

# Changes in avian species diversity following revegetation and an emphasis on sustainability at an East Seaham cattle-breeding property (2004-2018)

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Regular surveys of the avian population were conducted for 15 years across five sites on a cattle breeding property near East Seaham. The habitats were a mixture of remnant woodland, farm dams, ephemeral wetlands, open grassland and riparian forest. Habitat restoration had been undertaken in some areas. The property was being managed in accordance with sustainability principles.

A total of 81 surveys were conducted between 2004 and 2018 and 175 species were recorded. Eight threatened species were recorded; White-throated Needletail *Hirundapus caudacutus*, White-bellied Sea-Eagle *Haliaeetus leucogaster*, Little Lorikeet *Glossopsitta pusilla*, White-fronted Chat *Epthianura albifrons*, Scarlet Robin *Petroica boodang*, Grey-crowned Babbler *Pomatostomus temporalis*, Varied Sittella *Daphoenositta chrysoptera*, and Dusky Woodswallow *Artamus cyanopterus*. Breeding or breeding behaviour was observed for 37 species.

The average annual species count for 2004-2018 was relatively constant at 54.3 with a standard deviation of  $\pm 2.6$ . The total average annual count was relatively constant averaging 256 from 2010-2015 and then increasing after 2016 to a maximum of 524.5 in 2018, following widespread rainfall.

The increase in numbers of Australasian Figbird *Sphecotheres vieilloti* over the survey period was statistically highly significant, while the increase in numbers of Rose Robin *Petroica rosea* was significant. The decline in numbers of White-winged Chough *Corcorax melanorhamphos* was statistically highly significant while the declines of Azure Kingfisher *Ceyx azureus* and Tawny Frogmouth *Podargus strigoides* were significant.

Species diversity on the property was considerably higher than on a number of similar properties that had been subject to long-term surveying in the Hunter Region.

## INTRODUCTION

Greswick Angus is a cattle breeding property of 121 hectares located adjacent to the Williams River at East Seaham. It is situated between the Wallaroo National Park, Columbey National Park and Columbey State Conservation Area. In 2004 family members John and Janelle Spearpoint through a property management planning process adopted a whole-of-farm approach to change business practices to emphasise sustainability. A balance was developed between the farming business, sustainability, erosion control and the impact on the Williams River catchment. Part of this plan was the fencing off and revegetation of the riverbank boundaries of the property. In spring 2001 and 2002 some 6,000 trees grown from seeds collected across the property were planted to revegetate the riverbank areas and provide shade lots for stock. Water-edge plants were planted along the river edge to stabilise the banks and native emergent

macrophytes were planted in the shallow sections of the river to provide a wave action buffer (Spearpoint 2006).

In 2004 a request for assistance with bird surveys was made to Hunter Bird Observers Club and bi-monthly bird surveys were commenced across the property in September 2004.

*“Surveying the birds and their lives on Greswick Angus was instigated by the need to monitor visible indicators of environmental health over the course of the Williams River Best Management Practice Project. In July 2004 Greswick Angus was selected as the Demonstration Site for this unique 4-year trial that focused on helping to protect the quality of the Lower Hunter’s drinking water supply.*

*“The project aimed to demonstrate and trial various methods for restoring riparian vegetation including bank erosion control, fencing, weed control,*

*revegetation and regeneration as well as stock and pasture management within the riparian zone.*" (Clarke 2008).

## METHODS

The first survey was conducted in September 2004 and covered the entire property. Surveys of individual sites commenced in November 2004. In 2015, the only survey conducted was a whole of property survey. All other years had between 5 and 7 surveys of all sites.

Observations were recorded in an Excel spreadsheet with separate worksheets for each site. The spreadsheet has been used to compile the data in this paper. Data from surveys up to and including December 2018 were analysed for this article.

Results are presented as Reporting Rates (RR). RR is the number of records for a species divided by the number of surveys, expressed as a percentage. The average counts per year and average number of species observed for the years 2010 to 2018 were calculated and are presented graphically.

To test the statistical significance of population changes over the survey period, the Chi Square test (with an assumption of unequal variance) was conducted on records of species from periods 2004-2010 and 2011-2018. Probability (P) values of less than 0.05 were classified as statistically significant and P values of less

than 0.01 as statistically highly significant (Fowler & Cohen 1996).

The survey details and observations for the five sites and the remainder of the property were also submitted to BirdLife Australia. (<https://birddata.birdlife.org.au/>)

## Site descriptions and survey protocols

At the commencement of surveys, the property was divided into five 2-ha sites, each representing a differing vegetation community. The five sites are shown in **Figure 1**.

Between two and nine observers conducted surveys on the second Tuesday of each alternate month commencing at 7.00 am in warmer months and 7.30 am during colder months with the final survey being completed by around 1.00 pm. Sites were surveyed in the same order on each occasion.

Initially the sites were surveyed for 20 minutes. Due to the growth of the revegetation plus changes over time in HBOC personnel, the 20-minute time frame was expanded to whatever time it took to complete a survey. Birds seen or heard for the five specific sites plus the remainder of the property were separately recorded and the data entered into the spreadsheet. Breeding or breeding behaviour was recorded and included observations of adult birds inspecting hollows, collecting nesting material, nest building, carrying food or together with dependent young.



**Figure 1.** The Greswick Angus property at East Seaham showing five survey sites.

On some occasions during the 15-year period, surveys of the property as a whole or some of the sites were not conducted due to flooding, impassable tracks or other unexpected factors. The routes normally taken and survey methods are detailed separately below for each site.

### Front Gate Forest

The first site surveyed was an area of approximately 200 x 100 m, from the homestead east to the property boundary (**Figure 1**). The dominant vegetation was remnant mature Spotted Gum *Corymbia maculata* and Grey Ironbark *Eucalyptus paniculata* with the density and diversity of the understorey of primarily native shrubs and herbs, varying according to frequency of grazing (**Figure 2**). Observers walked the perimeter of the site recording those birds within the site, while birds observed or heard outside the site were recorded as part of the overall property list.



**Figure 2.** Front Gate Forest (photo: Janelle Spearpoint)

### Quarry Lane

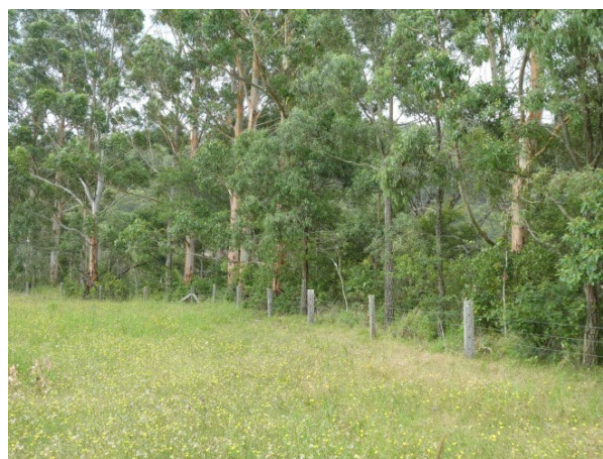
Quarry Lane was the second site surveyed and comprised a strip of riparian vegetation along the Williams River approximately 600 x 20 m (**Figure 1**, **Figure 3**). The site was dominantly remnant rainforest which had been supplementarily planted with woodland and rainforest species. The vegetation mainly consisted of Swamp Oak *Casuarina glauca* along the river with rainforest trees and shrubs behind. This was the most floristically diverse section of the property containing flowering gums *Eucalyptus* spp., *Angophora floribunda* and fruiting rainforest species such as Lilly Pilly *Syzygium smithii*, Cheese Tree *Glochidion fernandi* and Wild Quince *Guioa semiglauca*. Observers walked the length of the site recording birds within the site, while birds observed in the paddocks or on the river were recorded as part of the overall property list.



