Same, same but different: A comparison of bird surveys in two areas of urban Forster, New South Wales

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Bird surveys were undertaken at two areas within urban Forster, New South Wales, totalling 19 years (01/2001 to 04/2006, 11/2008 to 04/2012 and 05/2012 to 05/2021). A total of 166 species were recorded during both surveys, of which 11 species are listed as either vulnerable or endangered. A total of 45 species were recorded breeding within either of the two survey areas.

The two survey areas (named here as Hind and Gleneon), were similar in terms of total area surveyed, total species recorded, monthly species counts and numbers of resident species. However, 58 (35%) species exhibited significant or highly significant statistical differences in abundance between the two survey areas. Differing vegetation types and differing proximity to adjacent tracts of vegetation were the main reasons, although several other factors also apply.

Located immediately east of the Hind survey area, the presence of a large tract (70+ hectares) of mature forest was considered fundamental habitat for some of the species recorded within the survey area. Additionally, permanent water in a drainage channel and constructed wetlands provided habitat and foraging opportunities for some species.

Removal of rank grassland areas within the Gleneon survey area, which is currently occurring for the construction of residential housing, potentially will detrimentally impact seven species.

INTRODUCTION

"Rapid urban expansion is considered to be one of the leading threats to global biodiversity (Aronson et al. 2014; Seto et al. 2012). Urbanisation is typically associated with natural habitat loss, alteration of ecological processes and increased anthropogenic disturbance - all of which can ultimately have a negative impact on the abundance, richness and diversity of native species (McKinney 2002)," (Plummer et al. 2020). From analysis of avian abundance data, systematically collected across the United Kingdom through the 'Breeding Bird Survey' scheme, Plummer et al. (2020) found that "The majority of species responded negatively to the composition of the built environment, their densities decreasing significantly as building (70% of species), road (61% of species) and built surface (56% of species) percentage land covers increased ...". Plummer et al. (2020) concluded their study by emphasising the importance of interconnected natural areas within the urban environment and the benefits to both biodiversity, including birds, and the people living in those areas.

Located on the eastern side of Wallis Lake, on the lower Mid North Coast of New South Wales, Forster (**Figure 1**) was originally settled with its twin coastal village of Tuncurry, on the northwestern side, during the 1870s. Following first settlement, land around the coastal edges was steadily subdivided for housing, while portions away from the coastal edges were cleared for agriculture pursuits. Fortunately, many tracts of land, marginal for farming purposes, have remained intact. Additionally, prudent planning controls by the council (currently MidCoast Council) over the years have resulted in a mosaic of vegetated parcels remaining within the residential environment, mainly along ridge tops and natural drainage areas.

Avian surveys were conducted in two locations in south Forster totalling 19 years (01/2001 to 04/2006, 11/2008 to 04/2012, and 05/2012 to 05/2021). Data from the two survey areas were compared and are presented here. The extent to which differing composition of vegetation patches within and adjacent to the survey areas may have contributed to species diversity and abundance within the two survey areas is investigated.

METHODS

Site descriptions

Both survey areas were located in urban areas of southern Forster (**Figure 2**), separated by approximately 1.1 km. For a comparison of the general make-up of each survey area, the area was broken into three parts being road, residential and reserve. Road included the road pavement and footpath areas up to residential property boundaries, residential included all privately owned developed land and reserve included public reserve space, drainage reserves and undeveloped private land.

The first survey area ("Hind SA") was centred about Hind Avenue (32.2027°S, 152.5225°E), south of the main shopping centre (**Figure 2**). Originally low and partially swampy land was filled and subdivided during the 1980s. Contained within this survey area were two open drains with concrete bases, surrounded by either maintained grass or by mature vegetation. Wetlands were constructed, by the local council, in each of the two open drains during 2003 and planted out with a mix of macrophyte species. These two wetlands provided additional permanent water within the survey area. Boundaries of the Hind SA were Breese Parade to the north, a main drainage channel east of Goldens Road to the east and south and The Lakes Way to the west.

Overall, the Hind SA covers 43.1 ha with road, residential and reserve areas being 4.1 (9.5%), 26.0 (60.3%) and 13.0 (30.2%) ha respectively. Reserve areas within this survey area were a mix of mown grass along the drainage reserves, macrophyte growth within the drainage channel and mature vegetation. Mature vegetation types consist of a mix of either Coastal Sands Apple-Blackbutt Forest (Sydney Red Gum *Angophora costata*, Blackbutt *Eucalyptus pilularis*) and Northern Paperbark-Swamp Mahogany Saw-sedge Forest (Swamp Mahogany *Eucalyptus robusta* and Broad-leaved Paperbark *Melaleuca quinquenervia*) (Trees Near Me 2024). Additionally, to the east of the site was a large tract (70+ ha) of the two pre-mentioned forest types.

