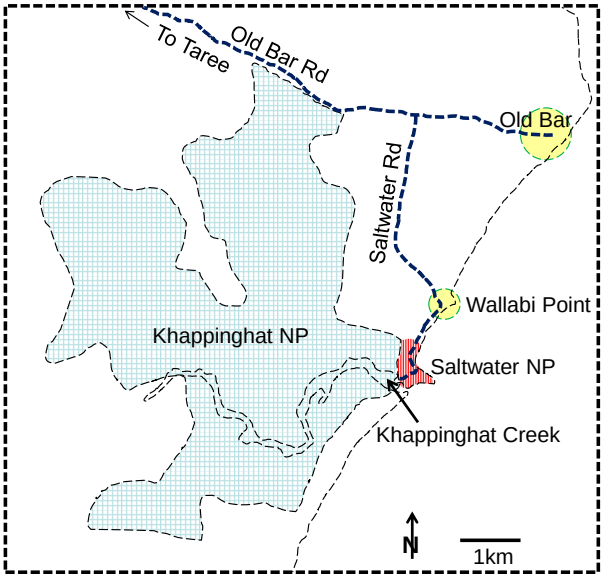

Figure 1. Saltwater NP and nearby locations

RESULTS AND DISCUSSION

123 species have been recorded including 30 species (25% of the total biodiversity) for which there was only one record. The full list is provided in the **Appendix** along with the Reporting Rate (RR) for each species. The RR is the percentage of times that the species has been recorded during the surveys (the number of times recorded, divided by total number of surveys). An indication of the number of birds for each species (when present) is also given in the **Appendix**.

Common Species

Only ten species had RRs greater than 70% (shown in **Bold** in the **Appendix**). Eight of those favour rainforest understorey, which is abundant at Saltwater NP. The two others, Laughing Kookaburra *Dacelo novaeguineae* and Australian Magpie *Cracticus tibicen* are readily detected birds of more open areas.

Species which exhibit cryptic behaviour or which only have small populations within the Park, and hence not always intersected with, may have been overlooked in some surveys. However, species such as Red-browed Finch *Neochmia temporalis*, Superb Fairy-wren *Malurus cyaneus*, White-browed Scrubwren *Sericornis frontalis* and Yellow-throated Scrubwren *S. citreogularis* usually are readily detected when present. An interpretation is that Saltwater NP does not permanently support many species; instead, that it offers them an extended range for foraging, based on territories in parts of the nearby Khappinghat NP. This speculation has been partially confirmed for some species. Usually Lewin's Honeyeater *Meliphaga lewinii*, Little Wattlebird *Anthochaera chrysoptera* and White-cheeked Honeyeater *Phylidonyris niger* are vocal and readily located within Saltwater NP, and present in good numbers. However occasionally when they have not been detected during a survey, it has been established that the birds were instead in nearby areas of the adjoining Khappinghat NP. It is assumed that the driver for this movement is food-related.

Threatened Species

Nine species classified as threatened under the NSW *Threatened Species Conservation Act 1995* were recorded in Saltwater NP; they are indicated in the **Appendix**. For most of those species, there were single records. The Wompoo Fruit-Dove *Ptilinopus magnificus* was recorded in six surveys, as single birds feeding or resting in the large fig trees (unknown *Ficus* species) that are a feature of the National Park. Possibly their presence has been overlooked sometimes; they have only twice been heard to call and it can be difficult to spot a stationary bird high in the foliage. One to two Australian Pied Oystercatchers *Haematopus longirostris*, both adult birds and apparently a pair, have mostly been present in the winter months (24 records). It appears that they move elsewhere to breed. Little Terns *Sternula albifrons* have been recorded six times, always in late summer. Birds in breeding and non-breeding plumage have been observed. The timing corresponds to the end of the breeding season of the colony at Old Bar (Fawcett & Thomas 2012) and presumably those present at Saltwater NP have been dispersing birds. It is noted that all gull and tern species have been absent from the Park or only present in very low numbers, outside of summer.

Sooty Oystercatchers *Haematopus fuliginosus* were recorded three times; notably however, this included a pair with a juvenile bird in summer 2015.