**Figure 3.** Quarry Lane (photo: Tom Kendall)

### Bamboo Bend

The next site surveyed was also a strip of riparian vegetation along the Williams River approximately 400 x 20 m (**Figure 1**, **Figure 4**). This section had been significantly revegetated and plant growth increased over the survey period. The area had less complex vegetation than Quarry Lane. The site was named after a stand of mature Bamboo (*Bambusa* spp.) midway along the transect. Observers walked the length of the site recording birds within the site, while birds observed in the paddocks or on the river were recorded as part of the overall property list.



**Figure 4.** Bamboo Bend (photo: Tom Kendall)

### Lagoon

This site, located northeast of Bamboo Bend, was an area of ephemeral freshwater wetland, with both open water and areas dominated by a sedge *Juncus* sp. and grasses (**Figure 1**, **Figure 5**). Outside of flood times, the site was approximately 300 x 40 m and was connected to the river by a drainage

channel and a flood gate. The water level increased during flooding of the Williams River or periods of substantial rains. During dry periods, the lagoon was dry and regularly grazed (Figure 6). A transect was walked around the perimeter of the site with some noise being made during Spring and Summer to flush cryptic birds such as Latham’s Snipe.



Figure 5. Lagoon almost at capacity (photo: Tom Kendall)



Figure 6. Lagoon dry. (photo: Tom Kendall)

### The Swamp

The last area surveyed was a shallow freshwater wetland approximately 300 x 60 m connected to the river by a drainage channel and a flood gate (Figure 1). This area was dominated by sedge *Juncus* sp. with limited open water except when at capacity (Figure 7). The site was periodically grazed (Figure 8). A transect was made to the east and west from a midway access point with observers walking through the grass and sedge to flush birds. Access was limited during times of high-water level or flood.



Figure 7. The Swamp in flood. (photo: Tom Kendall)



Figure 8. The Swamp dry (photo: Tom Kendall)

### The Rest of Greswick Angus

The balance of the property primarily consisted of grazing pasture interspersed with tree lots planted as part of the revegetation project. The bulk of this area was cropped and grazed on a rotational basis. There were at least five dams of varying size and ephemerality across the property with several temporary wet areas that were rainfall or flood dependent (Figure 1). All birds observed outside of the five nominated sites were recorded. Some sections of the property were not completely surveyed such as the riparian strip from the northern end of Bamboo Bend northwards for approximately 800 m along the river and sections of the grazing lands.

### RESULTS

By December 2018 a total of 175 species had been recorded during 81 surveys. Between 55 and 116 species were seen each year (Table 1). The average species per year was 97.6. Average species per survey ranged from 48.8 to 59.5 with the overall

average being 54.4. The overall yearly RR for Greswick Angus for all species are presented in **Table 2**. The yearly RR for all species from each of the six survey sites are presented in the **Appendix** (<https://www.hboc.org.au/wp-content/uploads/Greswick-Angus-Appendix-The-Whistler-Vol-17.pdf>). Eight threatened species were recorded and are listed in **Table 3**. Breeding behaviour was observed for 37 species that are listed in **Table 4**. Five species whose numbers have undergone significant or highly significant change over the survey period are listed in **Table 5**. The average counts per year and average number of species observed for the years 2010 to 2018 are shown in **Figure 9**.

## DISCUSSION

### Greswick Angus Overall

A total of 175 species was recorded across the property during the 81 surveys conducted. This highlights the diversity of habitat available despite being in relatively small parcels. The property provides a link between adjacent National Parks and Conservation Areas and allows species to forage and migrate widely. These larger nearby woodland areas may also assist in populating the site as habitat develops, or repopulating the site during recovery from drought.

Twenty-six species have RRs > 80% (**Table 2**). Twenty-one of these species would be expected on a farming property with grazing land and farm dams in the Hunter Region. The remaining five species in that category are associated with the riparian strip of remnant and revegetated vegetation, e.g. Brown Thornbill *Acanthiza pusilla* and Grey Fantail *Rhipidura albiscapa*.

There are twenty-eight species with RRs between 40% and 79% (**Table 2**). Two of these, the Oriental Dollarbird *Eurystomus orientalis* and Sacred Kingfisher *Todiramphus sanctus*, are migratory but seem to be site-faithful with a high RR each year. Breeding of the Sacred Kingfisher has been recorded with the Oriental Dollarbird a likely breeder as suitable hollows were available. The remainder were a diverse mix of woodland, grassland and wetland species reflecting the mix of habitats available on the property.

The remaining birds comprise 121 species with RR <39% (**Table 2**). They represent a broad range of species which is indicative of the mix of habitats. This group includes two migratory waders,

Latham's Snipe *Gallinago hardwickii* (RR 29.6%) and Bar-tailed Godwit *Limosa lapponica* (RR 1.2%). The latter was a single bird in February 2017 observed foraging on the muddy edges of a farm dam. Other groups of species include 19 summer visitors, 2 winter visitors (robins), and 10 raptor species (**Table 2**).

The Williams River attracted waterfowl such as Eurasian Coot *Fulica atra* and Dusky Moorhen *Gallinula tenebrosa* that were not normally seen within the boundaries of the property. Four species of tern and one gull were recorded on the property and along the Williams River; Greater Crested Tern *Thalasseus bergii*, Australian Gull-billed Tern *Gelochelidon macrotarsa*, Common Tern *Sterna hirundo*, Caspian Tern *Hydroprogne caspia* and Silver Gull *Larus novaehollandiae*. The associated riparian vegetation attracted species which utilised the river to forage such as Azure Kingfisher *Ceyx azureus* and Australasian Darter *Anhinga novaehollandiae*.

The riparian forest contained a mix of woodland and rainforest tree species with an understorey during normal times. Species such as Grey Fantail, Superb Fairy-wren *Malurus cyaneus*, White-browed Scrubwren *Sericornis frontalis*, Brown Thornbill plus other thornbill and honeyeater species foraged and bred in this strip. Wet sclerophyll bird species such as Lewin's Honeyeater *Meliphaga lewinii*, Satin Bowerbird *Ptilonorhynchus violaceus*, Wompoo Fruit-Dove *Megaloprepia magnifica* and Brown Cuckoo-Dove *Macropygia phasianella* inhabited the riparian strip in conjunction with dry sclerophyll species such as Striated Pardalote *Pardalotus striatus*, Rufous Whistler *Pachycephala rufiventris*, Brown-headed Honeyeater *Melithreptus brevirostris* and Varied Sittella *Daphoenositta chrysoptera*.

A group of two Moreton Bay Figs *Ficus macrophylla* and one Port Jackson Fig *Ficus rubiginosa* were present between The Lagoon and Bamboo Bend. When fruiting, they attracted Channel-billed Cuckoo *Scythrops novaehollandiae*, Eastern Koel *Eudynamys orientalis*, Topknot Pigeon *Lopholaimus antarcticus* and Australasian Figbird *Sphecotheres vieilloti*.

From 2004-2018, species recorded ranged from 36-81 while total number of birds recorded varied from 160-1507 (2010-2018 only). This is a minimum count as not all areas of the property were surveyed and birds of passage moving through the property may not have been recorded.