The second survey area ("Gleneon SA") was centred about the intersection of Gleneon Drive and Greenview Place (32.2208°S, 152.5319°E) (Figure 2). Originally a dairy farm with orchards, the Gleneon SA was subdivided in the late 1980s and early 1990s. Fronting Pipers Bay, within Wallis Lake, a caravan park covers part of the southern section of the survey area and was considered residential land. Land east of Tea Tree Road and north of The Lakes Way was undeveloped rank grassland. Boundaries of the Gleneon SA are up to 350 m east of Tea Tree Road, the edge of Pipers Bay to the south, up to 100 m west of Tahiti Avenue and up to 150 m north of The Lakes Way. Birds on Wallis Lake were not included in the survey area. During early 2018, the local council constructed a small wetland within the survey area footprint and planted various macrophyte species. Growth of these aquatic plants has had mixed results; however, the wetland has provided a permanent water body within the survey area.



Figure 1. Aerial image showing location of two urban bird surveys in south Forster, NSW, with reference to Tuncurry, Wallis Lake and Booti Booti National Park. Hind = Hind Avenue survey area; Gleneon = Gleneon Drive survey area. Image courtesy of NearMaps.



Figure 2. Aerial image showing boundaries of two urban bird surveys in Forster, NSW. Hind = Hind Avenue survey area; Gleneon = Gleneon Drive survey area. Image courtesy of NearMaps.

Overall, the Gleneon SA covers 42.3 ha with road, residential and reserve areas being 7.2 (17.0%), 15.9 (37.6%) and 19.2 (45.4%) ha respectively. Reserve

within this survey area was predominately rank, sparsely grazed, grassland on undeveloped private land, areas of mown grass in public reserves and around drainage channels and small tracts of Estuarine Swamp Oak Twigrush Forest (Trees Near Me 2024) dominated by *Casuarina glauca*. Additionally, to the north and northeast of the site were several small tracts and to the southeast a large tract of the pre-mentioned forest type.

Weather data

Rainfall and temperature data were obtained from the Bureau of Meteorology website (BOM 2024). Their nearest recording station (No. 060013) is located adjacent to Forster breakwall, north of the two survey areas (~3.4 km from Hind and ~5.5 km from Gleneon). The average rainfall for the area was 1220 mm (1896 to 2024) from an average of 89 rain days per year. The mean January and February temperatures varied by only 0.1°C, being 26.6°C and 26.5°C respectively, while the mean July temperature was 18.7°C (1999 to 2020).

Surveys and data management

Hind Avenue surveys were undertaken between January 2001 and April 2006 and then again between November 2008 and April 2012. Although Gleneon Drive surveys ranged between May 2012 and May 2021, observations between January and July 2016 were misplaced and no observations were undertaken during September 2014. Records of avian species were noted during the combination of daily morning walks and undertaking normal residential activities after work or on weekends, whilst residing in each of the two urban survey areas. Identifications were made either audibly or visually and with the aid of binoculars when required.

Birds were recorded either within or flying over each survey area. Counts for species recorded are the maximum observed at any one time. For larger flocks of birds, five- or 10-unit estimates were periodically made up to a maximum of 100 individuals. Flocks greater than 100, although rare, were recorded as 100. The capping of maximum individuals to 100 will have an impact in the overall average count for that species, however the impact is considered minimal for the purposes of these two survey areas. Although tallied on a weekly basis, records were summarised into monthly lists. These monthly summaries have been entered into the BirdLife Australia atlas (Birdata) as a 'Systematic [within] 500 m [of a central point] area search'. Recording and summarising bird observations into monthly totals will increase the survey effort for each individual month when compared to individual short timeframe surveys conducted monthly. As surveys of these two areas were undertaken in a similar format, survey effort is comparable across both areas.

Due to the differing total number of surveys within each survey area, species observations were converted to a Reporting Rate (RR) for comparison. The RR is the ratio of the number of records to the total number of surveys, expressed as a percentage. Any species with a RR greater than 79%, I considered to be resident within the survey area.

In line with Cooper *et al.* (2014), the following months were combined for seasonal migration comparisons: winter (May, June and July) and summer (November, December and January). For classification as a summer migrant, a species had to be recorded a minimum of four times during summer and at least five times more frequently than in winter (Newman 2007). For a winter migrant, this was reversed.

Breeding records were based on the following criteria: active visible nest; feeding of a dependant juvenile; observing a recently fledged juvenile; repeated visits to a nest (e.g. termitarium by a kingfisher / kookaburra) or to a small patch of vegetation (e.g. clump of grass by a fairywren) with food.

The differences in observation frequency for each species from the two survey areas was statistically tested using the Yates-corrected Chi-squared test (Fowler & Cohen 1994). Where the expected frequency of any species was less than 5 in either survey set, species were omitted from further testing, due to insufficient observations. For one degree of freedom, Chi-squared results between 3.84 and 6.62 are considered to be 'Significant', while over 6.63 the result is 'Highly Significant'.