Frugivorous Species

Saltwater NP contains many large fig trees and also other rainforest trees. These attract frugivorous species, which were often recorded in the Park. Regent *Sericulus chrysocephalus* and Satin Bowerbird *Ptilonorhynchus violaceus*, Green Catbird *Ailuroedus crassirostris*, Australasian Figbird *Sphecotheres vieilloti* and Wonga Pigeon *Leucosarcia picata* all had RRs in the range 25-60%. In the most favourable circumstances, 20+ Figbirds and 10-15 each of Regent and Satin Bowerbirds were present. Several other fruit-eating pigeons and doves have been recorded, albeit less frequently.

Species of Regional Interest

Some records appear noteworthy in a regional context (based on Stuart 1994-2014a):

- Crescent Honeyeater *Phylidonyris pyrrhopterus* in June 2009. This species is generally considered to be confined locally to high altitude parts of the Gloucester Tops. There is only one other low altitude record for the Hunter Region, at Arcadia Vale near Lake Macquarie in October 2006 after strong westerly winds (Stuart 2007). There is also one record from a mid-altitude location (Raine 2014).
- Noisy Pitta *Pitta versicolor* recorded May 2011 and August 2013. Coastal winter records may be increasing.
- Russet-tailed Thrush *Zoothera heinei* recorded August 2011. Coastal records are quite uncommon.
- Spectacled Monarch *Symposiarchus trivirgatus* was first recorded in December 2010, and with several more records in subsequent years. This seems to be associated with a southerly extension of the coastal range for the species. Its RR at Saltwater NP is much higher than for the regionally more common Black-faced Monarch *Monarcha melanopsis*, which

appears to be a casual visitor to the Park. Both species are considered to be summer migrants to the Hunter Region (Stuart 2014a); thus the RR of 16.7% for Spectacled Monarch, present for only ~6 months of the year, compares favourably to RRs at Saltwater NP for more sedentary species such as White-browed Scrubwren *Sericornis frontalis* and Satin Bowerbird. A similar situation applies for the Spangled Drongo *Dicrurus bracteatus*, with an RR of 36.4% despite it being absent in summer.

Breeding Records

There are two confirmed breeding records:

- A pair of Yellow-throated Scrubwrens had a nest with young February 2010 (also, a pair was nest-building September 2012).
- A pair of Brown Thornbills *Acanthiza pusilla* had a nest with young September 2013 (M. Kearns pers. comm.).

Indications that other species may have bred in the National Park include observations of:

- Australian Brush-turkey *Alectura lathami* tending a mound August and November 2009.
- Regent Bowerbird feeding fledged young October 2012.
- Eastern Yellow Robin feeding fledged young September 2010 (P. Drake-Brockman pers. comm.).

The lack of breeding records may at least in part be a consequence of the survey method. The main goal of area surveys is to obtain an inventory of birds present. There is less opportunity for the detailed observation of individual birds that is normally required to monitor breeding activity effectively.

CONCLUSIONS

123 species have been recorded in Saltwater NP although 25% of those are one-off records. Relatively few species appear to be solely dependent upon the small National Park for their survival. Frugivorous species often are present in good numbers.

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APPENDIX

The Birds of Saltwater National Park

Species	Scientific Name	RR	Estimated Population*
Australian Brush-turkey	*Alectura lathami*	66.7%	4-8
Brown Quail	*Coturnix ypsilophora*	1.5%	<5
Black Swan	*Cygnus atratus*	4.5%	1-2
Chestnut Teal	*Anas castanea*	3.0%	1-2
Pacific Black Duck	*Anas superciliosa*	1.5%	1-2
White-headed Pigeon	*Columba leucomela*	22.7%	1-3
Brown Cuckoo-Dove	*Macropygia amboinensis*	4.5%	1-2
Emerald Dove	*Chalcophaps indica*	3.0%	1-2
Crested Pigeon	*Ocyphaps lophotes*	9.1%	1-2

Note: * When Recorded

Appendix: The Birds of Saltwater National Park cont.