**Table 1.** Survey records summary, Greswick Angus overall

	All Surveys	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of Surveys	81	2	6	6	7	7	7	6	5	5	6	6	1	5	6	6
Number of Species	175	74	93	97	110	106	116	96	101	103	97	109	55	92	104	107
Species per Survey	54.4	54.5	53.2	52.5	57.7	53.6	53.1	52.0	52.6	56.4	48.8	56.8	55.0	54.8	55.3	59.5
Species RR≥80%	26	35	32	33	32	28	26	31	27	36	31	34	55	38	34	38
Species RR≥40%	54	74	57	48	66	60	59	52	68	70	46	58	55	65	57	63

**Table 2.** Species reporting rates, all surveys, Greswick Angus overall (\*Summer Visitor, \*\*Winter Visitor)

Common Name	RR% All Surveys	2004 RR%	2005 RR%	2006 RR%	2007 RR%	2008 RR%	2009 RR%	2010 RR%	2011 RR%	2012 RR%	2013 RR%	2014 RR%	2015 RR%	2016 RR%	2017 RR%	2018 RR%
Masked Lapwing	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Noisy Miner	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Pacific Black Duck	98.8	100.0	100.0	100.0	85.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Eastern Rosella	98.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	83.3	100.0	100.0	100.0	100.0	100.0
Brown Thornbill	98.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	80.0	100.0	100.0	100.0	100.0	100.0	100.0
Australian Magpie	98.8	100.0	100.0	83.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Willie Wagtail	98.8	100.0	100.0	100.0	100.0	100.0	85.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Laughing Kookaburra	97.5	100.0	100.0	100.0	85.7	100.0	85.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Yellow Thornbill	97.5	100.0	83.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	83.3	100.0	100.0	100.0	100.0	100.0
Yellow-faced Honeyeater	97.5	100.0	100.0	100.0	100.0	100.0	85.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	83.3	100.0
Pied Butcherbird	97.5	100.0	100.0	100.0	100.0	100.0	85.7	100.0	100.0	100.0	100.0	83.3	100.0	100.0	100.0	100.0
Grey Fantail	97.5	100.0	100.0	100.0	100.0	85.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	83.3
Superb Fairy-wren	96.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Australian Raven	96.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0	60.0	100.0	83.3	100.0	100.0	100.0	100.0	100.0
Whistling Kite	95.1	100.0	100.0	100.0	100.0	85.7	100.0	83.3	100.0	100.0	83.3	100.0	100.0	100.0	83.3	100.0
Black-faced Cuckoo-shrike	92.6	100.0	100.0	100.0	100.0	100.0	85.7	100.0	80.0	100.0	83.3	83.3	100.0	80.0	83.3	100.0
Magpie-lark	92.6	100.0	100.0	100.0	100.0	71.4	85.7	100.0	80.0	80.0	83.3	100.0	100.0	100.0	100.0	100.0
Welcome Swallow	91.4	100.0	100.0	83.3	100.0	85.7	85.7	100.0	80.0	100.0	83.3	100.0	100.0	100.0	83.3	83.3
White-faced Heron	90.1	100.0	66.7	83.3	100.0	100.0	85.7	66.7	100.0	100.0	100.0	83.3	100.0	80.0	100.0	100.0
Grey Butcherbird	88.9	50.0	100.0	100.0	85.7	100.0	71.4	100.0	100.0	100.0	50.0	100.0	100.0	100.0	66.7	100.0
Purple Swamphen	87.7	100.0	83.3	100.0	100.0	71.4	100.0	100.0	80.0	100.0	66.7	100.0	100.0	80.0	66.7	83.3

Common Name	RR% All Surveys	2004 RR%	2005 RR%	2006 RR%	2007 RR%	2008 RR%	2009 RR%	2010 RR%	2011 RR%	2012 RR%	2013 RR%	2014 RR%	2015 RR%	2016 RR%	2017 RR%	2018 RR%
Cattle Egret	86.4	100.0	83.3	100.0	100.0	85.7	57.1	50.0	80.0	100.0	100.0	83.3	100.0	100.0	83.3	100.0
White-browed Scrubwren	86.4	100.0	83.3	66.7	100.0	71.4	100.0	100.0	100.0	80.0	100.0	83.3	100.0	80.0	66.7	83.3
Australian Wood Duck	84.0	100.0	100.0	83.3	100.0	85.7	85.7	83.3	60.0	40.0	83.3	100.0	100.0	60.0	100.0	83.3
Galah	82.7	100.0	100.0	100.0	85.7	85.7	71.4	83.3	60.0	100.0	50.0	100.0	100.0	100.0	83.3	50.0
Silvereye	81.5	100.0	66.7	66.7	85.7	85.7	100.0	83.3	60.0	80.0	83.3	50.0	100.0	100.0	83.3	100.0
Grey-crowned Babbler	76.5	100.0	100.0	100.0	42.9	42.9	42.9	66.7	60.0	100.0	66.7	83.3	100.0	100.0	100.0	100.0
Yellow-rumped Thornbill	75.3	100.0	83.3	66.7	100.0	100.0	100.0	66.7	40.0	80.0	83.3	50.0	100.0	20.0	83.3	66.7
Crested Pigeon	74.1	100.0	33.3	66.7	57.1	85.7	28.6	100.0	100.0	80.0	33.3	100.0	100.0	100.0	100.0	83.3
Lewin's Honeyeater	74.1	50.0	33.3	50.0	42.9	85.7	71.4	83.3	60.0	80.0	100.0	100.0	100.0	100.0	83.3	83.3
Golden-headed Cisticola	71.6	100.0	100.0	66.7	71.4	57.1	57.1	83.3	100.0	100.0	66.7	83.3	100.0	60.0	33.3	50.0
Striated Pardalote	65.4	50.0	83.3	100.0	71.4	71.4	57.1	66.7	60.0	80.0	66.7	83.3	0.0	80.0	16.7	33.3
Little Black Cormorant	64.2	50.0	50.0	83.3	85.7	28.6	71.4	33.3	80.0	60.0	50.0	50.0	100.0	80.0	83.3	83.3
Straw-necked Ibis	64.2	50.0	83.3	83.3	100.0	57.1	71.4	33.3	20.0	20.0	33.3	66.7	100.0	80.0	83.3	83.3
White-bellied Sea-Eagle	64.2	50.0	66.7	66.7	100.0	42.9	57.1	66.7	40.0	80.0	66.7	66.7	0.0	20.0	100.0	66.7
Red-browed Finch	64.2	100.0	66.7	50.0	42.9	85.7	100.0	100.0	80.0	80.0	16.7	50.0	0.0	60.0	50.0	50.0
Chestnut Teal	59.3	50.0	50.0	16.7	57.1	57.1	85.7	83.3	100.0	80.0	83.3	50.0	0.0	40.0	16.7	66.7
Rainbow Lorikeet	59.3	50.0	83.3	33.3	42.9	57.1	57.1	33.3	40.0	60.0	33.3	83.3	100.0	100.0	66.7	83.3
Common Myna	58.0	50.0	50.0	83.3	85.7	71.4	57.1	66.7	60.0	60.0	50.0	50.0	100.0	60.0	50.0	0.0
Australian Pelican	55.6	100.0	83.3	66.7	85.7	85.7	42.9	50.0	20.0	60.0	16.7	16.7	100.0	80.0	16.7	66.7
Little Pied Cormorant	53.1	0.0	33.3	16.7	71.4	28.6	71.4	66.7	20.0	100.0	16.7	66.7	100.0	40.0	83.3	83.3
Golden Whistler	51.9	0.0	50.0	50.0	28.6	42.9	42.9	50.0	60.0	60.0	66.7	100.0	0.0	60.0	50.0	50.0
Noisy Friarbird	50.6	50.0	66.7	33.3	42.9	71.4	28.6	33.3	40.0	40.0	33.3	50.0	0.0	100.0	66.7	66.7
Red Wattlebird	49.4	0.0	50.0	33.3	42.9	71.4	14.3	83.3	40.0	60.0	33.3	16.7	100.0	60.0	66.7	83.3
Australasian Darter	48.1	50.0	66.7	83.3	71.4	14.3	28.6	50.0	80.0	40.0	33.3	16.7	0.0	20.0	66.7	66.7
Blue-faced Honeyeater	48.1	0.0	0.0	0.0	42.9	57.1	14.3	16.7	40.0	60.0	50.0	83.3	100.0	100.0	100.0	83.3
Little Corella	46.9	50.0	33.3	33.3	71.4	28.6	28.6	33.3	60.0	60.0	50.0	50.0	100.0	80.0	16.7	66.7
White-necked Heron	44.4	0.0	50.0	16.7	42.9	57.1	28.6	0.0	20.0	40.0	100.0	66.7	100.0	60.0	50.0	50.0
Eastern Yellow Robin	44.4	0.0	16.7	0.0	28.6	28.6	14.3	16.7	40.0	100.0	83.3	66.7	100.0	60.0	66.7	83.3
Oriental Dollarbird *	43.2	50.0	50.0	33.3	42.9	14.3	57.1	50.0	60.0	20.0	50.0	33.3	100.0	40.0	50.0	50.0
Wedged-tailed Eagle	42.0	0.0	83.3	100.0	42.9	42.9	42.9	50.0	40.0	40.0	16.7	33.3	0.0	40.0	16.7	16.7
Dusky Moorhen	42.0	50.0	66.7	100.0	71.4	28.6	42.9	0.0	60.0	20.0	0.0	50.0	0.0	0.0	66.7	33.3