Audible differentiation between Spotted *Pardalotus punctatus* and Striated *P. striatus* Pardalotes is difficult for me. As such, records were predominately by observation only and are therefore under-recorded. During my time in Hind Avenue, pardalotes were only recorded once confirmed by sight. When resident in Gleneon Drive, a 'Pardalote *sp.*' observation line was added to the bird list.

RESULTS

A complete list of species recorded is provided in Appendix (available the at https://www.hboc.org.au/the-whistler-volume-19/). The Appendix contains a list of birds recorded within each survey area and whether they were observed breeding. It also contains minimum, maximum and average numbers of individuals, overall reporting rates, seasonal reporting rates, migratory classification and any statistical differences in abundance. Overall, 166 species were recorded, with 146 and 142 recorded within the Hind and Gleneon survey areas, respectively.

The average number of species recorded monthly in each survey area was 60 (**Table 1**). This table also shows the remarkably similar results for both minimum and maximum monthly counts. Eleven species are listed as threatened under either the NSW *Biodiversity Conservation Act 2016* (BC Act) or Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). These species, along with their conservation status, are listed in **Table 2**.

Thirty-four species were classified as resident within the Hind SA, of which 16 were recorded in all surveys. Similarly, within the Gleneon SA, 35 species were resident with 18 of them recorded in every survey month. From these two data sets, 29 species were classed as resident at both survey areas. Forty-five species were recorded breeding within one or other of the two survey areas (**Table 3**).

Sixteen species were classified as summer migrants and ten species as winter migrants into either of the two survey areas (**Table 4**). Only seven of the 26 species were migrants into both survey areas.

The Chi-squared test of significance produced nine significant and 49 highly significant differences to the observation of species in the survey areas, which is 35% of the overall species recorded. Twenty-seven differences applied to species in the Hind SA (**Table 5**) and 31 applied to species in the Gleneon SA (**Table 6**). Further commentary on these differences is made within the discussion section of this paper.

Month		Hind A	venue		Gleneon Drive				
Month	п	Average	Min	Max	п	Average	Min	Max	
January	10	64	47	74	8	60	51	67	
February	10	59	43	70	8	57	41	67	
March	10	56	38	69	8	60	50	64	
April	10	56	41	74	8	61	56	70	
May	8	58	47	69	8	62	56	68	
June	8	57	47	67	8	58	42	66	
July	8	60	46	69	8	60	45	65	
August	8	62	48	72	9	60	48	67	
September	8	62	46	78	8	57	36	73	
October	8	66	55	80	9	63	55	74	
November	9	61	49	72	9	63	55	76	
December	9	60	48	72	9	61	55	72	
Total	106	60	38	80	100	60	36	76	

Table 1. Summary of monthly averages of birds recorded within two survey areas in urban Forster.

Table 2. Species recorded in either of the two urban Forster survey areas and listed as either vulnerable or endangered under the NSW *Biodiversity Conservation Act 2016* (BC Act) or vulnerable or critically endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). E = endangered, V = vulnerable, CE = critically endangered and V1 = vulnerable.

Species	BC		EPBC Act	
Species	Е	V	CE	V1
Wompoo Fruit-Dove		Yes		
White-throated Needletail				Yes
Black Bittern		Yes		
Bar-tailed Godwit				Yes
Latham's Snipe		Yes		
Osprey		Yes		
Square-tailed Kite		Yes		
Spotted Harrier		Yes		
White-bellied Sea-Eagle		Yes		
Swift Parrot	Yes		Yes	
Little Lorikeet		Yes		
Totals	1	8	1	2

Table 3. List of species	recorded breeding with	thin either of the	e two urban Forster	r survey areas. HA	A = Hind Avenue and
GD = Gleneon Drive.					

Species	HA	GD	Species	HA	GD
Australian Wood Duck	Yes		Striped Honeyeater	Yes	
Pacific Black Duck	Yes		Little Wattlebird	Yes	Yes
Chestnut Teal	Yes		Red Wattlebird	Yes	Yes
Spotted Dove	Yes	Yes	Yellow-faced Honeyeater	Yes	
Crested Pigeon	Yes	Yes	Noisy Miner		Yes
Tawny Frogmouth	Yes	Yes	Yellow Thornbill	Yes	
Eastern Koel	Yes		Australasian Figbird	Yes	Yes
Channel-billed Cuckoo	Yes		Olive-backed Oriole	Yes	Yes
Lewin's Rail		Yes	Black-faced Cuckoo-shrike	Yes	
Buff-banded Rail		Yes	Pied Currawong	Yes	Yes
Purple Swamphen	Yes		Australian Magpie	Yes	Yes
Dusky Moorhen	Yes		Pied Butcherbird	Yes	
White-faced Heron	Yes	Yes	Grey Butcherbird	Yes	Yes
Masked Lapwing		Yes	Willie Wagtail	Yes	
Southern Boobook	Yes		Leaden Flycatcher	Yes	
Oriental Dollarbird	Yes	Yes	Magpie-lark	Yes	Yes
Sacred Kingfisher	Yes		Torresian Crow	Yes	Yes
Laughing Kookaburra	Yes		Tree Martin	Yes	
Galah	Yes		Welcome Swallow	Yes	Yes
Eastern Rosella	Yes	Yes	Common Starling	Yes	
Rainbow Lorikeet	Yes		Common Myna	Yes	Yes
Scaly-breasted Lorikeet	Yes		House Sparrow	Yes	
Superb Fairy-wren	Yes		Total	41	21

