Bird habitat creation and use at Tweed Sands Lake

Thea Shell

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ABSTRACT

Wetland habitats are in decline globally. The loss and fragmentation of wetlands can have detrimental impacts on a variety of fauna, including bird populations. The creation of artificial wetlands, at sites such as quarries, is one approach that increases the amount of habitat available for vulnerable species. There is little knowledge on improving biodiversity attributes during mining activities and insight into the potential benefits of this is essential to guiding future enhancement actions.

This study investigated the effect of revegetation and time since disturbance on bird communities at Tweed Sands Lake. Time since disturbance and the presence of vegetation did not dramatically affect the bird abundance, species diversity or composition at Tweed Sands Lake. However, a definite trend was found towards older, vegetated sites to supporting a wider range of species and a more unique community composition. This trend suggests that given time, rehabilitated areas can provide higher bird species populations, and support diverse bird communities.

INTRODUCTION

Wetland habitats are in decline globally (Dugan, 1992) and in Australia wetland loss has been severe (Finlayson and Rea, 1999). The loss of wetlands is a serious threat to many fauna worldwide including birds (Ma et al., 2004). Birds are highly mobile and many depend on waterbodies and vegetated areas surrounding wetlands. These habitats provide essential habitat services such as foraging, roosting, breeding, and refuge, to birds, including threatened and migratory species. The creation of artificial wetland habitat in areas such as quarries, can help to

slow the rate of wetland loss and bird population decline. Waterbird species such as ducks, egrets, and cormorants, in particular are reliant on wetlands, foraging for aquatic vegetation, insects, and fish. Other wetland dependant species such as swamphen, crakes and rails, utilise the edges of wetlands. Threatened species such as Australasian Bittern and Latham's snipe particularly require wetland areas of high vegetation cover. Species such as Australian Reed Warbler, whilst not using the water, predominantly occur in tall rush or reed vegetation. Other bird species benefit highly from the riparian vegetation adjacent to wetlands. Honeyeaters, finches, doves and small insectivores will utilise trees, shrubs and grasses adjacent to wetland areas. Raptors such as White-bellied Sea-eagle and Bramany Kite are regularly found in association with lakes and rivers, as they prey on fish and wetland birds. Thus wetlands provide essential habitat for many bird species across Australia.

Quarry activities often result in dramatically altered parcels of land. Extraction activities produce steep cliff faces, deep pools or open lakes and areas which are devoid of top soil. As such, it is difficult to utilise these areas for agricultural or urban developments. Natural regeneration can take decades (Řehounková and Prach, 2008). The active conversation of worked areas to a more natural state through improvements, planting of native species or provision of fauna habitat qualities, such as nesting sites (Xing and Pia, 2003) and creation of artificial wetlands, is ethically responsible (Shrivastava, 1995; Kelly and Hodge, 1996) and dramatically improves the site (Yundt and Lowe 2002) which can be used by a range of fauna (John, 1993; Worrall et al., 1998).

Tweed Sands Lake is an artificial water body situated on the Tweed River floodplain near Cudgen in northern New South Wales. Tweed Sands Lake forms part of an active sand extraction quarry. The Tweed Coast once contained many several freshwater lakes, and swamps. Through expanding agriculture, sand extraction and urbanisation, many of these waterbodies have been drained. Creation of artificial wetlands, such as Tweed Sands Lake, provides much needed habitat to local and migratory fauna. Following rehabilitation efforts including a planting program, vegetation has become established in sections of Tweed Sands Lake while sand extraction activities continue in other areas of the lake. Often quarries undertake rehabilitation works to improved biodiversity attributes after extraction activities have ceased (Usher, 1979; Bell, 2001). The impact of this 'early' planting on bird communities is not well documented and the outcomes of this study may help further rehabilitation efforts and benefit local and migratory avifauna.

OBJECTIVES

This study aims to identify vegetated and un-vegetated areas of Tweed Sands Lake, and determine approximate time since disturbance for each. The study also aims to determine what bird species or groups are likely to use each of these habitat types and determine which, if any, provide the best quality habitat for birds and provide comment on if recent rehabilitation has had an effect on the bird community. It is hoped that this information can further understanding of bird community at Tweed Sands Lake, and guide future management and rehabilitation efforts.