Species	Scientific Name	RR	Estimated Population*
Peaceful Dove	Geopelia striata	1.5%	1
Bar-shouldered Dove	Geopelia humeralis	16.7%	1-2
Wonga Pigeon	Leucosarcia picata	39.4%	2-3
Wompoo Fruit-Dove[V]	*Ptilinopus magnificus*	9.1%	1
Rose-crowned Fruit-Dove[V]	*Ptilinopus regina*	1.5%	1
Topknot Pigeon	*Lopholaimus antarcticus*	10.6%	2-10
Tawny Frogmouth	*Podargus strigoides*	1.5%	2
White-throated Needletail	*Hirundapus caudacutus*	7.6%	Flying over
Fork-tailed Swift	*Apus pacificus*	1.5%	Flying over
Wedge-tailed Shearwater	*Ardenna pacifica*	1.5%	5-10
Australasian Gannet	*Morus serrator*	15.2%	1-2
Little Pied Cormorant	*Microcarbo melanoleucos*	10.6%	1-2
Great Cormorant	*Phalacrocorax carbo*	22.7%	1-5
Little Black Cormorant	*Phalacrocorax sulcirostris*	12.1%	5-15
Pied Cormorant	*Phalacrocorax varius*	28.8%	1-5
Australian Pelican	*Pelecanus conspicillatus*	13.6%	1-2
Great Egret	*Ardea alba*	4.5%	1-2
Striated Heron	*Butorides striata*	4.5%	1
White-faced Heron	*Egretta novaehollandiae*	45.5%	1-2
Little Egret	*Egretta garzetta*	6.1%	1
Eastern Reef Egret	*Egretta sacra*	1.5%	1
Nankeen Night-Heron	*Nycticorax caledonicus*	22.7%	1-5
Australian White Ibis	*Threskiornis molucca*	1.5%	1-2
Osprey[V]	*Pandion haliaetus*	16.7%	1-2
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	18.2%	1-2
Whistling Kite	*Haliastur sphenurus*	31.8%	1-2
Brahminy Kite	*Haliastur indus*	10.6%	1-2
Grey Goshawk	*Accipiter novaehollandiae*	1.5%	1
Little Eagle[V]	*Hieraaetus morphnoides*	1.5%	1
Nankeen Kestrel	*Falco cenchroides*	1.5%	1
Australian Hobby	*Falco longipennis*	1.5%	1
Beach Stone-curlew[CE]	*Esacus giganteus*	1.5%	1
Australian Pied Oystercatcher[E]	*Haematopus longirostris*	36.4%	1-2
Sooty Oystercatcher[V]	*Haematopus fuliginosus*	4.5%	1-3
Red-capped Plover	*Charadrius ruficapillus*	13.6%	1-2
Black-fronted Dotterel	*Elseyornis melanops*	6.1%	1-2
Masked Lapwing	*Vanellus miles*	10.6%	2-4
Bar-tailed Godwit	*Limosa lapponica*	1.5%	1-2
Little Tern[E]	*Sternula albifrons*	9.1%	5-10
Common Tern	*Sterna hirundo*	12.1%	5-10
Crested Tern	*Thalasseus bergii*	33.3%	20-50
Silver Gull	*Chroicocephalus novaehollandiae*	39.4%	10-30
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	1.5%	1-5
Galah	*Eolophus roseicapillus*	7.6%	1-2
Rainbow Lorikeet	*Trichoglossus haematodus*	15.2%	2-6
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	42.4%	4-10
Australian King-Parrot	*Alisterus scapularis*	3.0%	1-2
Eastern Rosella	*Platycercus eximius*	1.5%	1-2
Eastern Koel	*Eudynamys orientalis*	16.7%	1-2
Channel-billed Cuckoo	*Scythrops novaehollandiae*	1.5%	1
Shining Bronze-Cuckoo	*Chalcites lucidus*	9.1%	1-2
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	13.6%	1-2
Brush Cuckoo	*Cacomantis variolosus*	1.5%	1
Azure Kingfisher	*Ceyx azureus*	1.5%	1-2
Laughing Kookaburra	***Dacelo novaeguineae***	**86.4%**	**2-4**
Sacred Kingfisher	*Todiramphus sanctus*	6.1%	1-2

Note: *When Recorded; Species shown in **Bold** have RRs of greater than 70%
NSW Threatened Species: V: Vulnerable E: Endangered CE: Critically Endangered

Appendix: The Birds of Saltwater National Park cont.