Table 4. Species classified as either summer or winter migrants within either of the two urban Forster survey areas, with a comparison to the 2019 HBOC Annual Bird Report (ABR; Williams 2020). Altitudinal migrant (AM), resident (R), summer migrant (SM) and winter migrant (WM)

Spania	Hind A	Avenue	Gleneo	Status	
Species	Summer	Winter	Summer	Winter	ABR
Grey Teal		WM			R
Topknot Pigeon		WM			R
White-throated Needletail	SM		SM		SM
Eastern Koel	SM		SM		SM
Channel-billed Cuckoo	SM		SM		SM
Straw-necked Ibis		WM		WM	R
Nankeen Night-Heron	SM				R
Cattle Egret				WM	R
Latham's Snipe	SM		SM		SM
Whistling Kite		WM			R
Brahminy Kite	SM				R
Rainbow Bee-eater			SM		SM
Oriental Dollarbird	SM		SM		SM
Azure Kingfisher		WM			R
Sacred Kingfisher	SM				SM
White-cheeked Honeyeater			SM		R
Eastern Spinebill		WM			R
Olive-backed Oriole			SM		R
Golden Whistler				WM	R
Grey Shrike-thrush				WM	R
White-breasted Woodswallow	SM		SM		SM
Rufous Fantail	SM				SM
Leaden Flycatcher	SM				SM
Rose Robin				WM	AM
Australian Reed-Warbler	SM				SM
Silvereye			SM		R
TOTAL	12	6	10	5	26

Snecies	Number of Records		γ^2	Statistical Significance
species	HA	GD	λ	Statistical Significance
Grey Teal	11	1	6.24	Significant
Chestnut Teal	81	26	24.22	Highly Significant
Peaceful Dove	38		33.93	Highly Significant
Purple Swamphen	106	59	10.29	Highly Significant
Dusky Moorhen	106		98.07	Highly Significant
Striated Heron	13		10.40	Highly Significant
Great Egret	93	58	5.81	Significant
Southern Boobook	74	15	34.52	Highly Significant
Azure Kingfisher	28		24.51	Highly Significant
Sacred Kingfisher	47	2	37.02	Highly Significant
Peregrine Falcon	17		14.15	Highly Significant
Sulphur-crested Cockatoo	106	70	5.08	Significant
Variegated Fairy-wren	40	13	11.29	Highly Significant
White-cheeked Honeyeater	82	16	39.44	Highly Significant
Spotted Pardalote	55	1	47.16	Highly Significant*
Striated Pardalote	39	3	27.19	Highly Significant*
Grey Shrike-thrush	56	20	14.16	Highly Significant
White-bellied Cuckoo-shrike	25		21.68	Highly Significant
Spangled Drongo	77	24	23.85	Highly Significant
Leaden Flycatcher	33	4	19.61	Highly Significant
Australian Raven	33	8	12.70	Highly Significant
Australian Reed-Warbler	18	2	10.40	Highly Significant
Tree Martin	20	5	7.05	Highly Significant
Silvereye	51	22	9.18	Highly Significant
Common Starling	59	19	17.31	Highly Significant
Red-browed Finch	52	27	5.97	Significant
House Sparrow	67	1	58.45	Highly Significant
Total species	27	•	•	

Table 5. Results of Chi-squared (χ^2) test of species between two survey areas in southern Forster applying to the Hind Avenue survey area. See Methods for survey area descriptions. HA = Hind Avenue and GD = Gleneon Drive

* The highly significant statistical result for both pardalote species may not be accurate, due to the author's poor audible differentiation skills.

Table 6. Results of Chi-squared (χ^2) test of species between two survey areas in southern Forster applying to the Gleneon Drive survey area. See Methods for survey area descriptions. HA = Hind Avenue and GD = Gleneon Drive

	Number of				
Species	Rec	ords	χ^2	Statistical Significance	
	HA	GD		_	
Brown Quail		11	9.69	Highly Significant	
Black Swan	1	10	6.30	Significant	
Tawny Frogmouth	36	59	6.46	Significant	
Pheasant Coucal	4	50	40.20	Highly Significant	
Buff-banded Rail	1	21	17.55	Highly Significant	
Straw-necked Ibis	30	53	7.19	Highly Significant	
Cattle Egret	8	42	23.76	Highly Significant	
White-necked Heron	4	14	5.04	Significant	
Silver Gull	2	19	13.15	Highly Significant	
Osprey	23	38	4.08	Significant	
Black-shouldered Kite	25	51	9.75	Highly Significant	
Square-tailed Kite		15	13.91	Highly Significant	
Swamp Harrier	2	19	13.15	Highly Significant	
White-bellied Sea-Eagle	44	79	11.49	Highly Significant	
Whistling Kite	26	51	8.95	Highly Significant	
Rainbow Bee-eater		48	48.84	Highly Significant	