BACKGROUND INFORMATION

Site description

Tweed Sands Lake (28°15´S 153°32´E) is located near Chinderah on the far north coast of New South Wales. The lake has been artificially created through sand extraction activities and has naturally filled with brackish water. Previous to quarry activities, the land was cleared of native vegetation and used for agriculture, most recently, as a tea tree plantation. The waterbody is approximately 17 hectares, and is currently expanding. Following extraction and other quarry activities such as spoil dumping, weed spraying and habitat creation, the banks of the lake are made to be a 'clean slate', and free from vegetation. In some areas which have long been undisturbed from quarry activities, native and exotic vegetation has colonised. In addition to this 'natural revegetation', the bank has in places been subject to revegetation and enhancement works. These began in 2011 and are still continuing. Aquatic species such as sedges and juncus have been planted within created channels and wetlands, fringed by planted shrubs and trees. The trees and shrubs planted include Lilly Pilly, Eucalypt, Sheoak and Callistermon. The revegetated area spans approximately 300 m of the lake's edge south west boundary.

METHODS

Treatments were selected based on time since disturbance (age being 'old' or 'new') and whether a site had been revegetated (naturally or planted) or not. The treatment selection predominately focussed upon the terrestrial plant species. Sites were selected based on a habitat assessment with assistance from aerial imagery. Sites were selected to be at least 100m from another (Figure 1). Due to the size of the lake, and ratio of treatment areas, a total of 15 sites were selected.

Treatment types

1) New vegetated (3 sites) – Recently (since 2011) disturbed by earthworks. Site planted out with sedges, juncus, shrubs and trees. Grass height maintained by slashing. In some areas natural revegetation by she-oak seedlings (Figure 2).
2) Old vegetated (5 sites) – Undisturbed for over 14 years. Characterised by tall trees, predominantly sheoak. Some shrubs, fallen debris such as logs, and an understory of exotic grass (Figure 3).
3) Old unvegetated (3 sites) – Undisturbed for over 14 years. Dominated by weeds, often sprayed with herbicide, has an artificially created bund wall. No trees or shrubs (Figure 4).
4) New unvegetated (4 sites) – Recently (since 2011) disturbed by earthworks such as 'scalping' or dredged with machinery. Little vegetation, only weeds and grasses (Figure 5).

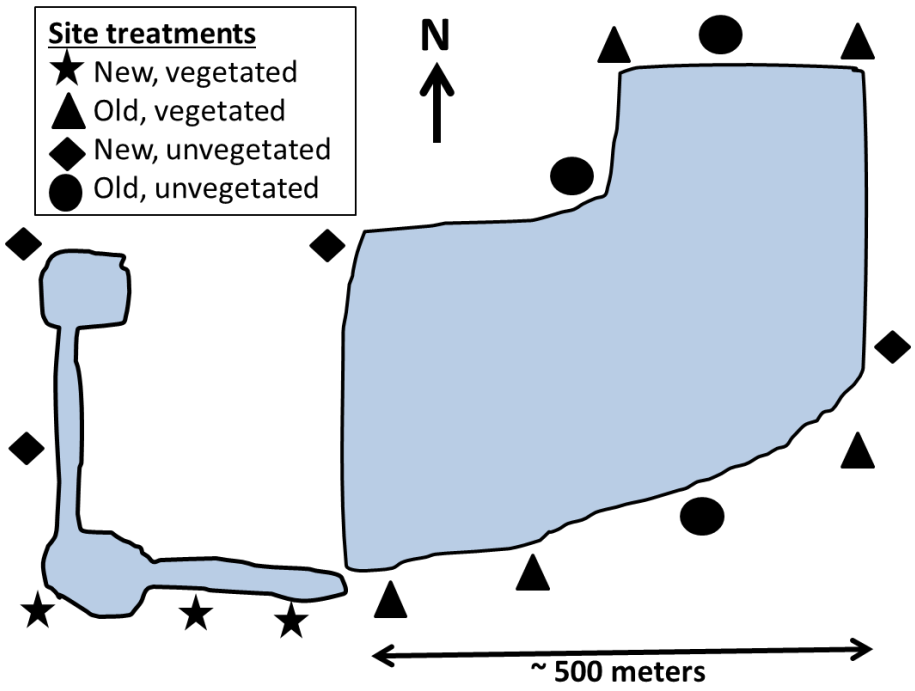

Figure 1. Representation of Tweed Sands Lake waterbody and selected sites.

