A study of the presence/absence of fauna and the relationships between birds and vegetation communities at Tilligerry Habitat, Tanilba Bay, NSW

Figure 1. An eastern bearded dragon (*Pogona barbata*) and a newly emerged cicada (*Cicadoidea* spp.) on site at Tilligerry Habitat State Reserve.

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Abstract

Protecting biodiversity is essential for the persistence of healthy ecosystem processes and has great benefits to industry and the general public. The Australian government has recognised the need to monitor conservation areas to mitigate human induced pressures on natural ecosystems. Anthropogenic climate change, altered fire regimes, isolation and management of exotic species are all threats to these ecosystems, compounded in sites that require revegetation such as Tilligerry Habitat State Reserve which was mined for minerals prior to 1971. Active rehabilitation efforts have been conducted at THA since original surveys were conducted in 1998. This survey looks at the current biodiversity of vegetation, birds and nocturnal fauna species within the Reserve to assess the progression of the site for conservation purposes. The survey used six plots to conduct vegetation and bird surveys to determine the characteristics of the vegetation communities and bird presence throughout the site. Three spotlighting transects were observed within the reserve to detect presence of nocturnal fauna. Data was analysed to determine species richness and similarity of species composition between plots and transect lines. Vegetation floristics and composition do not match projected communities, however this study showed a high species richness of both flora and birds and a low similarity of species presence between both plots and transects respectively. Low numbers of exotic species suggest effective weed control and adequate habitat for native species. Wider biodiversity studies to further investigate vegetation as well as studies on other taxa groups would provide a better overview of the biodiversity of Tilligerry Habitat State Reserve.

1 Introduction

1.1 Conservation targets

The protection and management of biodiversity and ecological communities is an issue of global importance, as it directly impacts the health of ecosystem processes, as well as the success of industries such as tourism (Australian Government Department of Environment 2014). There are also strong cultural values attributed to the ecosystems and biodiversity of global regions by local communities and a direct link exists between the health of ecosystems and human physical and mental health (Sandifer, Sutton-Grier & Ward 2015). In recognition of this importance, the Convention on Biological Diversity has set the global AICHI Biodiversity Targets and several nations have committed to additional targets to ensure adequate protection of natural resources and ecosystems is achieved (Natural Resource Management Ministerial Council 2010).

Australia is recognised as a megadiverse continent and, as part of the AICHI Biodiversity Targets, the federal government has committed to protecting and managing an extra 600,000 square kilometres of terrestrial ecosystems and to protect over 1700 threatened species (Australian Government Department of Environment 2014; Natural Resource Management Ministerial Council 2010). Active management and monitoring of conservation areas is required to assist with resilience in respect to human related pressures including climate change, isolation, exotic species, altered fire regimes and rehabilitation of environments after invasive activities such as mining is required. Community engagement has been recognised as a key component of achieving these goals.

1.2 Threats to Australian ecosystems

Anthropogenic climate change is already affecting weather patterns and is projected to have a large impact on biodiversity and ecosystems as it continues (Black and Karoly 2016). As current global weather patterns such as the El Niño phase of the El Niño–Southern Oscillation (ENSO) are likely to become more frequent and intense in Australia, which will in turn influence the frequency of drought as well as the risk and intensity of bushfires (Fletcher et al. 2015). Freshwater wetlands and their ecological functions are also expected to be impacted by the changing climate (Keith et al 2010). This will directly impact on current the current reserve systems as reliable water sources and sufficient space for fauna to escape fires may not exist within them. Further, the increased frequency and intensity of fires may affect the composition of native flora and thus habitat structure for fauna (Pekin et al. 2009).

Natural fire patterns in Australian sclerophyll communities suggest a 7-17 year gap between events which provides opportunity for members of the Myrtaceae, Ericaceae, Fabaceae, and Proteaceae families to regenerate by either resprouting or reseeding (Auld & Ooi 2008). As residential, agricultural and industrial development has encroached on these vegetation communities, fire regimes have been altered due to safety concerns, with rural firefighting services conducting hazard reduction burns out of season in selected areas (Brummel 2010). For optimal seed germination, soil temperatures must reach 80-100˚C which is not always achievable with this altered fire regime. Alternately arson can increase fire frequency in some areas, which can also change the structure and composition of the vegetation community as obligate reseeders may not reach maturity to reproduce within the frequency interval (Pekin et al. 2009).

The current National Reserve System of Australia is based on a history of site selection which was made with different priorities deemed important to decision making at that time. Historically, reserves were allocated based on aesthetic value or otherwise the ‘worthless

lands' theory whereby mostly unusable land was placed under protection (Mendel & Kirkpatrick 2002). Over time the focus of the reserve system has shifted towards biodiversity and conservation value with a focus on reserve connectivity to reduce the isolation and improve genetic exchange and access to habitat for both flora and fauna (Laita et al. 2011; Mendel & Kirkpatrick 2002). Connectivity is not a simple goal in practice as several existing reserves are isolated by roads, residential, agricultural or industrial areas which creates limitation on the growth of non-transient biota. Small, isolated reserves are also particularly susceptible to exotic species due to a small surface area: volume ratio (Fensom 1998; Pyšek 2002).

Part of the management challenge for reaching conservation goals is rehabilitating sites that have been utilised for natural resource extraction such as mining. Silica and mineral sand mining has been commonly conducted along the coastal dunes of New South Wales (NSW) since the 1950s (McNair 1993). This process, particularly mineral sand mining involves the removal of all vegetation and topsoil from established dunes. The topsoil/sand layer is shaped into an artificial dune on site and revegetated with native species, however valuable microflora and microfauna are often lost in this process and seedbeds damaged (McNair 1993). This level of disturbance leaves the area highly susceptible to the above-mentioned pressures of climate change, altered fire regimes, isolation and exotic species which compounds the time and effort required to successfully rehabilitate these sites (Barkley 1998; Herath et al 2009; McNair 1993).

1.3 Site history

Tilligerry Peninsula is part of the Port Stephens Council in NSW (Figure 2). Mineral sand mining practices in this area have been performed since the 1950s. Tilligerry Habitat State Reserve is a coastal, 9ha site in Tanilba Bay, located on a Pleictocene inner dune barrier

system which provides an example of a site which faces all of the above-mentioned pressures (Figure 1). This site was originally owned by the Worimi people. The southern section of the site was subjected to heavy mineral mining for rutile and zircon which ceased in 1971 (Barkley 1998; Fensom 1998). Upon the cessation of mining, minimal rehabilitation efforts were conducted, the topsoil was used to create an artificial dune and sown with *Chloris gayana*, an exotic grass used for soil stabilisation (Fensom 1998).

Between the cessation of mining and the inception of the site as crown land to be managed by the Tilligerry Habitat Association Inc (THA) in 1993, the southern area of the site was left badly degraded, with high erosion susceptibility, a large presence of exotic species and further damage through recreational and vehicle usage (Barkley 1998). Two studies were conducted on the site which helped determine the original vegetation communities which would have been found on the site as well as fauna presence which formed the basis of rehabilitation techniques employed by the THA (Barkley 1998; Fensom 1998).

The aim of the THA is to conserve and rehabilitate the Tilligerry Habitat State Reserve as well as utilise the site for education and community engagement on the values of the natural ecosystems found within the site and the broader Tilligerry Peninsula. Over the last seventeen years, the THA has actively implemented weed control and revegetation to restore the vegetation communities and provide habitat for native fauna. They constructed a system of boardwalks and clearly defined paths to minimise the impacts of recreational activities of the site. The site is also part of the critical koala habitat found within the Peninsula and therefore forms a part of the proposed Tilligerry Peninsula Koala Corridor Restoration Project (ATLAS of Living Australia 2016).