Common Name	RR% All Surveys	2004 RR%	2005 RR%	2006 RR%	2007 RR%	2008 RR%	2009 RR%	2010 RR%	2011 RR%	2012 RR%	2013 RR%	2014 RR%	2015 RR%	2016 RR%	2017 RR%	2018 RR%
Sacred Kingfisher *	42.0	50.0	16.7	33.3	28.6	42.9	42.9	33.3	60.0	40.0	50.0	50.0	100.0	40.0	50.0	50.0
Australasian Pipit	42.0	50.0	50.0	50.0	71.4	57.1	57.1	66.7	20.0	20.0	33.3	33.3	0.0	20.0	16.7	33.3
Black Swan	39.5	0.0	50.0	0.0	57.1	42.9	42.9	33.3	60.0	60.0	50.0	33.3	100.0	40.0	16.7	33.3
Grey Teal	38.3	0.0	0.0	0.0	28.6	71.4	57.1	0.0	40.0	60.0	33.3	0.0	0.0	60.0	83.3	83.3
Brown Falcon	37.0	0.0	0.0	100.0	42.9	71.4	14.3	33.3	20.0	40.0	33.3	33.3	0.0	40.0	33.3	33.3
Great Cormorant	35.8	50.0	66.7	33.3	28.6	57.1	57.1	0.0	20.0	60.0	16.7	50.0	0.0	0.0	16.7	50.0
Spotted Pardalote	35.8	0.0	50.0	33.3	42.9	28.6	0.0	33.3	20.0	40.0	33.3	33.3	0.0	80.0	16.7	83.3
Great Egret	34.6	0.0	0.0	0.0	42.9	42.9	42.9	33.3	60.0	40.0	33.3	33.3	0.0	40.0	66.7	33.3
Eurasian Coot	34.6	0.0	16.7	33.3	0.0	14.3	0.0	0.0	40.0	20.0	83.3	83.3	0.0	20.0	83.3	83.3
Australian King Parrot	34.6	50.0	66.7	16.7	28.6	28.6	14.3	33.3	40.0	20.0	0.0	50.0	0.0	60.0	50.0	50.0
Olive-backed Oriole	34.6	50.0	50.0	33.3	42.9	28.6	42.9	16.7	20.0	20.0	33.3	16.7	0.0	40.0	66.7	33.3
Grey Shrike-thrush	33.3	0.0	0.0	0.0	28.6	42.9	14.3	66.7	40.0	60.0	33.3	66.7	0.0	80.0	0.0	33.3
Australasian Grebe	32.1	0.0	16.7	16.7	42.9	42.9	57.1	0.0	20.0	40.0	83.3	16.7	0.0	0.0	33.3	50.0
Scaly-breasted Lorikeet	30.9	0.0	16.7	16.7	42.9	28.6	28.6	50.0	20.0	0.0	0.0	50.0	0.0	40.0	50.0	66.7
Scarlet Honeyeater	30.9	100.0	16.7	0.0	71.4	28.6	28.6	50.0	40.0	40.0	16.7	33.3	0.0	0.0	33.3	16.7
Latham's Snipe *	29.6	50.0	50.0	33.3	42.9	42.9	28.6	16.7	40.0	20.0	33.3	33.3	0.0	20.0	0.0	16.7
White-throated Gerygone *	29.6	50.0	0.0	0.0	14.3	28.6	14.3	50.0	40.0	40.0	33.3	50.0	0.0	40.0	33.3	50.0
Eastern Koel *	28.4	50.0	16.7	33.3	42.9	28.6	14.3	50.0	40.0	20.0	16.7	33.3	0.0	0.0	33.3	33.3
Common Starling	28.4	100.0	66.7	66.7	42.9	14.3	14.3	50.0	0.0	20.0	33.3	16.7	0.0	0.0	16.7	0.0
Torresian Crow	27.2	0.0	50.0	66.7	28.6	0.0	0.0	0.0	0.0	0.0	0.0	50.0	100.0	60.0	66.7	33.3
Channel-billed Cuckoo *	25.9	0.0	33.3	16.7	28.6	28.6	14.3	33.3	40.0	20.0	16.7	33.3	0.0	20.0	33.3	33.3
Striped Honeyeater	25.9	0.0	0.0	0.0	0.0	0.0	42.9	83.3	60.0	40.0	16.7	0.0	0.0	20.0	33.3	66.7
Rufous Whistler *	25.9	50.0	33.3	16.7	14.3	28.6	42.9	33.3	40.0	20.0	0.0	33.3	0.0	20.0	16.7	33.3
Satin Bowerbird	24.7	50.0	33.3	0.0	14.3	42.9	57.1	33.3	20.0	0.0	33.3	16.7	0.0	20.0	16.7	16.7
Mistletoebird	24.7	0.0	50.0	33.3	28.6	28.6	42.9	33.3	20.0	0.0	0.0	33.3	0.0	0.0	33.3	16.7
Striated Thornbill	23.5	0.0	0.0	0.0	28.6	42.9	28.6	0.0	0.0	20.0	33.3	16.7	0.0	60.0	33.3	50.0
Bar-shouldered Dove	22.2	50.0	0.0	50.0	14.3	28.6	0.0	33.3	40.0	20.0	16.7	50.0	100.0	0.0	0.0	16.7
Black-shouldered Kite	22.2	100.0	16.7	33.3	14.3	0.0	14.3	16.7	0.0	40.0	83.3	33.3	0.0	0.0	0.0	16.7
Rainbow Bee-eater *	21.0	100.0	33.3	33.3	28.6	42.9	28.6	16.7	20.0	0.0	16.7	0.0	0.0	0.0	16.7	0.0
White-breasted Woodswallow*	21.0	0.0	0.0	16.7	28.6	14.3	28.6	50.0	20.0	60.0	16.7	33.3	0.0	20.0	0.0	0.0