Three twenty minute stationary bird surveys were conducted at each site. Bird surveys took place between 10/4/2014 and 16/4/2014. Surveys were conducted from dawn to dusk, at different times of day. The order in which sites were surveyed was randomised and the same site was not surveyed twice in one day. The same observer conducted all bird surveys, and surveys were not conducted in adverse conditions such as high wind, extreme temperatures, or when sand extraction activities were taking place. Birds that were either seen or heard were recorded. Birds were identified and common names used based on Simpson and Day (2010). Birds utilising the site, such as for roosting, foraging, loafing, and raptors scanning within site area were included. Birds flying high over the site, and not interacting with other birds within the site, or the habitat, were not included. Care was taken not to count the same bird twice. Each site was subject to a brief habitat assessment to determine dominant vegetation and structural characteristics.

Figure 2. New revegetated site.

Figure 3. Old revegetated site.

Figure 4. Old un-vegetated site.

Figure 5. New un-vegetated site.

Data analysis

Sites were lumped based on time since disturbance (Young and Old) and presence of either planted or natural revegetation (No-Vege and Vege). The total number of birds (bird abundance) and total number of species (species density) were pooled for each treatment type. The difference in bird abundance and species density were tested across treatment types using the non-parametric Kruskal-Wallis test. This test was used as our count data did not meet the assumption of normally distributed errors. Species composition patters were assessed using non-metric dimensional scaling (NMDS) ordination with ANOSIM analysis. Simper analysis was used to identify which species were contributing most highly to any compositional dissimilarity observed.

RESULTS

Across the four treatment types, fifteen hours of surveys recorded 636 individual birds of 72 species (Appendix A). There were no surveys that failed to record any bird species. On average, sites contained 42.4 (±16.1 SD) individuals representing 11.5 (±3.6 SD) species. A wide range of species were recorded including ducks, honeyeaters, finches and raptors. Some species such as Pacific-black Duck and Superb Fairy-wren occurred regularly at the majority of sites. Some species, such as Double-barred Finch, and Fairy Martin, occurred once at one site. No threatened species were recorded on site. Species listed as Migratory under the EPBC Act that were recorded on site were: Fork-tailed Swift, White-bellied Sea-eagle, Eastern Great Egret, and Cattle Egret. Very few invasive or pest bird species were recorded during surveys. One pest species that was recorded was Mallard. Mallard was recorded with one individual occurring each at site 8 and site 15.

Bird abundance did not differ across all sites and treatments. No statistical significance was found between Young and Old sites ($\chi 2 = 0.05$, df = 1, p = 0.81), No-Veg and Veg sites ($\chi 2 = 0.34$, df = 1, p = 0.56) or between the four treatments ($\chi 2 = 0.35$, df = 3, p = 0.95; Fig.6a). Statistically significant differences were not observed for

species density between Young and Old sites ($\chi 2$ = 3.26, df = 1, p = 0.07), No-Veg and Veg sites ($\chi 2$ = 1.35, df = 1, p = 0.24) or between vegetation states taking both these factors into account ($\chi 2$ = 5.77, df = 3, p = 0.12; Fig.1b). However, these findings are suggestive more species to be occurring in Old sites (p = 0.07), and in particular, those Old sites that are vegetated (Fig. 6b).