Below average rainfall and several months of above average temperatures have occurred in Tanilba Bay since the restoration process was initiated (Appendix 1; Appendix 2).

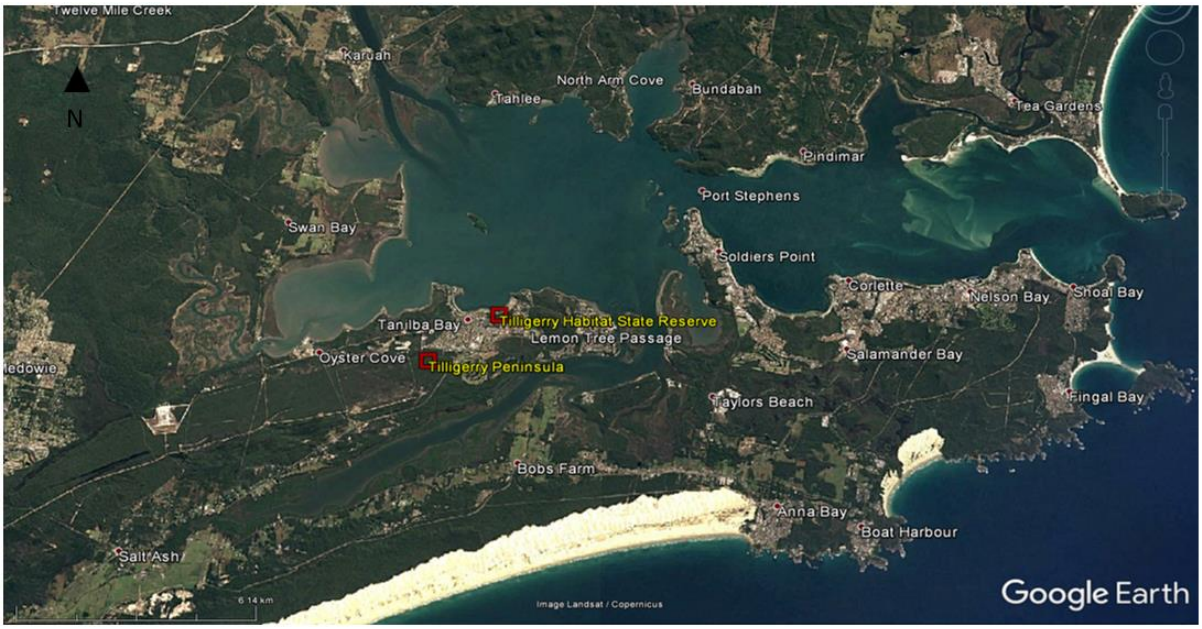


Figure 2. Tilligerry Penisula and Tilligerry Habitat State Reserve

1.4 Study aims

Since the initial studies, there has been minimal scientific research into the progression of the site. There is a need to observe the current biodiversity within the site to assess the efficacy of the management practices of the THA to date and to determine if anything more needs to be done to promote biodiversity in the Reserve.

This study aims to observe the characteristics of current vegetation communities, to observe the presence of both avian and nocturnal fauna and to look at the relationships between the presence of avian fauna and vegetation communities.

2 Methods

2.1 Vegetation survey

The Tilligerry Habitat State Reserve site was separated into vegetation communities based on AUSLIG classification from original studies conducted on the site in 1997 and 1998 (Barkley 1998; Fensom 1998). The Habitat was reclassified by the THA in reference to the 2003 Lower Hunter and Central Coast Regional Environment Management Strategy which led to the current vegetation mapping (Figure 3). There are sharp boundaries between the communities which led to the use of stratified sampling in order to try to represent each vegetation community (Fensom 1998).

Six 20x20m plots were used for the vegetation surveys throughout the site (Figure 4; Table 1). Vegetation surveys were conducted within these plots, observations recorded on the overall species richness of each plot as well as average height and composition of the vertical stratum layers, dominant species of the plot. Ten 1x1m quadrats were sampled throughout each plot for percent cover-abundance of each species by stratum, with nine stratified quadrats and one randomly selected quadrat (Figure 5; Barkley 1998; Fensom 1998). Cover abundance was determined using the modified Braun-Blanquet scale (Table 2). PFC of stratums, Tree diameter at breast height, logs and leaf litter cover and depth were also recorded to determine the habitat value of the plot. Species identification was conducted with the assistance of local experts in conjunction with book and internet resources: *Field guide to the native plants of Sydney*, *Native plants of the Sydney Region*, *PlantNET* and *Nelson Bay Native Plants* (Diemar 2012; Fairley & Moore 2010; PlantNET 2017; Robinson 2003).

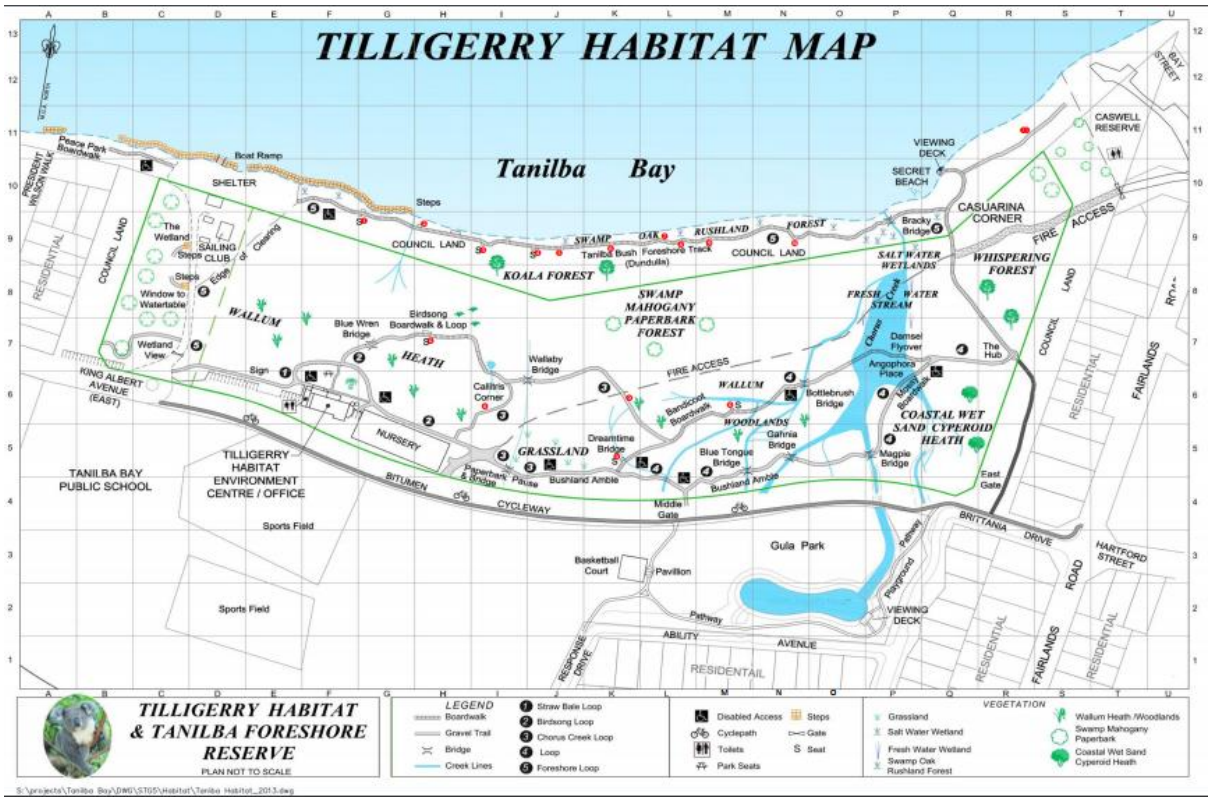


Figure 3. The current map of vegetation communities (Tilligerry Habitat Assosciation 2013).