Species	Scientific Name	RR	Estimated Population*
Rainbow Bee-eater	Merops ornatus	4.5%	1-2
Dollarbird	Eurystomus orientalis	12.1%	1-2
Noisy Pitta	Pitta versicolor	3.0%	1
Regent Bowerbird	Sericulus chrysocephalus	57.6%	4-10+
Satin Bowerbird	*Ptilonorhynchus violaceus*	28.8%	2-8+
Superb Fairy-wren	*Malurus cyaneus*	59.1%	4-10
Red-backed Fairy-wren	*Malurus melanocephalus*	1.5%	1-2
Variegated Fairy-wren	*Malurus lamberti*	24.2%	2-5
Yellow-throated Scrubwren	*Sericornis citreogularis*	43.9%	4-6
White-browed Scrubwren	*Sericornis frontalis*	34.8%	4-6
Large-billed Scrubwren	*Sericornis magnirostris*	19.7%	2-4
Brown Gerygone	***Gerygone mouki***	**84.8%**	**10-20**
Striated Thornbill	*Acanthiza lineata*	1.5%	5-10
Yellow Thornbill	*Acanthiza nana*	15.2%	5-10
Brown Thornbill	***Acanthiza pusilla***	**71.2%**	**10-20**
Spotted Pardalote	*Pardalotus punctatus*	12.1%	1-2
Eastern Spinebill	*Acanthorhynchus tenuirostris*	43.9%	2-5
Lewin's Honeyeater	***Meliphaga lewinii***	**87.9%**	**5-15**
Yellow-faced Honeyeater	*Lichenostomus chrysops*	31.8%	2-6
Little Wattlebird	***Anthochaera chrysoptera***	**83.3%**	**5-20+**
Red Wattlebird	*Anthochaera carunculata*	3.0%	1-2
Scarlet Honeyeater	*Myzomela sanguinolenta*	40.9%	5-10
Brown Honeyeater	*Lichmera indistincta*	1.5%	1
Crescent Honeyeater	*Phylidonyris pyrrhopterus*	1.5%	1
White-cheeked Honeyeater	*Phylidonyris niger*	47.0%	5-15
Noisy Friarbird	*Philemon corniculatus*	13.6%	2-4
Eastern Whipbird	***Psophodes olivaceus***	**77.3%**	**2-4**
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	25.8%	1-2
Crested Shrike-tit	*Falcunculus frontatus*	1.5%	1
Golden Whistler	***Pachycephala pectoralis***	**74.2%**	**5-10**
Grey Shrike-thrush	*Colluricincla harmonica*	10.6%	1-2
Australasian Figbird	*Sphecotheres vieilloti*	45.5%	5-20+
Olive-backed Oriole	*Oriolus sagittatus*	4.5%	1-2
White-breasted Woodswallow	*Artamus leucorynchus*	3.0%	2-4
Grey Butcherbird	*Cracticus torquatus*	6.1%	1-2
Pied Butcherbird	*Cracticus nigrogularis*	47.0%	1-2
Australian Magpie	***Cracticus tibicen***	**75.8%**	**2-4**
Pied Currawong	*Strepera graculina*	27.3%	1-2
Spangled Drongo	*Dicrurus bracteatus*	36.4%	1-8+
Rufous Fantail	*Rhipidura rufifrons*	19.7%	1-2
Grey Fantail	***Rhipidura fuliginosa***	**72.7%**	**5-10**
Willie Wagtail	*Rhipidura leucophrys*	65.2%	2-4
Forest Raven	*Corvus tasmanicus*	63.6%	2-4
Leaden Flycatcher	*Myiagra rubecula*	1.5%	1
Black-faced Monarch	*Monarcha melanopsis*	6.1%	1-2
Spectacled Monarch	*Symposiarchus trivirgatus*	16.7%	1-2
Magpie-lark	*Grallina cyanoleuca*	24.2%	1-2
Rose Robin	*Petroica rosea*	1.5%	1
Eastern Yellow Robin	***Eopsaltria australis***	**74.2%**	**5-10**
Silvereye	*Zosterops lateralis*	54.5%	2-10
Welcome Swallow	*Hirundo neoxena*	22.7%	2-10
Tree Martin	*Petrochelidon nigricans*	1.5%	2-10
Bassian Thrush	*Zoothera lunulata*	1.5%	1
Russet-tailed Thrush	*Zoothera heinei*	1.5%	1
Mistletoebird	*Dicaeum hirundinaceum*	3.0%	1-2
Red-browed Finch	*Neochmia temporalis*	47.0%	5-10