Species composition is a determinate of the bird community at a site. It takes into account both the number of birds and species of birds at a site. Species composition was found to not differ significantly between the sites for vegetation (R2 = 0.06, p = 0.19) or the four treatment combinations (R2 = 0.07, p = 0.26; Fig. 7). There was however, a suggestion of a unique species assemblage for Old sites, when compared to Young sites (R2 = 0.13, p = 0.07). The reason for this trend depends on species with a higher average abundance or unique presence at a particular site type (Table 1). Species that contributed the highest difference between the bird communities at New and Old sites include Pacific Black Duck, Masked Lapwing, and Superb Fairy-wren. For example, Masked Lapwing was twelve times more likely to occur at a New site, than an Old site. While Purple Swamphen was fifteen times more likely to occur at an Old site than a New site. A New site was more likely to regularly have species such as Masked Lapwing, Red-browed Finch, Australian Wood Duck, Masked Lapwing, and Willie Wagtail. While species such as Welcome Swallow, Pacific Black Duck, Superb Fairy Wren, Welcome Swallow, Fork Tailed Swift and Brown Honeyeater were more likely to be regularly recorded at Old sites.

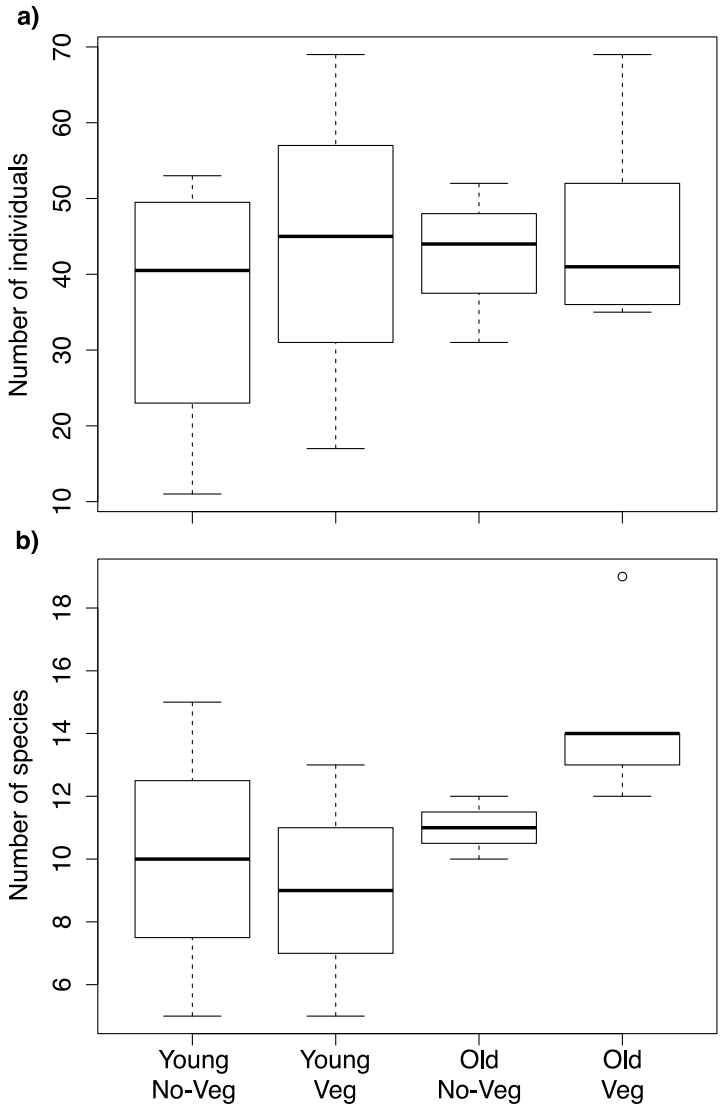

Figure 6. Boxplots of **a)** total abundance, and **b)** species density for the four identified vegetation states.