Common Name	RR% All Surveys	2004 RR%	2005 RR%	2006 RR%	2007 RR%	2008 RR%	2009 RR%	2010 RR%	2011 RR%	2012 RR%	2013 RR%	2014 RR%	2015 RR%	2016 RR%	2017 RR%	2018 RR%
Sulphur-crested Cockatoo	19.8	50.0	33.3	50.0	28.6	0.0	14.3	0.0	0.0	0.0	16.7	50.0	0.0	20.0	33.3	0.0
Royal Spoonbill	18.5	0.0	33.3	0.0	28.6	14.3	14.3	16.7	0.0	40.0	16.7	16.7	0.0	0.0	33.3	33.3
Tree Martin	18.5	0.0	16.7	33.3	57.1	28.6	0.0	16.7	0.0	0.0	0.0	0.0	0.0	40.0	16.7	33.3
Australasian Figbird	17.3	0.0	0.0	0.0	0.0	0.0	0.0	16.7	20.0	20.0	0.0	16.7	100.0	60.0	50.0	50.0
White-winged Chough	17.3	0.0	16.7	33.3	42.9	57.1	28.6	16.7	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brown Quail	16.0	0.0	0.0	0.0	14.3	28.6	28.6	0.0	40.0	40.0	16.7	33.3	0.0	20.0	0.0	0.0
Great Pied Cormorant	16.0	0.0	50.0	16.7	28.6	0.0	28.6	0.0	0.0	20.0	33.3	16.7	0.0	0.0	16.7	0.0
Eastern Spinebill	16.0	0.0	0.0	16.7	0.0	14.3	14.3	16.7	20.0	40.0	16.7	16.7	100.0	40.0	0.0	16.7
Brown-headed Honeyeater	16.0	0.0	0.0	16.7	0.0	0.0	57.1	0.0	20.0	40.0	16.7	50.0	0.0	20.0	0.0	0.0
Swamp Harrier	14.8	0.0	33.3	16.7	28.6	0.0	28.6	0.0	20.0	20.0	0.0	0.0	0.0	0.0	16.7	33.3
Plumed Egret	13.6	0.0	33.3	16.7	0.0	14.3	42.9	0.0	0.0	20.0	0.0	16.7	0.0	20.0	16.7	0.0
Australian White Ibis	13.6	50.0	0.0	0.0	0.0	14.3	42.9	16.7	0.0	40.0	0.0	0.0	0.0	0.0	50.0	0.0
Nankeen Kestrel	13.6	50.0	16.7	33.3	0.0	0.0	0.0	0.0	40.0	0.0	16.7	16.7	0.0	0.0	0.0	50.0
Musk Lorikeet	13.6	0.0	0.0	16.7	42.9	14.3	0.0	33.3	0.0	0.0	16.7	16.7	0.0	20.0	0.0	16.7
Brown Goshawk	12.3	50.0	16.7	16.7	14.3	14.3	0.0	16.7	20.0	0.0	0.0	16.7	0.0	20.0	0.0	16.7
Red-rumped Parrot	12.3	50.0	16.7	33.3	14.3	14.3	0.0	0.0	0.0	20.0	0.0	16.7	0.0	20.0	0.0	16.7
Eastern Whipbird	12.3	0.0	33.3	0.0	14.3	14.3	0.0	0.0	0.0	40.0	0.0	33.3	100.0	0.0	0.0	16.7
Australian Hobby	11.1	50.0	16.7	16.7	14.3	14.3	14.3	0.0	0.0	20.0	0.0	0.0	0.0	20.0	16.7	0.0
Azure Kingfisher	11.1	0.0	33.3	0.0	28.6	28.6	14.3	16.7	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pied Currawong	11.1	0.0	33.3	0.0	14.3	28.6	28.6	16.7	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0
Rose Robin **	11.1	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	50.0	33.3
Nankeen Night-Heron	9.9	50.0	16.7	16.7	14.3	0.0	0.0	0.0	20.0	0.0	16.7	33.3	0.0	0.0	0.0	0.0
Pied Stilt	9.9	0.0	0.0	0.0	14.3	0.0	14.3	0.0	0.0	0.0	16.7	16.7	0.0	0.0	16.7	50.0
Caspian Tern	9.9	0.0	0.0	0.0	14.3	14.3	0.0	16.7	0.0	0.0	16.7	16.7	0.0	0.0	0.0	50.0
Fan-tailed Cuckoo	9.9	0.0	0.0	0.0	0.0	0.0	14.3	16.7	20.0	0.0	16.7	16.7	0.0	0.0	33.3	16.7
Varied Sittella	9.9	0.0	0.0	0.0	0.0	0.0	14.3	16.7	0.0	0.0	16.7	33.3	0.0	20.0	16.7	16.7
Australasian Shoveler	8.6	0.0	16.7	0.0	42.9	0.0	14.3	0.0	0.0	20.0	0.0	0.0	0.0	0.0	16.7	0.0
Tawny Frogmouth	8.6	50.0	16.7	0.0	28.6	42.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White-throated Needletail *	8.6	0.0	0.0	16.7	0.0	14.3	14.3	0.0	20.0	0.0	0.0	16.7	100.0	0.0	16.7	0.0
Pheasant Coucal	8.6	0.0	0.0	0.0	0.0	0.0	14.3	16.7	20.0	0.0	0.0	16.7	100.0	20.0	16.7	0.0
Jacky Winter	8.6	0.0	0.0	0.0	0.0	14.3	28.6	0.0	0.0	0.0	33.3	16.7	0.0	20.0	0.0	0.0