Figure 4. Map showing the coordinates of southwest corner of each plot with Tilligerry Habitat State Reserve.

Table 1. Plot numbers and expected vegetation types (Tilligerry Habitat Association 2013; Office of Environment & Heritage 2003).

PLOT NUMBER	VEGETATION TYPE	MINED/UNMINED
TH001	Wallum Heath	Mined
TH002	Coastal Wet Sand Cyperoid Heath	Mined
TH003	Eucalyptus Forest	Unmined
TH004	Swamp Mahogany Paperbark Forest	Unmined
TH005	Wallum Heath	Mined
TH006	Wallum Grasslands	Mined

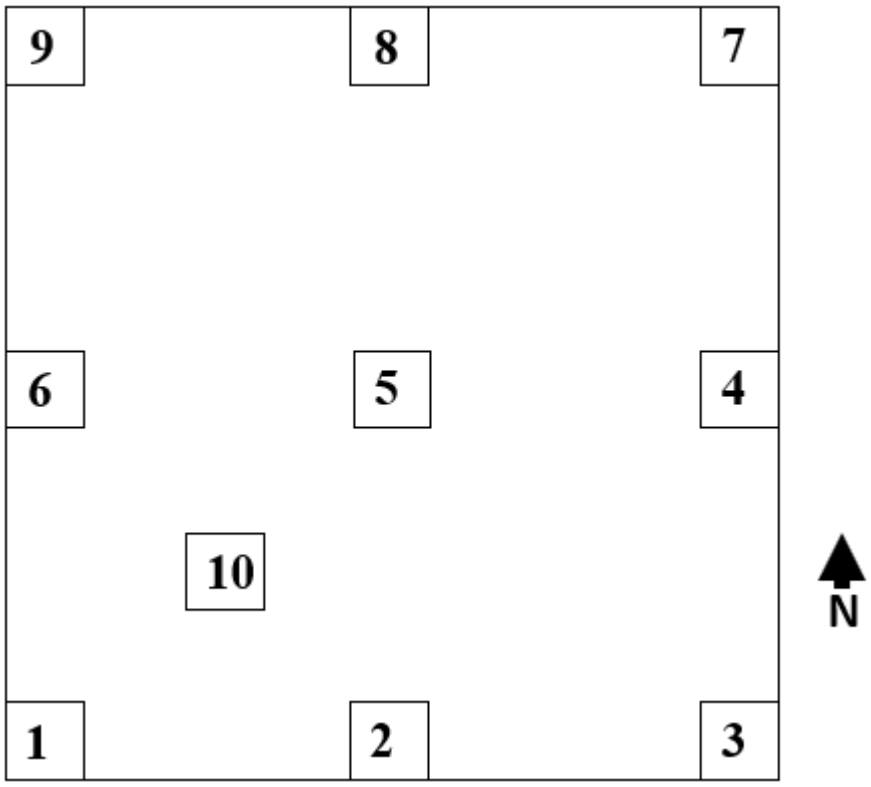


Figure 5. The 20x20m plot design with nine stratified quadrats and one randomly selected quadrat.

Table 2. Modified Braun-Blanquet scale.

BRAUN BLANQUET SCALE	PERCENT COVER
1	<5% few individuals
2	<5% multiple individuals
3	5-25%
4	25-50%
5	50-75%
6	75-100%

2.2 Bird surveys

Bird surveys were conducted at each plot over a four-day period from the 14th November to the 17th November 2017. They were conducted from 6am each morning for ten minutes at each plot, with the order of observation randomised to avoid time bias in recordings. All birds seen and heard from each plot were recorded each day and recorded to species level where possible. National Geopraphic, 8x42 binoculars were used, with a range of 110m-1000m. A local amateur expert assisted with bird identification on the first day of observation, and *Field guide to the birds of Australia* was used to assist with subsequent identification as needed (Simpson & Day 2010).

2.3 Spotlighting surveys

Spotlighting was conducted over four nights from the 15th November to the 18th November 2017. A team of four completed the first spotlighting trip, and the subsequent nights were covered by a team of two observers, each carrying either a handheld Dolphin torch or a UKVISION headtorch to look for eyeshine. Three transect lines were walked using

established tracks and boardwalks throughout the Habitat. Australian Topo Maps was used to record each transect line (Figure 6). The order and direction of the transect lines were randomised each night to avoid time bias in observations. Visual and audio observations were recorded.

Figure 6. Spotlighting transects conducted through Tilligerry Habitat, recorded by Australian Topo Maps.

2.4 Data analysis

Species richness of each vegetation plot was established with consideration to the presence of exotic and native species. The percent-cover abundance of each quadrat, recorded using the Braun-Blanquet scale, was adjusted to represent the midpoint of each category for statistical analysis (Table 2; Maarel 2007). A Kruskal-Wallis one-way non-parametric ANOVA was used to determine the difference between the percent-cover abundance of each of the ten quadrats within each plot. The Jaccard Similarity Index was used to determine the similarity of species presence within each plot. The dominant species and PFC of each stratum and key

habitat features of each plot was recorded and tabulated. Species richness was also addressed with respect to exotic species.

The data from the bird surveys were used to establish the species richness of each plot and a species saturation curve was used to assess whether the effort was sufficient to determine species richness at each plot. The frequency of occurrence of a species on each observation day was also recorded to observe for evidence of site fidelity. The Jaccard Similatrity Index was used to test for similarity of species composition in terms of presence for species between the six plots. A comparison of species richness for both avian fauna and flora species to look for a trend.

The data from the spotlighting surveys were used to establish the species richness of the overall site as well as each transect. The frequency of occurrence of a species on each observation was recorded to observe for differences between the edges of the Tilligerry Habitat State Reserve in comparison to the centre. The Jaccard Similarity Index was used to test the similarity of species composition with regards to the edges and the centre of Tilligerry Habitat State Reserve.

Table 2: Modified Braun-Blanquet scale with cover percentage approximation adjustment.

BRAUN-BLANQUET SCALE	PERCENT COVER	APPROXIMATION ADJUSTMENT
1	<5%, few individuals	0.1
2	<5% lots of individuals	2.5
3	5-25%	15
4	25-50%	37.5
5	50-75%	62.5
6	75-100%	87.5

3 Results

3.1 Vegetation survey

There was a total of 74 species found within survey plots at the Tilligerry Habitat State Reserve (Table 3). Several species were only observed at one plot. Some grass species were unable to be identified to species level due to the lack of flowers. Four exotic flora species were observed throughout the survey plots (Table 3). *A. longifolia, D. caerulea*, *E. robusta* and *I. cylindrica* were found consistently at each plot.

The dominant species for each stratum within each plot was identified (Table 4). This suggests that *E. robusta*, is a dominant canopy tree throughout the plots. Shrubs dominated the midstorey in TH005 and TH006, whereas ferns and sedges were prominent in TH003 and TH004. The ground layer of TH003 remained dominant with ferns, whereas TH004 diverged into grass species (Table 4).

With respect to PFC, TH003 and TH004 displayed the high PFC for the 1-5m and 12-20 or 20m+ categories with comparatively lower scores in the other stratums. TH002 and TH005 both had their highest PFC in the 1-5m range, whereas TH001 and TH006 had the highest PFC in the 0-1m range (Figure 7).

Species richness assessments showed that the rehabilitated sites, TH001, TH002, TH005 and TH006 had the highest species richness (Figure 8). Exotic species were not observed at the unmined plots, TH003 and TH004, although overall exotic species richness was low amongst all sites.