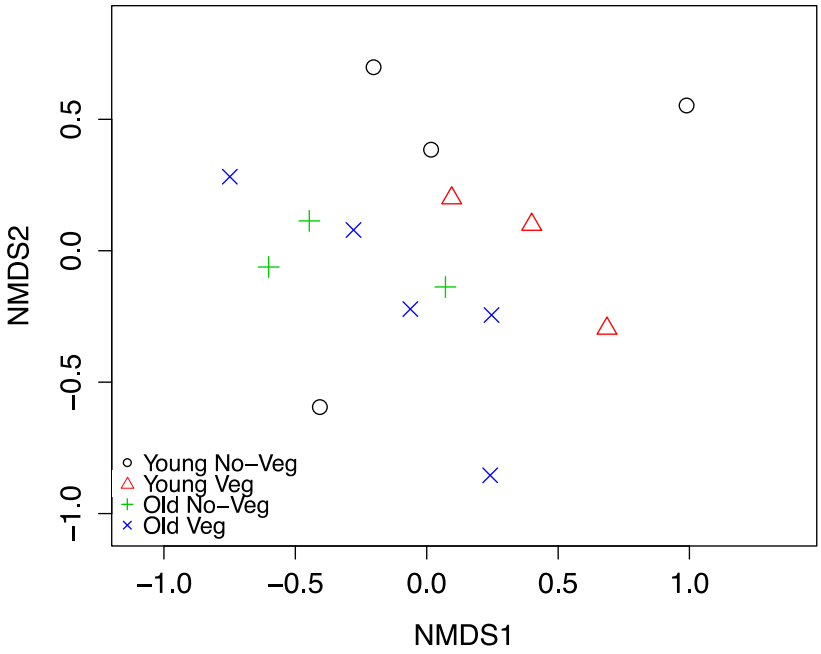

Figure 7. NMDS ordination for log-transformed abundance site data for the four vegetation states. Two-dimensional stress = 0.15

Table 1. SIMPER results of species contributing to compositional difference observed between site types. Species presented up to 90% contribution to the difference. Average abundance (Av. Abund) of each species where species name is presented on the side of the site type they more commonly occur.

New			**Old**
	Av. Abund	Av. Abund	
	4.5	9.5	Pacific Black Duck
Masked Lapwing	5.0	0.4	
	5.7	5.9	Superb Fairy Wren
	2.1	2.8	Welcome Swallow
	2.7	3.0	Fork Tailed Swift
	2.3	2.9	Brown Honeyeater
Red Browed Finch	3.3	1.1	
	0.4	2.5	Little Black Cormorant
Aust. Wood Duck	2.1	0.5	
	0.0	1.9	Cattle Egret
	0.0	2.0	Hardhead
	0.1	1.8	Eurasian Coot
	0.1	1.5	Purple Swamphen
Willie Wagtail	2.0	1.3	
Golden Headed Cisticola	1.4	1.4	Golden Headed Cisticola
Black Faced Cuckoo Shrike	1.1	0.3	
Torresian Crow	0.6	0.4	
Blue-faced Honeyeater	0.6	0.2	
Mistletoebird	0.7	0.0	
	0.3	0.4	Thornbill sp.
	0.2	0.4	Great Cormorant
Double-barred Finch	0.6	0.0	
	0.0	0.4	White-browed Scrubwren
Brown Quail	0.3	0.0	
	0.0	0.4	White-bellied Sea-eagle
Stubble Quail	0.5	0.0	
Australian Pipit	0.5	0.0	
	0.0	0.4	Fairy Martin

DISCUSSION

The results of this study suggested that recent disturbance affects bird abundance and diversity and older, vegetated areas may provide the most beneficial habitat to birds in an artificially created wetland. In addition to this, even the highly modified areas of Tweed Sands Lake supported many individuals and species of birds.

Bird abundance was similar across all sites. The age of a site since disturbance, or the presence of vegetation did not dramatically affect the number of birds recorded at each site. This shows that neither treatment type supported a dramatically larger, or smaller numbers of birds. As there were birds recorded at survey sites, we can determine that Tweed Sands Lake provides suitable habitat for birds across all its vegetation and age sites. Given that there are still active extraction areas within the quarry, this helps to provide support that even for areas that have been recently disturbed, the quarry activities do not appear to have an impact on the number of birds occurring in these areas.

Non-native species are often found in highly modified and disturbed landscapes can displace natives. The minimal number of invasive bird species recorded at the quarry was very encouraging, however it is unclear to what this is attributed to.