Table 6 continued

Species	Number of Records		χ^2	Statistical Significance	
	НА	GD		_	
Australian Hobby	20	44	9.67	Highly Significant	
Musk Lorikeet	7	22	7.61	Highly Significant	
Satin Bowerbird	34	58	7.17	Highly Significant	
Blue-faced Honeyeater	7	89	73.21	Highly Significant	
Noisy Friarbird	41	66	6.88	Highly Significant	
Eastern Spinebill	24	49	9.36	Highly Significant	
Noisy Miner	47	100	21.57	Highly Significant	
Brown Thornbill	41	66	6.88	Highly Significant	
Pardalote <i>sp</i> .		13	11.80	Highly Significant*	
Eastern Whipbird	5	50	37.84	Highly Significant	
White-breasted Woodswallow	30	64	13.60	Highly Significant	
Rose Robin	3	12	4.75	Significant	
Golden-headed Cisticola	2	31	25.44	Highly Significant	
Tawny Grassbird		54	55.20	Highly Significant	
Mistletoebird	44	86	15.44	Highly Significant	
Total species		31			

* The highly significant statistical result for both pardalote species may not be accurate, due to the author's poor audible differentiation skills.

DISCUSSION

As indicated in the site description section above, there are differences in habitat structure, both within and adjacent to each survey area. These differences may, in part, have influenced the avifaunal population of each survey area resulting in statistical differences for 58 species.

Of the 27 statistical differences for species from the Hind SA, four are significant and 23 highly significant. However, two highly significant differences are for the two pardalote species. Located within the Hind Avenue survey area are two constructed wetlands and a drainage channel. These permanent water sources provided foraging opportunities and breeding habitat for eight species recording statistical differences. Water depth within the drainage channel was generally less than 500 mm, except during flooding events. From time to time, macrophyte vegetation in the drainage channel, dominated by cumbungi *Typha latifolia*, was mown by council.

Chestnut Teal *Anas castanea* was recorded just below resident status (RR 76%) within the Hind SA. In contrast, Grey Teal *Anas gracilis*, with a RR of just 10%, was considered a winter migrant. Cooper *et al.* (2014) noted that "... it [Grey Teal] vacates much of the higher-altitude parts of the State [NSW] ... during June and July". Grey Teal favoured the drainage channel. Both Purple Swamphen *Porphyrio porphyrio* and Dusky Moorhen *Gallinula tenebrosa* were recorded as resident and breeding. Macrophyte growth, in the drainage channel to the east, and the maturing vegetation within the constructed wetlands, provided ideal habitat for the two species in the Hind SA. Recently, following maturation of the constructed wetland, Purple Swamphen has become a breeding resident in the Gleneon SA. Two other waterbird species, Striated Heron *Butorides striata* and Great Egret *Ardea alba*, were predominately observed in the drainage channel.

With a RR of 26%, Azure Kingfisher *Ceyx azureus* was classed as a winter migrant within the Hind SA. Although considered a resident species (Higgins 1999; Williams 2020), Higgins states: "Some movements of adult associated with breeding ..." and "Seasonality in occurrence apparent in some areas". Conversely, Australian Reed-Warbler *Acrocephalus australis* was recorded as a summer migrant. Again, macrophyte growth within the drainage channel provided suitable habitat.

As mentioned in the site description, a large tract of mature forest, with developed understorey, is located adjacent to the Hind SA. Six species are considered to have recorded statistical differences as a direct result of this large tract of vegetation providing suitable habitat. These species were mainly recorded adjacent to the tract, with some foraging slightly distant, but mostly retreating back into the forest. Three species, Variegated Fairy-wren *Malurus lamberti*, Silvereye *Zosterops lateralis* and Redbrowed Finch *Neochmia temporalis*, were recorded at, or just below, moderate RR and mostly along and adjacent to the drainage channel / forest interface. Transient in nature, Silvereyes were most often recorded along the edge of the understorey, which consisted mainly of Lantana *Lantana camara*. Both Variegated Fairy-wren and Red-browed Finches were often recorded within the grass along the drainage channel, retreating into the understorey when disturbed.

White-cheeked Honeyeaters *Phylidonyris niger* were recorded at just below resident status (RR 77%) in the Hind SA. Conversely, within the Gleneon SA, they appeared predominantly during flowering events by callistemon species in spring (RR 35%) and into summer (RR 19%) resulting in a summer migrant classification. Within Booti Booti National Park, to the south of the Gleneon SA, the species is a breeding resident (Turner 2020). This suggests that the presence of the adjacent forest provided suitable habitat to sustain the species throughout the year.