Note: *When Recorded; Species shown in **Bold** have RRs of greater than 70%
NSW Threatened Species: V: Vulnerable E: Endangered CE: Critically Endangered

Red-browed Finch include amphibian larvae in diet

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The diet of the subspecies of Red-browed Finch *Neochmia temporalis temporalis* includes amphibian larvae, which has not been previously documented.

INTRODUCTION

The diet of Red-browed Finches *Neochmia temporalis* has been extensively studied in various geographic areas of Australia. The bird lives along the east coast of Australia with the greater population east of the coastal divide. There are three noted subspecies, but the observations in this report are confined to *N. temporalis temporalis*. This subspecies is only occurs in NSW. The present observations were made in the Olney State Forest of the Watagan Mountains NSW. Red-browed Finches visited the study site in the warmer months where it was observed that they include amphibian larvae in their diet, catching them from the surface of ponds.

TECHNIQUE

A polyethylene artificial 50-litre water hole was set up on a ridge 300m from a dry-bed natural water course. The site was in eucalypt forest 428m above sea level. Documentation of birds attending to drink or bathe was performed intermittently over a two-year period. 42 species attended this site. The attendance was weather dependent with visitations increasing in hot dry periods. Observation totalled 260hrs with 125 visits. These were weather dependent, but averaged a two-hour observation period each week. The period of study was 1 February 2013 to 1 February 2015.

DISCUSSION and OBSERVATIONS

Red-browed Finches are uncommon in the dense forest of the Watagan Mountains where the waterhole was established and apart from roadside grass there is not a lot of monocotyledon seed, which normally constitutes the greater part of their diet (Read 1994) so in this area they were considered transients. The finches attended the study site between November and February, usually in pairs; the largest group visiting in December was six.

In January 2014, the first documented observation of *Neochmia temporalis* catching amphibian larvae was made and the behaviour was photographed. This behaviour was documented on a further four occasions, the last being January 2015.

The fishing technique involved the bird walking around the pool looking for aquatic food, and then catching the amphibian larva with a quick bill snatch, reaching under the water surface. At no time did the bird submerge its head to more than eye level and one bird caught four larvae in a 10 minute period. All catching was performed in a standing mode. Most larvae were swallowed immediately, though on several occasions the bird would first throw the tadpole onto adjacent ground.

No observations were made of the bird using feet or bill whipping to kill the tadpole before swallowing. The species of the tadpole was not determined. The size of tadpole caught was small and always pre-metamorphic.

Red-browed Finches holding tadpoles caught at a waterhole in the Watagan Mountains. (Photos by Bruce Hosken)

CONCLUSIONS

Grass finches in Australia are well known to eat insects and larvae to supplement a seed diet, and insects may be part of the diet for new hatchlings (Cole 1908, Scopfer 1989). Crop studies of wild birds have revealed non-insect live food consumption has been rare. In particular no reports of vertebrate larvae have been made. In a study of Red-browed Finches in South Australia, Mollusca: Gastropod was reported from crop analysis (Read 1994).

Whether the inclusion of tadpole in the diet of these finches coincides with the feeding of new hatchlings, similar to the feeding of insects, was not determined. Although the birds only attended the waterhole during the breeding season no finch nests were apparent in the vicinity of the waterhole.

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Noisy Miner lacking grey plumage pigmentation

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At the beginning of 2012 an unusually plumaged Noisy Miner *Manorina melanocephala* was frequently present in my garden at Woodville, NSW (I have since moved to Tasmania). At first glance the bird was white, but closer inspection indicated that the only feathers which are normally grey lacked pigmentation. The black head feathers, green/yellow tinged feathers in the wings and the yellow soft parts were all normally coloured. In flight the effect was dramatic, with the bird appearing all white in stunning contrast to the rest of the flock. The bird was seen regularly until October when it was last seen foraging in a flowering Silky Oak *Grevillea robusta* with other Noisy Miners. It was next seen on one occasion in February 2013 and then again on 27 May 2013. In May 2013 a similarly plumaged bird was photographed in Victoria and described in the link http://comebirdwatching.blogspot.com.au/2013/05/white-noisy-case-of-aberrant-plumage.html.