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Greater Crested Tern	7.4	0.0	33.3	16.7	0.0	0.0	0.0	16.7	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White-winged Triller *	7.4	0.0	0.0	16.7	0.0	0.0	28.6	0.0	20.0	0.0	16.7	16.7	0.0	0.0	0.0	0.0
Fairy Martin *	7.4	0.0	0.0	0.0	0.0	14.3	28.6	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3
Yellow-billed Spoonbill	6.2	50.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	16.7	16.7	0.0	0.0	0.0	16.7
Little Lorikeet	6.2	0.0	0.0	0.0	28.6	0.0	0.0	0.0	20.0	0.0	0.0	0.0	100.0	0.0	0.0	16.7
Shining Bronze-Cuckoo *	6.2	50.0	0.0	0.0	0.0	28.6	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Pallid Cuckoo *	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	16.7	0.0	0.0	16.7	33.3
White-naped Honeyeater	6.2	0.0	0.0	0.0	0.0	14.3	14.3	16.7	0.0	0.0	0.0	0.0	0.0	0.0	16.7	16.7
Common Cicadabird *	6.2	50.0	0.0	0.0	0.0	0.0	14.3	16.7	0.0	0.0	0.0	0.0	0.0	20.0	16.7	0.0
Tawny Grassbird	6.2	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	40.0	33.3	0.0	0.0	0.0	0.0	0.0
Hardhead	4.9	0.0	0.0	0.0	0.0	0.0	14.3	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
Rock Dove	4.9	0.0	0.0	33.3	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brown Cuckoo-Dove	4.9	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	20.0	0.0	16.7	0.0	20.0	0.0	0.0
Wonga Pigeon	4.9	0.0	0.0	33.3	0.0	14.3	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Little Egret	4.9	0.0	16.7	0.0	0.0	14.3	0.0	0.0	0.0	0.0	16.7	0.0	100.0	0.0	0.0	0.0
Peregrine Falcon	4.9	0.0	16.7	16.7	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Yellow-tailed Black-Cockatoo	4.9	0.0	0.0	0.0	0.0	14.3	14.3	0.0	0.0	20.0	0.0	0.0	0.0	20.0	0.0	0.0
Long-billed Corella	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	16.7	0.0	0.0	0.0	16.7	16.7
Variegated Fairy-wren	4.9	0.0	0.0	0.0	0.0	0.0	14.3	0.0	40.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0
Brown Gerygone	4.9	50.0	0.0	0.0	14.3	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
Collared Sparrowhawk	3.7	0.0	0.0	16.7	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Grey Goshawk	3.7	0.0	0.0	16.7	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Black-fronted Dotterel	3.7	0.0	16.7	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
Crimson Rosella	3.7	0.0	0.0	0.0	0.0	0.0	14.3	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
White-bellied Cuckoo-shrike	3.7	0.0	0.0	0.0	0.0	14.3	14.3	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0
Restless Flycatcher	3.7	0.0	0.0	16.7	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0
Brown Songlark *	3.7	0.0	0.0	33.3	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spotted Dove	2.5	0.0	0.0	0.0	0.0	0.0	0.0	16.7	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Topknot Pigeon	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	16.7
Black-necked Stork	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	16.7	0.0
Silver Gull	2.5	0.0	0.0	0.0	14.3	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Horsfield's Bronze-Cuckoo*	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	16.7
Brush Cuckoo	2.5	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0
White-plumed Honeyeater	2.5	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0
Rufous Songlark *	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3
European Goldfinch	2.5	0.0	0.0	0.0	14.3	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
King Quail	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White-headed Pigeon	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0
Wompoo Fruit-Dove	1.2	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fork-tailed Swift *	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
Pacific Baza	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0
Red-kneed Dotterel	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
Bar-tailed Godwit *	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Australian Gull-billed Tern	1.2	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Common Tern *	1.2	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Southern Boobook	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Eastern Barn Owl	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White-throated Treecreeper	1.2	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Southern Emu-wren	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0
Buff-rumped Thornbill	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Little Wattlebird	1.2	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White-fronted Chat	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0
Brown Honeyeater	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Dusky Woodswallow	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0
Rufous Fantail *	1.2	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spangled Drongo	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0
Forest Raven	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Scarlet Robin **	1.2	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Australian Reed-Warbler	1.2	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Little Grassbird	1.2	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Double-barred Finch	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0
Plum-headed Finch	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0

In October 2018 over 1500 birds were recorded during the survey. The 81 species observed comprised mainly wetland birds including 286 Grey Teal *Anas gracilis*, 109 Pacific Black Duck *Anas superciliosa*, 71 Cattle Egret *Bubulcus ibis*, 501 Straw-necked Ibis *Threskiornis spinicollis* and 191 Yellow-faced Honeyeater *Lichenostomus chrysops* moving through the riparian zone. Whilst this number is around three times that normally observed it indicates that at certain times and in certain conditions the property can support much larger populations.

### Front Gate Forest

Between 2004 and 2018 there were 77 surveys carried out on this site with a total of 51 species recorded (**Appendix Table 1**). This area recorded 7-27 species per year with consistent counts in the high teens to low twenties. Four to six surveys were conducted each year except in 2004, with only one survey conducted in November, and 2015 with surveys in February and April only.

Two species had RR >80%; Noisy Miner *Manorina melanocephala* (RR 97.4%) and Eastern Rosella *Platycercus eximius* (RR 81.8%). Both species appear to find this remnant of open forest highly suitable. Three species had RR 77.9%-40%; Australian Magpie *Gymnorhina tibicen*, Pied Butcherbird *Cracticus nigrogularis* and Grey-crowned Babbler *Pomatostomus temporalis* (**Appendix Table 2**). All five species in the above two categories have been recorded breeding in this site. The remaining 22 species had RR ranging from 32.5% to 5.2% and comprised a mix of open forest species plus some waterfowl utilising the adjacent farm dam.

Tawny Frogmouth *Podargus strigoides*, Blue-faced Honeyeater *Entomyzon cyanotis*, Grey Butcherbird *Cracticus torquatus*, Crested Pigeon *Ocyphaps lophotes* and Common Myna *Acridotheres tristis* have also been recorded breeding in this woodland. A family of White-winged Choughs *Corcorax melanorhamphos* was present between August 2006 and August 2009. This species has not been recorded there since.

### Quarry Lane and Bamboo Bend

These two sites were strips of riparian vegetation each approximately 20 metres wide which had been supplementarily planted with woodland and rainforest species. The sites were fenced to exclude grazing. However, at times cattle were allowed to graze the grass border alongside Quarry Lane.

### Quarry Lane

Much of Quarry Lane was remnant rainforest species forming a mid-storey with large eucalypt and angophora species providing a canopy. Being the most heavily vegetated site and having a higher complexity of plant species with a good understorey, it recorded the highest diversity of bird species ranging from 23 to 56 (excluding 2004) seen in a calendar year. This is generally about twice the number of species seen in the similar site Bamboo Bend which had 16 to 33 species (excluding 2004). Some of the RR difference may have been influenced by surveys being conducted later in the morning at the latter site.

Between 2004 and 2018, 77 surveys were conducted with 4-6 surveys per year except in 2015 with surveys in February and April only. A total of 102 species was recorded overall with 23 - 56 species per year except in 2004 when only ten species were present on the sole survey (**Appendix Table 3**).

Five species had RR >80% and eight species had RR between 79.9% and 40% (**Appendix Table 4**). Of the thirteen species with RR >40%, ten species were generally found within the riparian vegetation. The other three species, Australian Magpie, Eastern Rosella and Laughing Kookaburra *Dacelo novaeguineae* mainly used the grassy strip and paddocks bordering the riparian vegetated strip. The remaining 89 species had RR ranging from 36.4% to 1.3%. Of these, 12 species were only seen on one or two occasions.

Summer visitors to Quarry Lane comprised 11 species with the Sacred Kingfisher recorded breeding and Oriental Dollarbird a possible breeder. Two winter species were recorded: Rose Robin *Petroica rosea*, first seen in June 2016; and Scarlet Robin recorded only in August 2007.

At least eleven species have been recorded breeding (**Table 4**). Those were Australasian Darter, Sacred Kingfisher, Superb Fairy-wren, Brown Thornbill, Striated Pardalote, Yellow-faced Honeyeater, Scarlet Honeyeater *Myzomela sanguinolenta*, Brown-headed Honeyeater, Black-faced Cuckoo-Shrike *Coracina novaehollandiae* and Australian Magpie.

Nine additional species may possibly be breeding as suitable habitat was available. These include Oriental Dollarbird, White-browed Scrubwren, Yellow Thornbill *Acanthiza nana*, Eastern Spinebill *Acanthorhynchus tenuirostris*, Lewin's Honeyeater, Golden Whistler *Pachycephala pectoralis*, Grey

Fantail, Eastern Yellow Robin *Eopsaltria australis* and Silvereye *Zosterops lateralis*.