Grey Shrike-thrush Colluricincla harmonica was recorded at moderate rates (RR 53%). Generally, within Booti Booti National Park, they are resident (Turner 2020), however unpublished data by Turner records them at similar rates (RR 48%) on Cape Hawke, part of the National Park, approximately 8 km to the east of the Hind SA. Cooper et al. (2020) reported a general decrease in RR for the species within NSW, between 1986 and 2006. They also stated that Grey Shrike-thrushes tend to inhabit remnant vegetation with understorey and not small patches (say <10 ha). Grey Shrike-thrushes are adversely affected by the presence of Noisy Miners Manorina melanocephala (Grey et al. 1997; Debus 2008). RR for Noisy Miners in the Hind SA was 44%, however in the Gleneon SA, the RR was 100%.

During surveys within Booti Booti National Park (1985-1988 and 2012-2015), Turner (2020) recorded White-bellied Cuckoo-shrike *Coracina papuenis* only once. Within the Hind SA, the species was recorded at a low rate (RR 24%) and not at all within the Gleneon SA. Although preferred habitats are open type sclerophyll forests or woodlands in drier areas, along the coast they include paperbark forests with Broad-leaved Paperbark as a typical tree species (Cooper *et al.* 2020).

The remaining 13 species, recording statistical differences within the Hind SA, are not considered direct beneficiaries of the adjacent forest or the permanent water. These species are more generalists in nature, however the existence of mature vegetation did contribute to the presence of some species.

Southern Boobook *Ninox boobook* was recorded just below resident status (RR 70%) and breeding within the Hind SA. One pair was regularly observed and bred in a large hollow of a Sydney Red Gum in the northern portion of the survey area, while a second pair was known to roost in the southern portion, within a residential backyard.

Both Sacred Kingfisher *Todiramphus sanctus* and Leaden Flycatcher *Myiagra rubecula* were recorded as summer migrants and breeding. A mix of mature trees and partially cleared understorey within the drainage reserves, and termitariums for the kingfisher, provided the ideal habitat for these species, during their stay.

Although possibly nesting on a telecommunications tower on the eastern side of the large tract, Peregrine Falcon *Falco peregrinus* was only recorded at a moderately low rate (RR 16%). The species most likely opportunistically hunted avian species within the Hind SA. Generally silent in behaviour, and observations often fleeting, peregrines were most likely under-recorded in the area.

Sulphur-crested Cockatoo *Cacatua galerita* was resident (RR 100%) within the Hind SA, while achieving a 70% RR within the Gleneon SA. Additionally, average numbers of individuals varied between the two survey areas, being nine and three respectively. Feeding by residents, within the Hind SA, contributed to the increased observations there.

Although recorded within both survey areas, Spangled Drongo Dicrurus bracteatus had a RR of 73%, just below resident status within the Hind SA and moderately low (RR 24%) within the Gleneon SA. Drongos benefitted from some periodic feeding by residents, within the Hind SA, and potentially the presence of more mature trees throughout the survey area. Within the Hunter Region, drongos have long been regarded as winter migrants or birds of passage (Hunter Region Annual Bird reports 1-26), however Williams (2020) states them as "Resident in the north of the Region, but typically absent from the south in summer". Cooper et al. (2020) suggests a possible southward and lower altitudinal range extension for breeding in response to temperature increases.

Three species of corvid are likely to be recorded within the Forster area. At times, vocalisations of the individual species can be difficult to differentiate, with Torresian Crows *Corvus orru* in particular known to produce a wide range of calls (pers. obs.). Within the Hind SA, loose flocks of up to 20 corvids were observed flying overhead at dusk, particularly during winter. It is suspected that an area of natural bushland, approximately 500 m north and surrounding the water supply reservoir, is a roost site. As the majority of those aggregations were silent, those observations were not included. It is likely that corvid species were under recorded within the Hind SA.

Although Tree Martin *Petrochelidon nigricans* was only recorded at moderately low levels (RR 19%) in the Hind SA, it was also recorded breeding. Birds were observed utilising small hollows in mature Blackbutts.

Overall, Common Starling Sturnus vulgaris was recorded moderately (RR 56%) within the Hind SA and also breeding. Within the Gleneon SA, their RR was moderately low (19%). However, over the duration of the Hind survey, starling flock sizes decreased. Based on annual NSW Bird Reports, Common Mynas Acridotheres tristis did not arrive in the Forster area until December 2001 (Higgins et al. 2006), however, records within the Hind SA commenced in September 2001. After arrival, increases in myna flock sizes correlated with the decrease of starling flock sizes. Records of starlings within the Gleneon SA were predominately of a small population utilising a shallow open drain for drinking. Post surveys, sightings of starlings within Forster have almost ceased (pers. obs.). Williams (2020) suggests a "... potential decline ..." within the Hunter Region generally.

House Sparrow *Passer domesticus* was recorded moderately often (RR 63%) within the Hind SA and breeding. Only a single sparrow observation was made within the Gleneon SA, most likely a transient individual. Similar to the decline of Common Starlings, only several small flocks of sparrows remain within Forster.