The plots did not show high similarity of species presence between plots, with TH005 and TH006 having the highest score, with slightly more than half of species shared (Table 5). TH004 and TH006 showed the lowest similarity score, with less than a tenth of species in common.

The Kruskal-Wallis non-parametric one-way ANOVA indicated that the null hypothesis can be upheld for percent cover-abundance within each of the plots ($p>0.05$, Table 6). This suggests that each 20x20m plot is representative of a similar community.

TH004 had the most habitat trees, logs and highest category of leaflitter depth, suggesting high habitat availability (Table 7). TH006 in comparison had the lowest scores across all three categories.

Table 3. Plant species found within Tilligerry Habitat State Reserve and frequency of sighting within each plot.

Species	TH001	TH002	TH003	TH004	TH005	TH006
Acacia elongata		X				
Acacia linifolia		X	X			
Acacia longifolia	X	X	X	X	X	X
Acacia suaveolens	X					
Acacia ulicifolia	X	X	X		X	X
Actinotus helianthi					X	X
Angophora costata	X		X			
Baloskian tetraphyllum		X	X	X		
Banksia serrata	X					
Billardiera scandens	X					
Bossiaea rhombifolia	X	X			X	
Breynia oblingifolia	X	X				X
Callistemon citrinus						X
Callistemon pachycephalus						X
Calochlaena dubia			X			
Cheilanthes distans					X	
Commelina cyanea	X					
Darwinia citreodora						X
Dianella caerulea	X	X	X	X	X	X
Dillwynia retorta		X				
Dodonaea triquetra			X	X		
Eleocharis sphacelata				X		
Entolasia marginata	X		X			
Epacris pulchella						X
Eragrostis browneii					X	X
*Erharta erecta**	X					
Eucalyptus resinifera					X	X
Eucalyptus robusta	X	X	X	X	X	X
Eucalyptus spp.						X
Eucalyptus tereticornis			X			
Euryomyrtus ramosissima					X	
Exocapus cupressiformis		X				X
Gahnia clarkei		X	X	X		
Gleichenia dicarpa		X				
Glochidion ferdinandi	X	X			X	X
Gonocarpus micanthus					X	
Gonocarpus teucrioides	X	X				
Hakea teretifolia		X				X
Hardenbergia violacea			X	X		
Imperata cylindrica	X	X	X	X	X	X

Species continued	**TH001**	**TH002**	**TH003**	**TH004**	**TH005**	**TH006**
Lomandra longifolia	X	X			X	X
Lycopediella cernua		X				
Melaleuca quinquinerva		X	X	X	X	X
Microlaena stipoides	X	X				
Omalanthus populifolius		X		X		
Oxylobium robustum				X		
Pandorea pandorana			X	X		
Parsonsia straminea	X				X	
*Paspalum dilatatum**					X	X
*Pennisetum clandestinum**	X					
Persoonia lanceolata		X			X	
Persoonia levis					X	X
Petrophile pulchella					X	X
Phragmites australis				X		
Pittosporum undulatum	X					
Platysace ericoides					X	X
Platysace lanceolata			X			
Poaceae				X	X	
Pomax umbellata	X				X	X
Pteridium esculentum	X		X	X		
Pultanaea blakelyi				X		
Stephania japonica	X					
Telmatoblechnum indicum		X	X	X		
Themeda triandra	X	X			X	X
*Tibouchina spp.**		X				
Tricoryne elatior					X	X
Woollsia pungens					X	
Zieria laevigata		X			X	

Table 4. Dominant species of each stratum for each plot at Tilligerry Habitat State Reserve.

Plot	0-1m	1-5m	5-12m	12-20m	20m+
TH001	*Imperata cylindrica, Pteridium esculentum, Dianella caerulea*	*Pteridium esculentum, Bossiaea rhombifolia, Breynia oblongifolia*	*Banksia serrata, Eucalyptus robusta, Angophora costata*		
TH002	*Imperata cylindrica, Dianella caerulea, Telmatoblechnum indicum*	*Gahnia clarkei, Baloskian tetraphyllum, Melaleuca quinquinerva*	*Melaleuca quinquinerva, Eucalyptus robusta*		
TH003	*Pteridium esculentum, Calochleana dubia, Telmatoblechnum indicum*	*Pteridium esculentum, Calochleana dubia, Gahnia clarkei*	*Eucalyptus robusta, Melaleuca quinquinerva*	*Angophora costata, Eucalyptus robusta, Melaleuca quinquinerva*	
TH004	*Telmatoblechnum indicum, Dianella caerulea, Imperata cylindrica*	*Telmatoblechnum indicum, Baloskian tetraphyllum, Phragmites australis*	*Melaleuca quinquinerva, Eucalyptus robusta*	*Melaleuca quinquinerva*	*Melaleuca quinquinerva, Eucalyptus robusta*
TH005	*Lomandra longifolia, Themeda triandra, Dianella caerulea*	*Leptospermum trinervum, Acacia ulicifolia, Leucopogan ericioides*	*Eucalyptus robusta, Eucalyptus resinifera*		
TH006	*Themenda triandra, Leucopogan ericoides, Imperata cylindrica*	*Acacia longifolia, Leptospermum trinervum, Petrophile pulchella*	*Melaleuca quinquinerva, Eucalyptus robusta, Eucalyptus resinifera*		

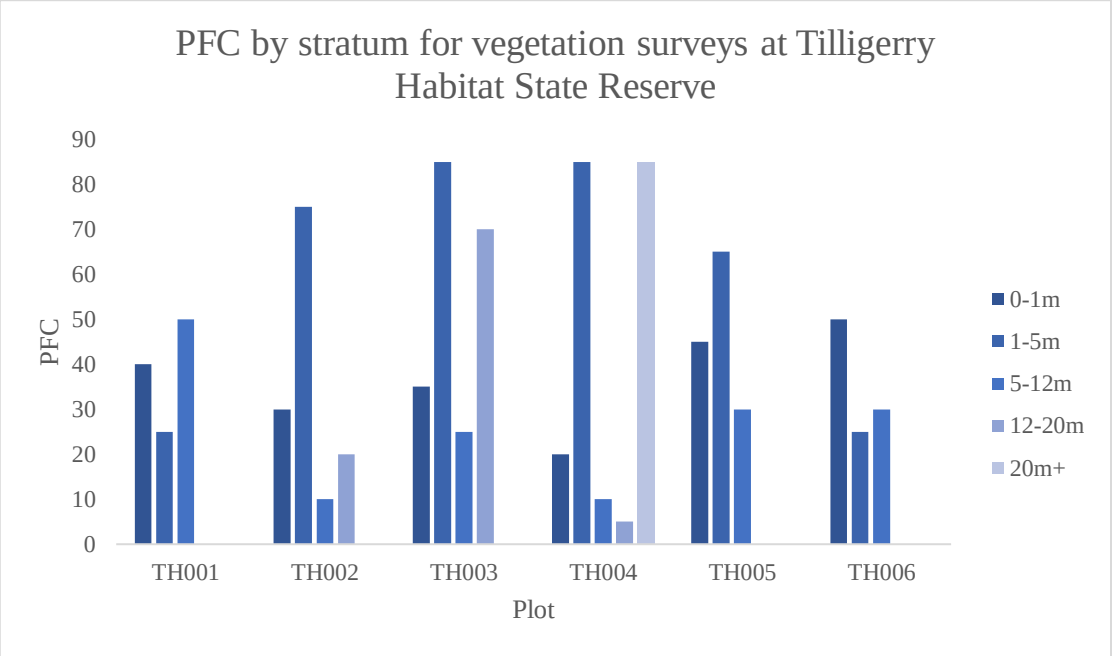


Figure 7. PFC by stratum for vegetation surveys at Tilligerry Habitat State Reserve.