### Bamboo Bend

Bamboo Bend, stretching from the southern boundary of the property northward along the Williams River, did not have the structural diversity or complexity of vegetation in Quarry Lane. Large eucalypts and angophoras were present, however, the mid-storey had not yet developed density and complexity with much of it having only been planted in 2001 - 2004. Being on a bend of the river it was also more open to winds from southerly, westerly and northerly aspects which may have impeded growth of revegetation. Possibly adding to this exposure is the complete absence of trees or shrubs on the opposite river bank, negating any buffering effect for westerly winds. The vegetation structure also had an effect on the diversity of avian species as both cover and foraging resources were limited.

Between 2004 and 2018, 77 surveys were conducted with 4-6 surveys per year except in 2015, with surveys in February and April only. Overall, 71 species were recorded ranging from 16 - 33 per year, except in 2004 with seven species present on the sole survey (**Appendix Table 5**).

Only one species, Superb Fairy-wren, had RR >80%, with seven species having RR 79.9% - 40%, six of which are species that are more commonly found in more open vegetation (**Appendix Table 6**). The remaining 63 species had RR ranging from 29.9% to 1.3%.

The only observation indicating possible breeding was of two adult Brown-headed Honeyeaters feeding four fledged young in June 2014. Suitable breeding habitat was available for resident species such as Superb Fairy-wren, White-browed Scrubwren, Yellow Thornbill, Brown Thornbill, Lewin's Honeyeater, Yellow-faced Honeyeater, Grey Fantail, and Red-browed Finch *Neochmia temporalis*.

### Lagoon

Between 2004 and 2018, 78 surveys were conducted with 4 - 6 surveys per year except in 2014 when there were 7 surveys, and in 2015 with only 2 surveys in February and April. A total of 45 species was recorded with species counts varying from 3 to 20 per year, and only one species recorded in the sole survey of 2004 (**Appendix Table 7**). This freshwater wetland periodically dries up and at such

times the number of species recorded drops to about half of that recorded when the wetland is at capacity.

No species had RR >80% with only one species having RR between 79.9% and 40%, the Golden-headed Cisticola *Cisticola exilis*, which was recorded in all years (**Appendix Table 8**).

The remaining 44 species had RR ranging from 29.5% to 1.3%. Three of those species, Pacific Black Duck, White-faced Heron *Egretta novaehollandiae* and Masked Lapwing *Vanellus miles* had RR between 29.5% and 26.9%. These species are commonly recorded in wetlands of this nature.

Latham's Snipe has been recorded here on nine of the 15 years surveyed with counts of 1-5 birds. It appears the juncus provides good cover while the occasionally exposed muddy areas provide diurnal foraging opportunities.

Three species have been recorded breeding on this site: Black Swan *Cygnus atratus*; Chestnut Teal *Anas castanea*; and Golden-headed Cisticola.

### The Swamp

Between 2004 and 2018, 77 surveys were conducted with 4-6 surveys per year except in 2015 with only 2 surveys in February and April, and 7 surveys in 2014. A total of 41 species was recorded with counts varying from 3 to 18 per year, and only three species recorded in the sole survey of 2004 (**Appendix Table 9**).

The Swamp was a permanent freshwater wetland about the same length as the Lagoon but wider and shallower, with one small area of open water. Bordering the wetland was an area of woodland with a copse of medium-sized trees resulting in an increased number of passerine species.

No species had RR >80% with only two species having RR between 79.9% and 40%; White-faced Heron and Australian Magpie (**Appendix Table 10**). The remaining 38 species had RR ranging from 29.9% to 1.3%.

Latham's Snipe was recorded here on 8 of the 15 years surveyed with counts of 1-13 birds. Again, juncus appears to have provided suitable habitat.

In February 2011 a covey of seven King Quail *Synoicus chinensis* were observed adjacent to the Swamp. A pair of unidentified small quail seen in February 2010 was also believed to have been King

Quail. No species has been recorded breeding at this site although it is possible that species such as Magpie-lark *Grallina cyanoleuca*, Noisy Miner and Australian Magpie may breed in the forested area on the southern border of the site.

### Threatened Species

White-throated Needletail *Hirundapus caudacutus* (RR 8.6%), listed as vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), was seen on seven occasions (**Appendix Table 11**).

Seven species listed as vulnerable under the NSW *Biodiversity Conservation Act 2016* (BC Act) were recorded (**Appendix Table 12**). Grey-crowned Babbler and White-bellied Sea-Eagle *Haliaeetus leucogaster* were common. The other five species were only occasionally present. Varied Sittella was recorded on eight occasions with 1-12 birds seen. Only two of these were winter records (August). Little Lorikeet *Glossopsitta pusilla* was recorded on five occasions. White-fronted Chat *Epthianura albifrons*, Scarlet Robin *Petroica boodang* and Dusky Woodswallow *Artamus cyanopterus* were each observed on one occasion only.

**Table 3.** Threatened species recorded at Greswick Angus 2004-2018.

Common Name	Records	RR%	Relevant Act
White-throated Needletail	7	8.6	EPBC Act
White-bellied Sea-Eagle	52	64.2	BC Act
Little Lorikeet	5	6.2	BC Act
White-fronted Chat	1	1.2	BC Act
Scarlet Robin	1	1.2	BC Act
Grey-crowned Babbler	62	76.5	BC Act
Varied Sittella	8	9.9	BC Act
Dusky Woodswallow	1	1.2	BC Act

### Breeding Species

A total of 37 species have been recorded breeding or exhibiting breeding behaviour (**Table 4**). This included nest with eggs, birds inspecting hollows, collecting nesting material, nest building, adult birds carrying food or seen with dependent young.

**Table 4.** Breeding species recorded at Greswick Angus 2004-2018.

Black Swan	Noisy Miner
Australian Wood Duck	Striated Pardalote
Crested Pigeon	White-browed Scrubwren
Tawny Frogmouth	Striated Thornbill
Purple Swamphen	Brown Thornbill
White-faced Heron	Grey-crowned Babbler
Little Pied Cormorant	Olive-backed Oriole
Australasian Darter	Black-faced Cuckoo-shrike
Masked Lapwing	White-winged Triller
Whistling Kite	Australian Magpie
Rainbow Bee-eater	Pied Butcherbird
Sacred Kingfisher	Grey Butcherbird
Galah	White-winged Chough
Eastern Rosella	Willie Wagtail
Superb Fairy-wren	Grey Fantail
Blue-faced Honeyeater	Australian Raven
Brown-headed Honeyeater	Golden-headed Cisticola
Scarlet Honeyeater	Common Myna
Yellow-faced Honeyeater	

The Grey-crowned Babbler was regularly recorded breeding in Front Gate Forest. A family of White-winged Choughs *Corcorax melanorhamphos* was present between August 2006 and August 2009. A nest was being built in August 2006 which was found abandoned after egg hatching on October 2006. A second nest was found blown from a tree on the same date.