Schizochroism is characterised by the lack of a single pigment from part or all of the plumage (Guay *et al.* 2012). This instance involved total loss of grey pigmentation, the dominant colour of Noisy Miners. Genetic mutations have long been associated with plumage aberrations and are exploited by bird breeders. However, there are a number of other possible causes including diet, which in this case seems unlikely because the rest of the flock was normal.

Despite its abnormal appearance the schizochroistic miner was accepted by the flock of miners and no antagonistic interactions were observed.

Schizochroistic birds are rare in the wild (Guay *et al.* 2012) and it is possible to speculate that a bird which so obviously stands out against the flock might be preferentially targeted by predators. Consequently its survival for 16 months was of interest as was its periodic occurrence in my garden. Noisy Miners may be less sedentary than is normally accepted.

Higgins *et al.* (2001) mention four Noisy Miners with aberrant plumage, all of which were classed as leucistic. In leucistic birds all pigments are missing from some or all feathers (Guay *et al.* 2012), which was clearly not the case in the bird described in this note.

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Increased understorey causes demise of mixed species flocks at Green Wattle Creek

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I published an article titled "Mixed foraging flocks in a Woodville woodland" in the Hunter Bird Observers Club Newsletter October/November 1997. The article was based on observations made during my monthly bird survey at Green Wattle Creek (32.661°S 151.649°E) on 12 July 1997 (Newman 2009). On that date I came across three separate foraging groups. Speckled Warbler *Chthonicola sagittata* and Jacky Winter *Microeca fascinans* were conspicuous members of these groups and the scolding calls of the former species often drew attention to the groups.

My newsletter article indicated that while each of the flocks had Speckled Warblers as core members, there were subtle differences in the composition of the flocks, possibly as a consequence of variations in the habitat they frequented. For instance, one flock in an area with fairly extensive shrub understorey was comprised primarily of small ground-feeding species, including Superb Fairy-wren *Malurus cyaneus* and Variegated Fairy-wren *Malurus lamberti* as well as Red-browed Finch *Neochmia temporalis*. Thornbills, particularly Yellow Thornbill *Acanthiza nana* and Brown Gerygone *Gerygone mouki* were often members of flocks in that area. In winter Brown Gerygone were very common in open woodland, having moved out of the dense wet forest areas where they breed, forming quite large groups at times.

The second mixed foraging flock and the one of primary interest to this note frequented an area of woodland with very little understorey. Jacky Winter, which favour open areas, were prominent members of this flock and used low perches for hawking. Speckled Warbler fed on the sparsely grassed ground with Buff-rumped Thornbill *Acanthiza reguloides*. Other members of this group included Varied Sittella *Daphoenositta chrysoptera* and White-throated Treecreeper *Cormobates leucophaea*. Foliage-feeding species attached to the group included Grey Fantail *Rhipidura albiscapa*, Golden Whistler *Pachycephala pectoralis*, Yellow-faced Honeyeater *Lichenostomus chrysops* and Fuscous Honeyeater *Lichenostomus fuscus*. The very mobile honeyeaters appeared to be transient rather than constant members of the group.

The third flock frequented intermediate habitat, combining open areas with some scrub understorey. In this flock the seemingly inevitable Speckled Warbler shared the understorey with White-browed Scrub-wren *Sericornis frontalis* and Silvereye *Zosterops lateralis* together with fairy-wrens. Thornbills and honeyeaters, including Lewin's Honeyeater *Meliphaga lewinii,* were present in the lower foliage of the trees together with an immature Rose Robin *Petroica rosea.*

The formation of these flocks was seasonal at Green Wattle Creek, primarily occurring in autumn and winter. During these seasons other species, including Spotted Pardalote *Pardalotus punctatus* and Willie Wagtail *Rhipidura leucophrys*, were noted in the mixed-species flocks in addition to those described above for the survey on 12 July 1997.