Of the 31 statistical differences that applied to species in the Gleneon SA, five are significant and 26 highly significant. Thirteen of these species, that have recorded statistical differences, utilized the grazing paddocks and rank grassland habitat within and adjacent to the survey area. However, nearly 15 ha (35.2%) considered reserve (paddocks and grasslands) within this paper, are currently being developed and this will severely impact the abundance of the majority of those species in the future.

Both Brown Quail Synoicus ypsilophorus and Buffbanded Rail Hypotaenidia philippensis were only recorded at low (RR 11%) to moderately low (RR 21%) rates, respectively. Due to their cryptic nature, they are most likely to have been under-recorded. Conversely, Pheasant Coucal Centropus phasianinus was recorded with a RR of 50% overall, and a RR of 88% in summer. All three species favoured the areas of rank grassland and adjacent estuarine Swamp Oak Twig-rush Forest. However, Buff-banded Rail, sometimes with dependant young, was also sighted in residential gardens, with suitable habitat. Rank grassland also provided suitable habitat for both Golden-headed Cisticola C. exilis (RR 31%) and Tawny Grassbird Cincloramphus timoriensis (RR 54%).

Straw-necked Ibis *Threskiornis spinicollis* was recorded as a winter migrant in both survey areas, however the average in the Gleneon SA (12) was twice that of the Hind SA (6). The presence of some livestock, at times, also provided foraging opportunities for Cattle Egret *Bubulcus ibis*, which was also recorded as a winter migrant in the Gleneon SA. White-necked Heron *Ardea pacifica* was recorded in low rates (RR 14%) within the paddocks.

Four raptors benefitted from hunting over the rank grassland areas; Black-shouldered Kite *Elanus axillaris*, Square-tailed Kite *Lophoictinia isura*, Swamp Harrier *Circus approximans* and Australian Hobby *Falco longipennis*. Turner (2020) noted a highly significant statistical decrease in RR of Black-shouldered Kites within Booti Booti National Park, over the period from 1985 to 2015. From personal observations, only a single pair is present in the Forster area and they breed on an active cattle property north-east of the Gleneon SA.

Classified as a summer migrant within both survey areas, White-breasted Woodswallows *Artamus leucorynchus* forage preferably over the open habitat of the Gleneon SA. Recorded at resident status during spring, summer and autumn, its overall RR averaged 64%.

As mentioned in the site description, Pipers Bay, which is a large embayment of the Wallis Lake system, is located immediately south of the Gleneon SA. Although birds on Wallis Lake were not included in the survey area, five species observed within the survey area are considered to have recorded statistical differences due to the proximity of the bay.

Although Black Swans *Cygnus atratus* are regularly observed foraging and loafing in Pipers Bay (pers. obs.), they were only recorded at a low rate (RR 10%) within the survey area. Also recorded at a moderately low rate (RR 19%) was Silver Gull *Larus novaehollandiae*. This species is most likely under-recorded, with birds traversing between Wallis Lake and local Pacific Ocean beaches, for roosting and foraging opportunities, silently at height or at night. Turner (2020) recorded them as residents within Booti Booti National Park.

Three species of raptors were also recorded more regularly based on the proximity of Pipers Bay to the Gleneon SA. Nesting on the same telecommunications tower that the Peregrine Falcon is suspected of nesting on, east of the large tract of forest, Ospreys Pandion haliaetus were regularly observed transporting sticks and fish overhead during the winter, spring and summer periods with an overall RR of 38%. Whistling Kite Haliastur sphenurus was recorded at a moderate rate (RR 51%) while White-bellied Sea-Eagle Haliaeetus *leucogaster* was recorded just below resident status (RR 79%). Both Osprey and White-bellied Sea-Eagle are listed as vulnerable under the BC Act (2016).

The remaining twelve species recording statistical differences within the Gleneon SA, are not considered direct beneficiaries of either the rank grassland or proximity to Pipers Bay and are more generalists in nature.

Overall, Tawny Frogmouths Podargus strigoides had RRs of 34% and RR 59% within the Hind and Gleneon survey areas, respectively. However, the spring RRs were higher, being 42% and 81%. They also bred regularly within both survey areas. They are generally considered a sedentary species and occupying permanent territories (Kaplan 2007; Rae 2009). However, Cooper et al. (2014) noted differences in monthly reporting rates between winter and spring / summer and suggested that birds are more active and vocal during the breeding season, possibly leading to observer bias. Locating roosting birds during autumn and winter proved more difficult than during spring and summer. Additionally, Tawny Frogmouths show high site fidelity when breeding (Higgins 1999) and, as such, once a nest was located, the area was regularly checked during the breeding season.

Classified as a summer migrant, observations of Rainbow Bee-eater *Merops ornatus* were in the Gleneon SA only. Generally, birds were initially heard and then sighted traversing over the survey area, generally either early in the morning or late in the evening. Observations of this species, within the Gleneon SA, may be a result of proximity to available nesting areas, rather than providing preferential foraging habitat.