### Long-term trends

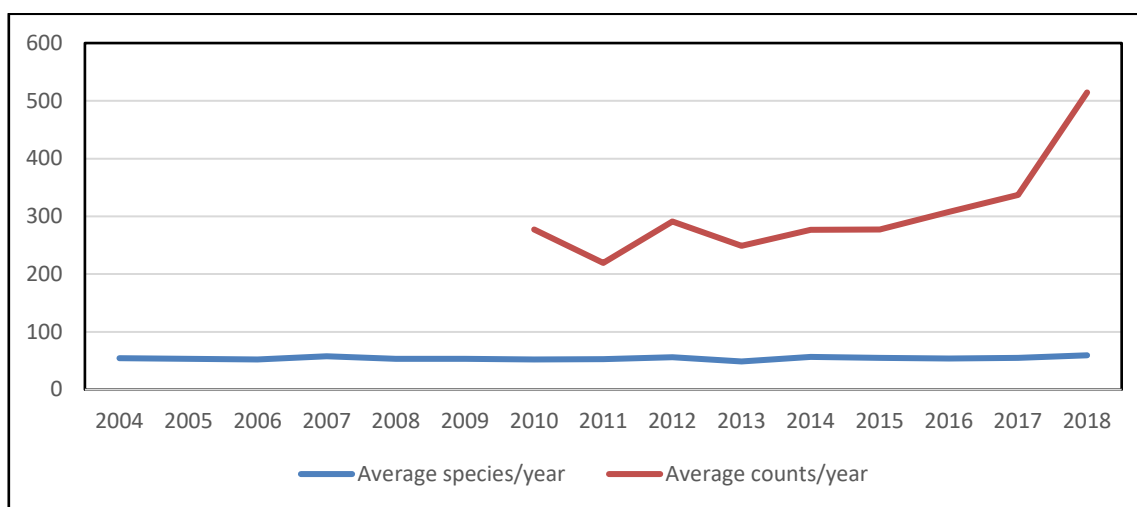
The average number of species observed per year for 2004-2018 and the average number of birds counted per year for 2010-2018 are presented in **Figure 9**. The average annual species was 54.3 and this has remained relatively constant with a standard deviation of  $\pm 2.6$ . Counts of numbers of birds present commenced in April 2010. The average number counted remained relatively constant from 2010-2015, averaging 265. From 2016 the average number counted increased considerably to a maximum of 514.5 in 2018.

The average number of species is a measure of species richness and it appears to have remained relatively constant over the 15 years of survey. The data from Greswick Angus suggests that the property and the surrounding woodland, wetland

and river provide habitat that sustains a diverse range of resident and migratory species.

The pronounced increase in the average number of birds counted from 2016 - 2018 (**Figure 9**) was

partly due to the influx of a large number of Anatidae, Ardeidae and Threskiornithidae following widespread rainfall from an East Coast Low in June 2016. In October 2018 the total count was 1507 birds.



**Figure 9.** Comparison of the average number of birds counted per year and average number of species recorded per year from 2010 to 2018. Prior to April 2010 species numbers were not recorded.

**Table 5.** Chi square values and probability of significance of population change for five species from Greswick Angus, for periods 2004-2010 and 2011-2018.

Species	No. of records		$\chi^2$ Value	P	Statistical significance
	2004-2010	2011-2018			
Australasian Figbird	1	13	8.85	< 0.01	Highly significant increase
White-winged Chough	13	1	8.65	< 0.01	Highly significant decline
Azure Kingfisher	8	1	4.01	< 0.05	Significant decline
Rose Robin	1	8	4.00	< 0.05	Significant increase
Tawny Frogmouth	7	0	5.15	< 0.05	Significant decline

The results from Chi Square tests, shown in **Table 5**, indicated there was a statistically highly significant increase in the records of Australasian Figbird and a significant increase in the records of Rose Robin. A statistically highly-significant decline in records of White-winged Chough and a significant decline in records of Azure Kingfisher and Tawny Frogmouth were identified.

The increase in Rose Robin records probably reflects the growth and maturation of the revegetation around areas of its preferred riparian forest habitat at Quarry Lane and Bamboo Bend. Other factors possibly influencing the increase are influx due to drought, or increased time taken during surveys, particularly of the riparian zones. The increase in Australasian Figbird records is

probably due to the extent of fruiting of the fig trees located between the Lagoon and the Swamp.

The species exhibiting highly significant and significant declines are not listed as threatened in NSW under the BC Act and are listed as Least Concern by BirdLife International and the IUCN. This indicates that their declines are probably due to local factors. While the decline in Tawny Frogmouth records may be related to the diurnal nature of the surveys, factors influencing a decline in White-winged Chough and Azure Kingfisher records are unclear.

The surveyed status of birds at Greswick Angus is in marked contrast to other regions of Australia where many species, particularly woodland birds, are in steady decline. Over one-third of Australia's

land bird species are woodland dependent and at least one in five of these is threatened and in decline. (Olsen *et al.* 2005).

## Diversity

The total species recorded at Greswick Angus, which is a measure of species diversity, was compared to that of similar areas within the Hunter Region that have been surveyed for extended

periods. The results are presented in Appendix **Table 6** which shows that the diversity at Greswick Angus is higher than most other areas surveyed in the region, although the range and quality of habitats across these survey sites are not the same. The range of habitats, rehabilitation efforts and management practices at Greswick Angus all undoubtedly contribute to the large number of species present.

**Table 6.** Comparison of species diversity from long-term studies of selected rural and conservation areas in the Hunter Region.

Location	Land use	Period	Species count	Reference
Butterwick	Cattle grazing	1996-2007	126	Newman (2007)
Green Wattle Creek	Cattle grazing	1996-2009	135	Newman (2009)
Bolwarra	Urban area	1994-2011	112	Tarrant (2011)
Martins Creek	Rural roadside	1999-2013	124	Newman (2014)
Laguna	Former grazing	1979-2012	124	Raine (2014)
Saltwater	National Park	2009-2015	124	Stuart (2015)
Curracabundi	National Park	2010-2013	126	Drake-Brockman (2015)
Dunns Creek	Rural roadside	2008-2014	113	Newman (2017)
Minmi	Reserve	2002-2009	153	Powers & Date-Huxtable (2017)
Tahlee	Private woodland	2014-2018	128*	Fleming (2019)
Booti Booti	National Park	1985-1988, 2012-2015	206	Turner (2020)
Blue Gum Hills	Reserve	2012-2016	91	Little (2021)
Yaraandoo	Cattle grazing	2011-2014	104	Newman (2022)
Greswick Angus	Cattle grazing	2004-2018	175	Kendall (this article)

\* Excludes records of waterbirds and shorebirds surveyed from the Tahlee shoreline.

## CONCLUSIONS

Greswick Angus is a working cattle breeding property with the priority of providing a sustainable and environmentally responsible business whilst considering the impact of farming activities on the immediate environment as well as the impact of farm runoff on the water supply for the Newcastle area.

The diversity of habitat across the property, namely remnant woodland, farm dams, ephemeral wetlands, open grassland and riparian forest, has contributed to attracting and maintaining significant populations of birds with 175 species recorded over the survey period. Breeding or breeding behaviour has been recorded in at least 37 of the species identified.

In his booklet “Striking the Balance: A Family’s Quest for a Sustainable Future in Agriculture” John Spearpoint wrote “*When we planned our revegetation activities, our focus was on erosion control. We didn’t really consider any indirect benefits to native plants and animals and the ecosystem services that they provide. Now that we are aware of their benefits, our plan is to maintain and improve bird habitat.*” (Spearpoint 2006).

From the results of the monitoring, it is evident that the number of bird species utilising the property has increased. Hill (2015) states “*One of the most useful things that birds can indicate is overall habitat quality. When birds are dependent on the habitat functioning in specific ways, the population trends of birds can tell us about how well the ecosystem*



*functions.” And “Since bird numbers can reflect the quality of the habitat, they can also be used to measure the effectiveness of habitat restoration.”*

This study has shown that with an environmentally conscious approach, targeted revegetation and sympathetic management, a working farm can provide habitat that sustains as well as increases avian populations from a wide mix of species. In turn, birds provided a positive return benefit, acting as pollinators, seed dispersers and agents of biological control.

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