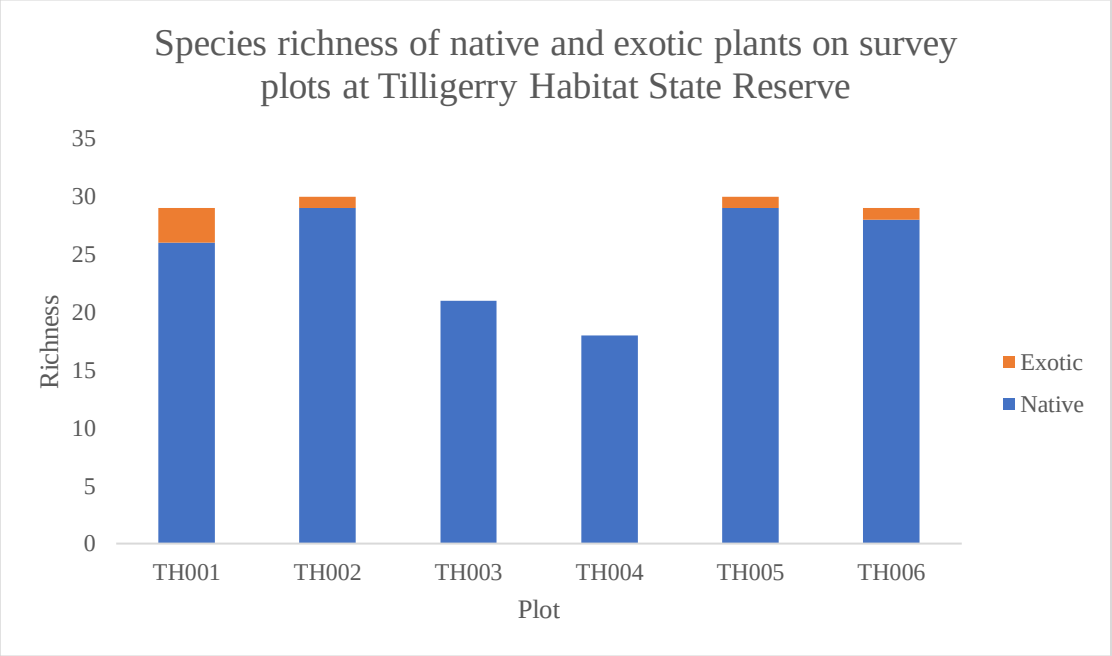


Figure 8. Species richness of native and exotic plant species on survey plots at Tilligerry Habitat State Reserve.

Table 5. Jaccard similarity index matrix of the presence of flora species found in plots at Tilligerry Habitat State Reserve.

	TH001	TH002	TH003	TH004	TH005	TH006
TH001		0.31	0.22	0.10	0.29	0.26
TH002			0.32	0.23	0.28	0.29
TH003				0.46	0.13	0.14
TH004					0.12	0.09
TH005						0.55
TH006						

Table 6. Results of the Kruskal-Wallis non-parametric one-way ANOVA of the differences in percent-cover abundance of quadrats within plots at Tilligerry State Habitat Reserve (P<0.05 to reject null hypothesis).

Plot	K value	Critical Value	P value
TH001	2.5964	16.9190	0.9782
TH002	4.4153	16.9190	0.8820
TH003	4.6228	16.9190	0.8659
TH004	7.7193	16.9190	0.5627
TH005	6.4120	16.9190	0.6981
TH006	8.2125	16.9190	0.5129

Table7. Habitat features of the plots at Tilligerry Habitat State Reserve.

Habitat	TH001	TH002	TH003	TH004	TH005	TH006
Number of trees >20cm DBH	8	7	13	29	4	2
Leaf litter depth (cm)	2-10	0-2	>10	>10	0-2	0-2
Logs >5cm diameter (total length m)	3	0	12	20	4	0

3.2 Bird surveys

There was a total of 46 avian species observed throughout the plots at Tilligerry Habitat State Reserve (Table 8). *T. haemotodus* was observed at least twice over all plots. *D. novaeguineae, O. saggittatus* were also observed across all plots, although *O. saggittatus* was present most frequently at TH006. *P. niger* was observed on three out of four visits, but was only observed on one plot. Overall 28 of these species were observed at two or more plots.

The plot with the highest species richness was TH002 with 25, closely followed by TH005 and TH006 (Figure 9). Exotic species were only observed on previously mined plots; however, they only represent small portions of the richness of each plot. One of the unmined plots, TH004 showed the lowest species richness with only 16 species observed. The species saturation curve suggests that TH003, TH004 and TH006 may be approaching saturation point, whereas further observations would likely continue to produce new species observations at TH005 (Figure 10). This trend is also evident at a slower rate for TH002 and TH001.

A comparison of the species richness of avian fauna and flora species showed a correlation between higher flora species richness and higher avian fauna species richness in TH002, TH005 and TH006 (Figure 11). TH003 and TH004 both had a similar correlation with lower

species richness in both avian fauna and flora. TH001 however had much higher flora species richness in comparison to avian fauna.

All of the plots showed poor similarity in terms of presence of birds, with none of the comparisons showing more than a 0.5 similarity score (Table 9). TH001 and TH002 were the least similar, with a score of 0.18. TH003 and TH006 had the highest similarity with a score of 0.44.

Table 8. Bird species found within Tilligerry Habitat State Reserve and frequency of sighting within each plot.

Common Name	Species	TH001	TH002	TH003	TH004	TH005	TH006
Striated Thornbill	*Acanthiza lineata*					1	1
Thornbill	*Acanthiza* spp.		1				
Eastern Spinebill	*Acanthorhynchus tenuirostris*		1			2	
Common Myna*	*Acridotheres tristis*	2					
Red Wattlebird	*Anthochaera carunculata*	1	1	4		2	
Little Wattlebird	*Anthochaera chrysoptera*	4		4		2	
Wattlebird	*Anthochaera* spp.				1		
Corella	*Cacatua spp.*		2	2	1		
Long-Billed Corella	*Cacatua tenuirostris*						1
Yellow-Tailed Black Cockatoo	*Calyptorhynchus lathami*		1				
Black-Faced Cuckoo-Shrike	*Coracina novaehollandiae*	1		1		2	1
Australian Raven	*Corvus coronoides*			1		1	1
Pied Butcherbird	*Cracticus nigrogularis*			2			
Australian Magpie	*Cracticus tibicen*	3	1	2			3
Grey Butcherbird	*Cracticus torquatus*		1				
Laughing Kookaburra	*Dacelo novaeguineae*	3	1	2	2	1	2
Galah	*Eolophus roseicapillus*		2	1	2		
Eastern Yellow Robin	*Eopsaltria australis*		3		1		
Eastern Koel	*Eudynamys orientalis*	1		2	1	1	
Magpie Lark	*Grallina cyanoleuca*	1	1	1		2	1
Welcome Swallow	*Hirundo neoxena*		1				
Yellow-Faced Honeyeater	*Lichenostomus chrysops*		1	1		3	1
Superb Fairy-Wren	*Malurus coronatus*	1					
Variegated Fairy-Wren	*Malurus lamberti*		1	1			1
Noisy Miner	*Manorina melanocephala*	2		1	1	1	
Leaden Flycatcher	*Myiagra rubecula*					2	
Crested Pigeon	*Ocyphaps lophotes*	1				1	
Olive-Backed Oriole	*Oriolus sagittatus*	1	2	1	1	2	4
Golden Whistler	*Pachycephala pectoralis*				1	1	2
Rufous Whistler	*Pachycephala rufiventris*	2			1	2	1
Spotted Pardalote	*Pardalotus punctatus*					1	
Noisy Friarbird	*Philemon corniculatus*		1	1			1
White-Cheeked Honeyeater	*Phylidonyris niger*	3					
New-Holland Honeyeater	*Phylidonyris novaehollandiae*					1	
Eastern Rosella	*Platycercus elegans*		1				
Eastern Whipbird	*Psophodes olivaceus*		2		4	2	2
Satin Bowerbird	*Ptilonorhynchus violaceus*		2		1		
Grey Fantail	*Rhipidura albiscapa*						1
Channel-Billed Cuckoo	*Scythrops novaehollandiae*		1		1		1
Pied Currawong	*Strepera graculina*	1					
Spotted Dove*	*Streptopelia chinensis*	3	1			2	1
Australian White Ibis	*Threskiornis molucca*					1	
Sacred Kingfisher	*Todiramphus sanctus*			2	3	3	2
Scaly-Breasted Lorikeet	*Trichoglossus chlorolepidotus*		3	1	1		2
Rainbow Lorikeet	*Trichoglossus haematodus*	2	2	4	2	2	4
Silvereye	*Zosterops lateralis*		1				