The vast majority of observations of Musk Lorikeet *Glossopsitta concinna*, within the Gleneon SA (RR 22%), were tied to flowering events. It could be expected that with more mature trees, and greater variety, within the Hind SA, more observations would have been recorded than the resultant 7% RR. Another species producing a surprising statistical result was Satin Bowerbird *Ptilonorhynchus violaceus*. Although found in a variety of habitats, from rainforests to modified urban parks and gardens (Higgins *et al.* 2006; Cooper *et al.* 2016), greater distance between trees within the Gleneon SA provided more opportunities to observe bowerbirds, with a resultant RR of 58%.

Five of the thirteen species of honeyeater recorded within both survey areas produced highly significant statistical differences. One species, White-checked Honeyeater, was previously mentioned within the Hind SA and the remaining four are within the Gleneon survey area. There was a stark difference in recording rates of Blue-faced Honeyeater Entomyzon cyanotis between the two survey areas. Recorded at resident status (89%) within the Gleneon SA, mobile juvenile birds observed during summer also suggests that the species bred in close proximity. A RR of just 7% within the Hind SA, was similar to what Turner (2020) recorded within Booti Booti National Park during the first survey period (1985 to 1988) and the second Birds Australia Atlas survey between 1998 and 2002 (Barrett et al. 2003).

Overall, observations of Noisy Friarbird *Philemon corniculatus* within the Gleneon SA produced a RR of 66%. Spring, summer and autumn RRs were very similar, being 69%, 69% and 75% respectively, with the winter RR being only 50%. However, the average individual count for spring, summer and autumn was only 3, while for winter, counts averaged 11. Although Turner (2020) suggested that the Booti Booti National Park isthmus does not support migrating Yellow-faced Honeyeaters *Caligavis chrysops*, increased counts of friarbirds, particularly during May, suggests that this conduit is suitable for this larger honeyeater species.

SA, Within the Hind Eastern Spinebill Acanthorhynchus tenuirostris was recorded with a low overall rate (RR 23%) and as a winter migrant. However, within the Gleneon SA, it was recorded moderately frequently (RR 49%) overall but at resident status (RR 83%) during winter. It is considered a common resident species within the Hunter Region (Williams 2020). Higgins et al. (2001) and Cooper et al. (2020) both suggest there are influxes of birds in some locations during winter.

The fifth honeyeater species with a statistically significant difference was Noisy Miner *Manorina melanocephala*, with a RR of 100% within the Gleneon SA and only 44% within the Hind SA. The simpler vegetation structure within the Gleneon SA is consistent with the miner's preferred habitat.

Observed foraging in the Swamp Oak patches on the northern side of the Gleneon survey area, Brown Thornbill *Acanthiza pusilla*, had a moderately high RR of 66%, compared to the RR of 39% within the Hind SA.

Eastern Whipbird *Psophodes olivaceus* was recorded moderately frequently (RR 50%) within the Gleneon SA. Although only recorded in low numbers, there were sufficient records of Rose Robin *Petroica rosea* to be classified as a winter migrant in the Gleneon SA. Post-survey, suitable habitat for both these species has been substantially reduced.

Within the Hind SA, Mistletoebird *Dicaeum hirundinaceum* was recorded moderately frequently (RR 42%) while within the Gleneon SA, it was considered resident (RR 86%). Similar to Musk Lorikeets and Satin Bowerbirds, the greater recording rates for Mistletoebird within the Gleneon SA is surprising, considering that mature vegetation is sparser.

CONCLUSIONS

The two survey areas were similar in terms of total area surveyed, total species recorded, monthly species counts and numbers of resident species. However, differing vegetation types and differing proximity to adjacent tracts of suitable habitat at the two sites resulted in about one-third of all species having significant or highly significant statistical differences in abundance, although two of those results can be attributed to other factors. A large tract of mature forest located immediately east of the Hind survey area seems to be fundamental habitat for some of the species recorded within the survey area. The presence of numerous mature trees within the survey area, even without understorey in some locations, provides an additional foraging area for resident species and a stepping stone for transient species passing through. Additionally, permanent water in the drainage channel and constructed wetlands provided habitat and foraging opportunities for some species.

The loss of suitable habitat due to clearance of rank grassland areas within the Gleneon survey area, which is currently occurring for construction of residential housing, potentially will detrimentally impact seven species: Brown Quail, Pheasant Coucal, Buff-banded Rail, Black-shouldered Kite, Variegated Fairy-wren, Golden-headed Cisticola and Tawny Grassbird. Several other species are also likely to be impacted. Ongoing surveys, as development occurs within the Gleneon survey area, and a comparison with the data presented here, will provide a summary of impacts of the residential development into the future.

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Appendix. List of species recorded during two urban Forster bird surveys, including reporting rates. This is available online <u>https://www.hboc.org.au/the-whistler/whistler-19/</u>.