Bell (1985) found thornbills were regular participants in mixed-species flocks of insectivorous birds. Participation was year-round, but fell off markedly during the breeding season. Buff-rumped Thornbill were a nuclear species around which other species gathered. They attracted species that fed on the ground or in the understorey. Bell found that when Varied Sittellas joined Buff-rumped Thornbills they attracted other thornbills including Striated Thornbill *Acanthiza lineata*, a canopy-feeding species. However, in less open areas where Buff-rumped Thornbills were absent Striated Thornbills acted as a nuclear rather than a follower species. When in mixed foraging flocks follower species tended to adapt and imitate the foraging preferences of nuclear or attracting species, an example being the increased proportion of time Striated Thornbill spent foraging on stringybarks when in association with Varied Sittella, which primarily feed on rough-barked trees (Bell 1985). In the Hunter Region it has been noted that Varied Sittella feed lower on trunks, right down to ground level, in the presence of mixed-species flocks containing Buff-rumped Thornbill (Mick Roderick pers. comm.).

There are a number of advantages in forming mixed-species flocks. One involves the possibility that collectively the flock will be more efficient in detecting predators, particularly ground predators. As suggested by Noske (1998) Varied Sittellas feeding as small groups on exposed branches may benefit from adopting a group foraging strategy. Their inclusion in mixed foraging flocks would enhance the effectiveness of this strategy and when in the company of Buff-rumped Thornbill also allow the trunks to be more fully exploited with less risk from ground predators, as described above. Bell (1985) proposed that it is easier for gregarious groups to maintain social cohesion in more open habitat. Although Speckled Warblers, the common factor in all the flocks, often provide the alarm system for the group with their grating scrub-wren-like call, it is unlikely that they are the most observant members of the mixed-species flock, because they primarily forage on the ground. However, when disturbance occurs they fly up to a perch and their alarm calls can be heard over considerable distances, punctuated by bursts of their surprisingly melodic song.

It is also probable that these mixed-species flocks feed more efficiently than any species would achieve on its own. For instance birds foraging on the ground, in the foliage and on trunks stir up insects for hawking Grey Fantail and Jacky Winter. As a group flocks are also more effective in finding areas where food is more abundant at a time of year when it is relatively scarce. As each species tends to specialise on different types of food and parts of the habitat, they are cooperative rather than competitive. However, when they have thoroughly gleaned an area it will require time to recover before it can be re-harvested.

Differences in the understorey apparently influenced the composition of the three mixed-species foraging groups described above. As the extent of the understorey decreased, the influence of ground-feeding species like the Buff-rumped Thornbill resulted in the habitat being fully exploited with species feeding on the ground, on trunks and branches, in the foliage and hawking in the open in the second group described. Based on Bell (1985) Buff-rumped Thornbill and Varied Sittella, two naturally gregarious feeders (Noske 1998 & Bell 1985) are the nuclear species which attract others. Both these species were absent from the mixed-species flocks exploiting areas with denser understorey, although Speckled Warblers still found the ground-level vegetation productive. This may indicate that Buff-rumped Thornbills and Varied Sittellas feel vulnerable to ground predators as the lower level vegetation cover increases. This would explain why Varied Sittellas appear to favour, but not exclusively, open woodland habitat (Newman 2015) in that they are able to forage lower and more fully exploit the trunks of rough-barked trees.

Since the original article was published in 1997 understorey at Green Wattle Creek has become dense since grazing ceased in the mid-1990s. As a consequence there have been changes in the diversity of the bird population of Green Wattle Creek with ground-feeding species like the Speckled Warbler and Buff-rumped Thornbill now scarce (Newman 2010 & 2014). The Varied Sittella has also declined (Newman 2015). Consequently, diverse mixed-foraging flocks of the type attracted to Buff-rumped Thornbills and Varied Sittellas no longer occur. Mixed-species flocks still occur in the canopy, but are less diverse and more distant from the observer and hence less obvious. No longer is there the thrill of being surrounded by a frenetically feeding group of birds.

ACKNOWLEDGEMENT

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Buff-rumped Thornbill *Acanthiza reguloides*
A nuclear species attracting other birds to mixed species flocks (see article on page 63)

Photo by George Voss

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