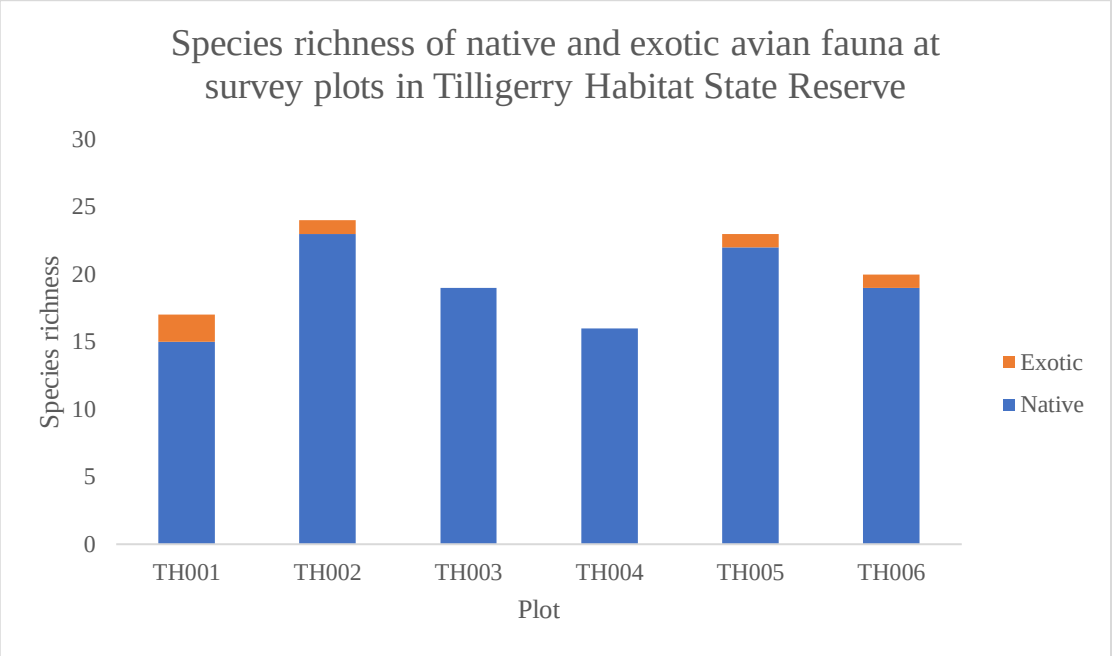


Figure 9. Species richness of native and exotic avian fauna at survey plots in Tilligerry Habitat State Reserve.

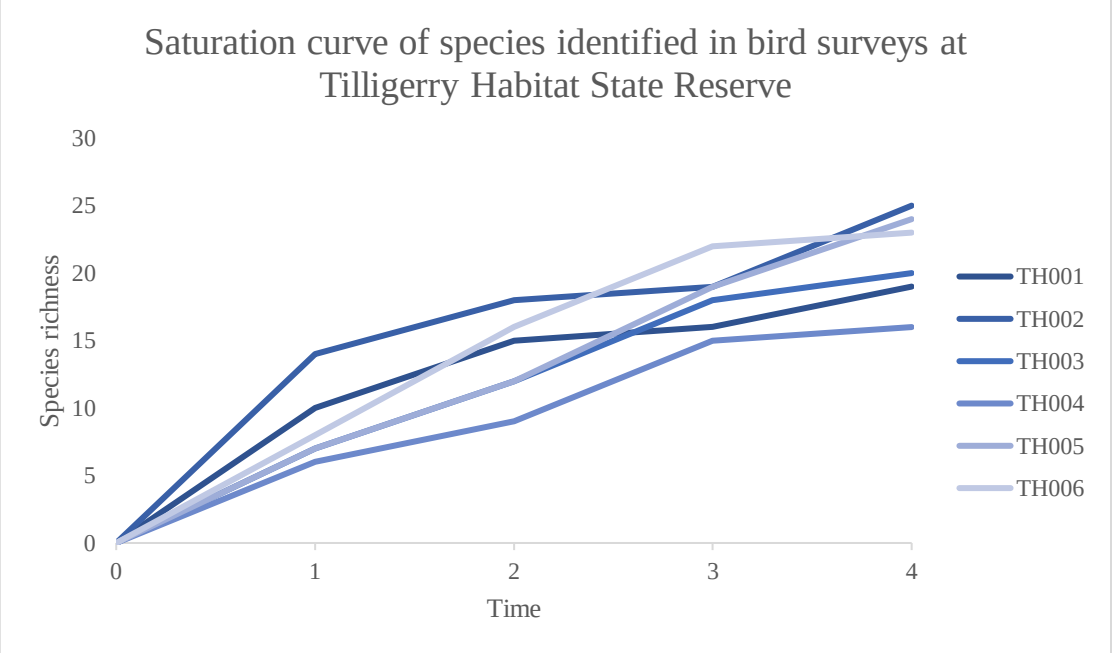


Figure 10. Species saturation curve of bird species observed at survey plots over the four-day observation period at Tilligerry Habitat State Reserve

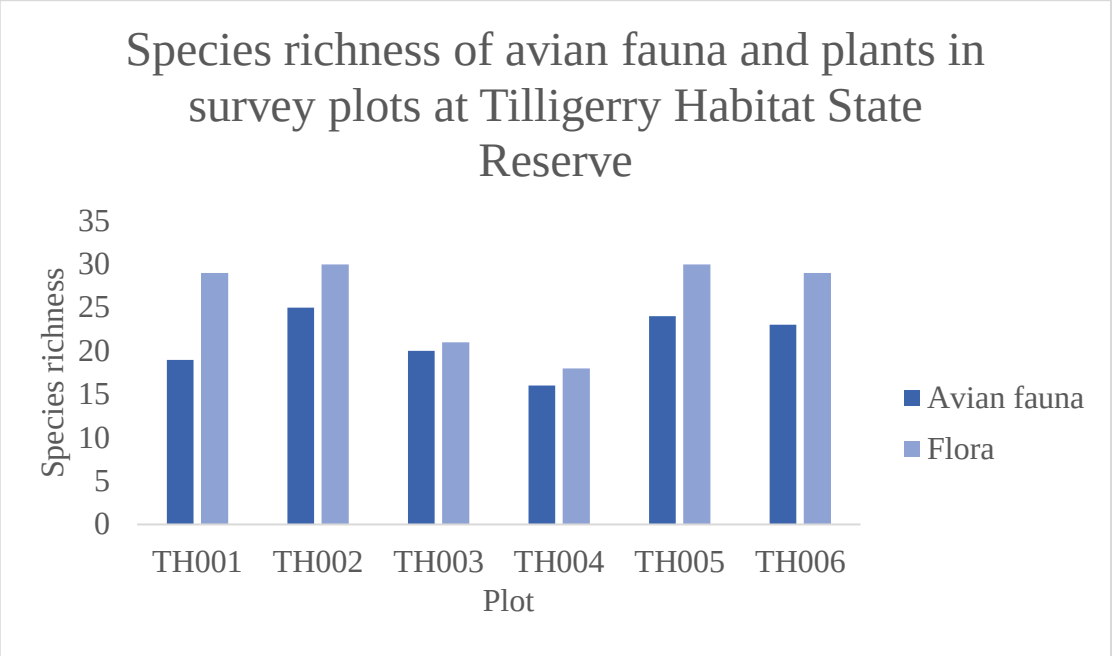


Figure 11. Species richness of avian fauna and plants in survey plots at Tilligerry Habitat State Reserve

Table 9. Jaccard similarity index matrix of the presence of bird species found in plots at Tilligerry Habitat.