Species density showed no significant difference between the treatment types. However there was a strong trend that suggested that more species occurred in Old sites, and in particular, Old sites that have been revegetated. Also, the trend towards a distinct species composition at older sites correlates with this result of trending higher species density at older sites. While this is a trend, and not statistically significant, it suggests that time since disturbance is one of the most important factors influencing bird communities at Tweed Sands Lake. This finding agrees with other studies that older rehabilitation areas have been found to support significantly increased avian abundance and richness at quarries in northern Australia (Brady and Noske, 2010). Older, long undisturbed sites contain different habitat attributes to newer, recently disturbed sites (Brady and Noske, 2010). A habitat attribute that is different in Old sites is the density and height of vegetation. New sites were of two extremes; recently mechanically worked or mined to exposed bare earth, or, as with the revegetated New sites, mechanically worked and followed by plantings that are still young and slashing of tall grasses. This creates a more open, low habitat structure. This low, open structure is preferred by some of the species indicated in the SIMPER analysis. For example, Masked Lapwing are ground dwelling birds which occur in mudflats, beaches and grasslands. They forage primarily on invertebrates that occur just below the ground and are commonly seen in highly disturbed environments, such as urban areas. These ecological attributes help explain why this species prefers the New sites. Some species, such as Brown Honeyeater, which was more likely to be found at Old sites, regularly utilise specific habitat requirements only found in Old sites, in this case, mature trees to forage in. Intuitively, mature trees were found in Old revegetated sites, as New vegetated sites have young trees, and unvegetated sites have no trees. Despite the data trend of less species occurring at sites that have been disturbed within the past 4 years, regardless of if they have been vegetated or not, it does not mean that vegetation efforts are in vain. Given that the data indicated that in particular older sites that have are revegetated supported more bird species, it can be inferred that in the long term, these revegetated sites will provide habitat to a wider range of bird species than those left un-vegetated. This encourages revegetation efforts and it is suggested that where possible, revegetation of Tweed Sands Lake is expanded to further areas. While it has been shown that wetland birds prefer a natural wetland to artificial one (Zhijun et al., 2004). In the case of Tweed Sands Lake, where no wetland existed previously, the creation of a new wetland in a landscape cleared of wetlands can only be beneficial to birds in the long-term.

Quarrys can play an important role in wildlife conservation (Davis, 1979). Wetlands, both artificial and natural, are critical habitat for a number of threatened or migratory Australian birds. Populations of Australasian Bittern and Painted Snipe have been dramatically affected by wetland clearing. Riparian vegetation areas have the potential to provide habitat for the migratory listed Rufous Fantail and Satin Flycatcher. The creation of artificial wetlands, such as at Tweed Sands Lake can be pivotal in providing much needed habitat and reaching critical wetland densities (Gibbs, 2000). The provision of additional aquatic and terrestrial vegetation adjacent to waterbodies, provides resources for a range of bird species and can assist the recovery of threatened species.

Tweed Sands quarry has begun final bank perimeter revegetation works while still maintaining a working quarry. Worldwide, the majority of quarries rehabilitate areas with vegetation after extraction activities have

ceased (Davis, 1979; Bejček and Tyrner, 1980; Bell, 2001; Novák and Konvička, 2006). Tweed Sands Lake is fairly unique in that it has begun rehabilitation efforts while extraction activities are still being undertaken. Natural regeneration is very slow but rehabilitation of derelict and barren sites can contribute to conservation purposes (Davis, 1979). Recolonization of revegetated quarries by birds in Australia following cessation of mining activites may take over 8 years (Nicols and Nicols, 2003). Natural revegetation is reliant on nearby remnant vegetation and can take up over 25 years to be successful (Řehounková and Prach, 2008). Thus the early planting start of revegetation, as being undertaken at Tweed Sands Lake, may assist to 'jumpstart' increased biodiversity benifits of the site for avifauna.

CONCLUSION

Quarries worldwide are often faced with the compromising dilemma of running a profitable enterprise, while making allowances for a number of factors such as safety, social aspects, health, and the environment. The creation of an artificial wetland at Tweed Sands Lake while quarry activities are continuing is fairly unique and highly utilised by local and migratory birds. Quarry companies, such as Hanson, and the surrounding community, can work in partnership to create, maintain and monitor these artificial wetlands. Revegetated areas do provide habitat for birds, but are too young to be distinctly different. Given time, plantings will provide resources for an increased number and variety of birds. The provision of biodiversity attributes through the continuation of revegetation programs at Tweed Sands Lake will benefit avifauna for the region, and for threatened and migratory species in a few short decades.