	TH001	TH002	TH003	TH004	TH005	TH006
TH001		0.18	0.38	0.22	0.43	0.28
TH002			0.39	0.33	0.24	0.39
TH003				0.35	0.40	0.44
TH004					0.30	0.33
TH005						0.43
TH006						

3.3 Spotlighting surveys

There were at least fourteen species of fauna observed through spotlighting surveys at Tilligerry Habitat State Reserve (Table 10). *Anura* spp. were observed through sound only and accurate identification was not successful. *Michrochirotera* were observed through sight, however species identification was not possible due to the lack of light and swift movement

of individuals. The exotic species *V. Vulpes* was observed on one night (Table 10). *P. peregrinus* was observed across all three transects over the observation period.

Species richness on each transect showed THT002 had the highest species richness with both THT001 and THT003 showing the same richness with respect to native species (Figure 11). An exotic species was only observed in THT003. The three transects showed poor similarity of species presence, with THT003 and THT002 showing the most similarity (0.36) and THT003 and THT001 showing the least similarity (0.22) (Table 11).

Table 10. Fauna species found within Tilligerry Habitat State Reserve and frequency of sighting within each transect.

Common name	Species	THT001	THT002	THT003
Frog	*Anura* spp.	1	3	2
Red Wattlebird	*Anthochaera carunculata*	1		
Little Wattlebird	*Anthochaera chrysoptera*		1	
Laughing Kookaburra	*Dacelo novaeguineae*		1	
Galah	*Eolophus roseicapillus*	3		
Eastern Koel	*Eudynamys orientalis*			1
Microbat	*Microchiroptera* spp.	3	1	
Crested Pigeon	*Ocyphaps lophotes*			1
Koala	*Phascolarctos cinereus*		1	
Tawny frogmouth	*Podargus strigoides*		1	1
Ringtail Possum	*Pseudocheirus peregrinus*	1	3	4
Brushtail Possum	*Trichosurus vulpecula*		1	
Masked Lapwing	*Vanellus miles*	1	1	1
Fox	*Vulpes vulpes*			1

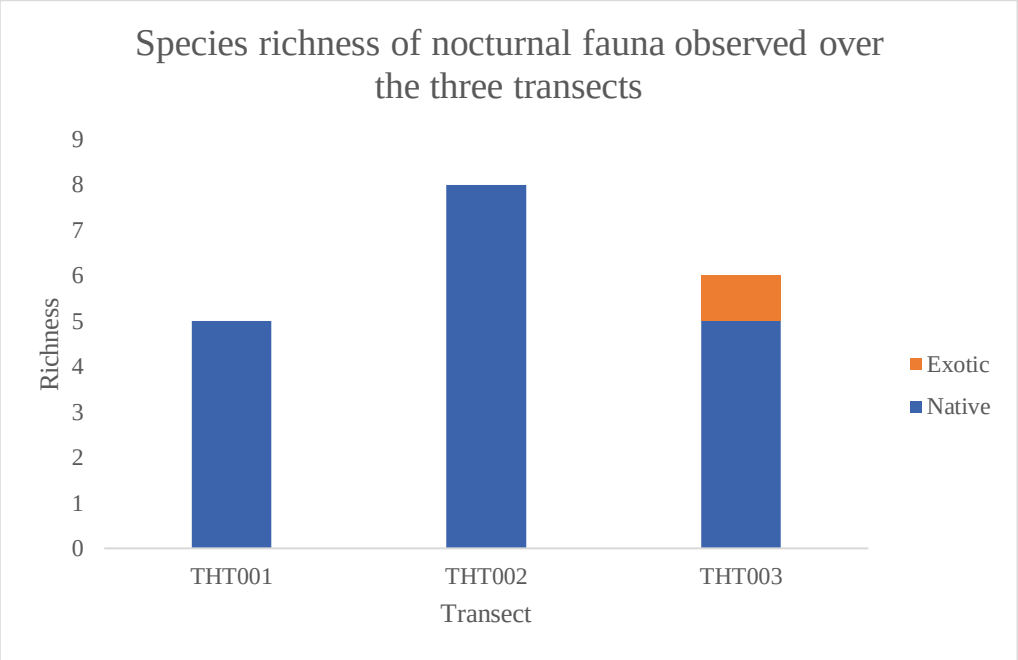


Figure 11. Species richness of fauna observed through spotlighting over three transects at Tilligerry Habitat State Reserve.

Table 11. Jaccard Similarity index of the presence of fauna species observed through spotlighting.

	THT001	THT002	THT003
THT001		0.30	0.22
THT002			0.36
THT003			

4 Discussion

The flora composition of the plots studied in the revegetated section of the Tilligerry Habitat State Reserve shows high proportions of species native to Australia. Weeds were in low richness and percent cover, with the plot closest to the edge of the Reserve, TH001, having the highest exotic richness. The edges are the hardest sections of a reserve to manage and these observations indicate successful weed control has occurred at this site (Barkley 1998;

Zurita et al. 2012). The dominant species and composition however, with the exception of TH004, which has had minimal disturbance, are not consistent with the major species of the vegetation communities identified by the Lower Hunter Central Coast Regional Environmental Management Strategy (House 2003). This may be due to a combination of altitude and seed availability for revegetation efforts. Other considerations are that the plots were in transitional zones. Further alteration of seedbanks could occur through mulch brought onto the site, as well as through wind dispersal from nearby areas (Landi et al. 2012).

Despite the inconsistencies of flora species, the plots were seen to support a high species richness of avian fauna, of a similar size to the 1998 bird survey (Fensom 1998). What has changed markedly since the original bird survey is the species richness across previously mined habitats, with avian richness in these areas now higher than in the unmined plots. The low similarity scores between plots suggest that there may be some site fidelity, this inference is supported further by frequency of observation for species such as *P. niger*. Other species however such as *T. haemotodus* did not demonstrate site fidelity and appear to be utilising the majority of the Reserve.

The presence of habitat trees did not appear to influence bird presence, although the spring nesting season had ceased for most birds. A lot of the smaller scrub birds prefer to inhabit dense shrub or fern cover, and the gap between the midstorey and upper canopy in TH003 and TH004 is large (Simpson & Day 2010). There was a cicada hatching event occurring whilst undertaking bird surveys, where cicadas were emerging from the dirt/gravel paths. It is possible that this event affected the distribution of insectivores such as *C. novaehollandiae* and *P. corniculatus* which were often sighted on plots near these pathways and incidentally between plots. The pathways near TH003 and TH004 are boardwalks and cicada activity in these areas were minimised. This theory however, is unsupported by literature and so further

research into insectivore distribution outside of a cicada emergence event would be required to validate this possibility (Koeng 2011).