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APPENDIX A

List of bird species recorded at Tweed Sands Lake, Chinderah. Recorded between 10/4/2014 and 16/4/2014 for QLA study. Alphabetised based on common names. Common names as listed in Simpson and Day (2010). Status based on listing under the Environmental Biodiversity Protection Conservation Act 1999.

Common name	Species name	Status
Australian Magpie	Cracticus tibicen	
Australian Pelican	Pelecanus conspicillatus	
Australian Pipit	Anthus novaeseelandiae	
Australian White Ibis	Threskiornis moluccus	
Australian Wood Duck	Chenonetta jubata	
Bar-shouldered Dove	Geopelia humeralis	
Black-faced Cuckoo-shrike	Coracina novaehollandiae	
Black-shouldered Kite	Elanus axillaris	
Black-wingerd Stilt	Himantopus himantopus	
Blue-faced Honeyeater	Entomyzon cyanotis	
Brahmany Kite	Haliastur indus	
Brown Falcon	Falco berigora	
Brown Goshawk	Accipiter fasciatus	
Brown Honeyeater	Lichmera indistincta	
Brown Quail	Coturnix ypsilophora	
Cattle Egret	Ardea ibis	Migratory
Chestnut Teal	Anas castanea	
Chestnut-breasted Mannikin	Lonchura castaneothorax	
Double-barred Finch	Taeniopygia bichenovii	
Dusky Moorhen	Gallinula tenebrosa	
Eastern Great Egret	Ardea alba modesta	Migratory
Eastern Rosella	Platycercus eximius	
Eastern Spinebill	Acanthorhynchus tenuirostris	
Eurasian Coot	Fulica atra	
Fairy Martin	Petrochelidon ariel	
Fan-tailed Cuckoo	Cacomantis flabelliformis	
Fork-tailed Swift	Apus pacificus	Migratory
Golden-headed cisticola	Cisticola exilis	
Great Cormorant	Phalacrocorax carbo	
Grey Fantail	Rhipidura albiscapa	
Hardhead	Aythya australis	
Laughing Kookaburra	Dacelo novaeguineae	
Leaden Flycatcher	Myiagra rubecula	
Lewin's Honeyeater	Meliphaga lewinii	
Little Black Cormorant	Phalacrocorax sulcirostris	
Little Corella	Cacatua sanguinea	
Little Eagle	Hieraaetus morphnoides	
Little Pied Cormorant	Microcarbo melanoleucos	
Magpie Lark	Grallina cyanoleuca	
Mallard	Anas platyrhynchos	*exotic
Masked Lapwing	Vanellus miles	
Mistletoebird	Dicaeum hirundinaceum	
Osprey	Pandion cristatus	

Common name	Species name	Status
Pacific Black Duck	Anas superciliosa	
Peaceful Dove	Geopelia striata	
Pied Butcherbird	Cracticus nigrogularis	
Pied Currawong	Strepera graculina	
Purple Swamphen	Porphyrio porphyrio	
Rainbow Bee-eater	Merops ornatus	Migratory
Rainbow Lorrikeet	Trichoglossus haematodus	
Red-browed Finch	Neochmia temporalis	
Restless Flycatcher	Myiagra inquieta	
Royal Spoonbill	Platalea regia	
Rufous Whistler	Pachycephala rufiventris	
Scrub brush-turkey (evidence)	Alectura lathami	
Silver Gull	Chroicocephalus novaehollandiae	
Spangled Drongo	Dicrurus bracteatus	
Spotted Pardelote	Pardalotus punctatus	
Straw-necked Ibis	Threskiornis spinicollis	
Striated Pardelote	Pardalotus striatus	
Stubble Quail	Coturnix pectoralis	
Superb Fairy-wren	Malurus cyaneus	
Swamp Harrier	Circus approximans	
Tern sp.	Sterna sp.	
Thornbill Sp.	Acanthiza sp.	
Torresian Crow	Corvus orru	
Welcome Swallow	Hirundo neoxena	
Whistling Kite	Haliastur sphenurus	
White-bellied Sea-eagle	Haliaeetus leucogaster	Migratory
White-browed Scrubwren	Sericornis frontalis	
White-faced Heron	Egretta novaehollandiae	
Willie Wagtail	Rhipidura leucophrys	