Spotlighting showed a composition of mammalian fauna consistent with those observed in the 1998 survey, with the exception of *V. vulpes*. Species richness seemed to be highest along the central transect which divides the mined and the unmined sections of the Reserve, with similar richness in both the outer transects which, in conjunction with low species similarity suggests that both sections are of significance to nocturnal fauna. The presence of *P. cinereus*, compounded by frequent sightings by members of the THA and visitors, highlights the importance of the Tilligerry Habitat State Reserve as part of the Tilligerry Peninsula Koala Corridor Restoration Project.

Two *V. vulpes* were observed in the habitat near TH006 where bandicoot diggings were refreshed each day. These exotic predators quickly impact on native fauna and control measures should be taken to prevent native fauna loss, either through baiting or humane cage trapping and removal (Coates 2013). *O. cuniculus* was also observed incidentally on site near the boundaries and may need to be monitored if measures are taken to remove *V. vulpes* from the reserve (Pech et al. 1992).

Whilst the plots in this study did not detect high similarities with the descriptions of the expected vegetation communities present on this site and the expected flora composition of the site pre-sand mining, there is a high species richness of native plants and birds, and several nocturnal species are utilising the habitat. Achieving a pre-disturbance composition is further affected by the isolation of the site, the alteration of the natural fire regime and climate change. The development of the Koala Corridor is a great step for *P. cinereus* and may indirectly benefit the migration of other fauna species into the habitat, although it may also increase the impacts of exotic species as well (Haddad et al. 2014).

Further studies into bird distribution and abundance during alternate seasons may provide a more comprehensive measure of species richness and a clearer pattern of the relationship between bird species and vegetation communities. Increased numbers of observers or utilising a voice recorder may have enabled more accurate data collection for the bird surveys as there was a lot of activity at most sites. Spotlighting during flowering events of the abundant *Melaleuca, Eucalyptus* and *Angophora* species may provide stronger evidence of habitat use by more transient fauna such as the Vulnerable *Pteropus poliocephaclus*, which have a colony nearby (Department of the Environment 2016). Studies into the ground dwelling mammals, reptile, amphibian and invertebrate populations would provide a more accurate picture of biodiversity in this site. Further replication of vegetation surveys may provide a more complete description of the mosaic of vegetation communities found within the Tilligerry Habitat State Reserve.

5 References

Atlas of Living Australia. 2016. Tilligerry Peninsula Koala Corridor Restoration Project 2. Available from https://collections.ala.org.au/public/show/dr3989 (accessed November 20, 2017).

Auld TD, Ooi MKJ. 2008. Heat increases germination of water-permeable seeds of obligate-seeding Darwinia species (Myrtaceae). Plant Ecology **200**:117–127.

Australian Government Department of Environment . 2014. Australia's Fifth National Report to the Convention on Biological Diversity. Australia's Fifth National Report to the Convention on Biological Diversity. Department of Environment , Canberra, A.C.T.

Barkley D. 1998. An investigation of the edaphic influences on spatial distribution of vegetation at an old sandmined site. thesis.

Black MT, Karoly DJ. 2016. Southern Australia's Warmest October on Record: The Role of ENSO and Climate Change. Bulletin of the American Meteorological Society **97**.

Brummel RF. 2010. Burning through boundaries: collaborative governance and wildland fire planning in the United States and New South Wales, Australia. thesis.

Bureau of Meteorology . 2017. Monthly mean maximum temperature. Available from http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=36&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=061078 (accessed November 20, 2017).

Bureau of Meteorology . 2017. Monthly rainfall. Available from http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display

_type=dataFile&p_startYear=&p_c=&p_stn_num=061395 (accessed November 20, 2017).

Coates T, Wright C. 2013. Predation of southern brown bandicoots Isoodon obesulus by the European red fox Vulpes vulpes in south-east Victoria. Australian Mammalogy **25**:107.

Department of the Environment. 2017. Available from http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf (accessed November 21, 2017).

Fairley A, Moore P. 2010. Native plants of the Sydney region: from Newcastle to Nowra and west to the Dividing Range, 3rd edition. Allen & Unwin, Crows Nest, N.S.W.

Fensom M. 1998. Investigating the ecological diversity of Tilligerry Peninsula, NSW, using quantitative biodiversity measurements as indicators. thesis.

Fletcher M-S, Benson A, Heijnis H, Gadd PS, Cwynar LC, Rees AB. 2015. Changes in biomass burning mark the onset of an ENSO-influenced climate regime at 42°S in southwest Tasmania, Australia. Quaternary Science Reviews **122**:222–232.

Haddad NM et al. 2014. Potential Negative Ecological Effects of Corridors. Conservation Biology 28:1178–1187.

Herath DN, Lamont BB, Enright NJ, Miller BP. 2009. Impact of fire on plant-species persistence in post-mine restored and natural shrubland communities in southwestern Australia. Biological Conservation **142**:2175–2180.

House S. 2013. Lower Hunter & Central Coast Regional Environmental Management Strategy, Technical Report, Digital Aerial Photo Interpretation & Updated Extant Vegetation Community Map. Lower Hunter & Central Coast Regional Environmental

Management Strategy, Technical Report, Digital Aerial Photo Interpretation & Updated Extant Vegetation Community Map, May 2013. Lower Hunter & Central Coast Regional Environmental Management Strategy, Callaghan. NSW.

Keith DA, Rodoreda S, Bedward M. 2009. Decadal change in wetland-woodland boundaries during the late 20th century reflects climatic trends. Global Change Biology **16**:2300–2306.

Koenig WD, Ries L, Olsen VBK, Liebhold AM. 2011. Avian predators are less abundant during periodical cicada emergences, but why? Ecology **92**:784–790.

Laita A, Mönkkönen M, Kotiaho JS. 2011. Assessing the functional connectivity of reserve networks in continuously varying nature under the constraints imposed by reality. Biological Conservation **144**:1297–1298.

Landi M, Ricceri C, Angiolini C. 2012. Evaluation of Dune Rehabilitation after 95 Years by Comparison of Vegetation in Disturbed and Natural Sites. Journal of Coastal Research **284**:1130–1141.

Maarel EVD. 2007. Transformation of cover-abundance values for appropriate numerical treatment – Alternatives to the proposals by Podani. Journal of Vegetation Science **18**:767.

McNair DL. 1993. Aspects of flora regeneration following mineral and silica sand mining Port Stephens and Myall Lakes region New South Wales. thesis.

Natural Resource Management Ministerial Council. 2010. Australia's Biodiversity Conservation Strategy 2010-2030. Department of Environment and Energy. Available from https://www.cbd.int/doc/world/au/au-nbsap-v2-en.pdf (accessed November 7, 2017).

Pech RP, Sinclair ARE, Newsome AE, Catling PC. 1992. Limits to predator regulation of rabbits in Australia: evidence from predator-removal experiments. Oecologia 89:102–112.

Pekin BK, Boer MM, Macfarlane C, Grierson PF. 2009. Impacts of increased fire frequency and aridity on eucalypt forest structure, biomass and composition in southwest Australia. Forest Ecology and Management **258**:2136–2142.

PlantNET (The NSW Plant Information Network System). Royal Botanic Gardens and Domain Trust, Sydney. http://plantnet.rbgsyd.nsw.gov.au. 19 November 2017.

Pyšek P, Jarošík Vojtěch, Kučera Tomáš. 2002. Patterns of invasion in temperate nature reserves. Biological Conservation **104**:13–24.

Robinson L. 2003. Field guide to the native plants of Sydney, 3rd edition. Kangaroo Press, East Roseville, NSW.

Sandifer PA, Sutton-Grier AE, Ward BP. 2015. Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: Opportunities to enhance health and biodiversity conservation. Ecosystem Services **12**:1–15.

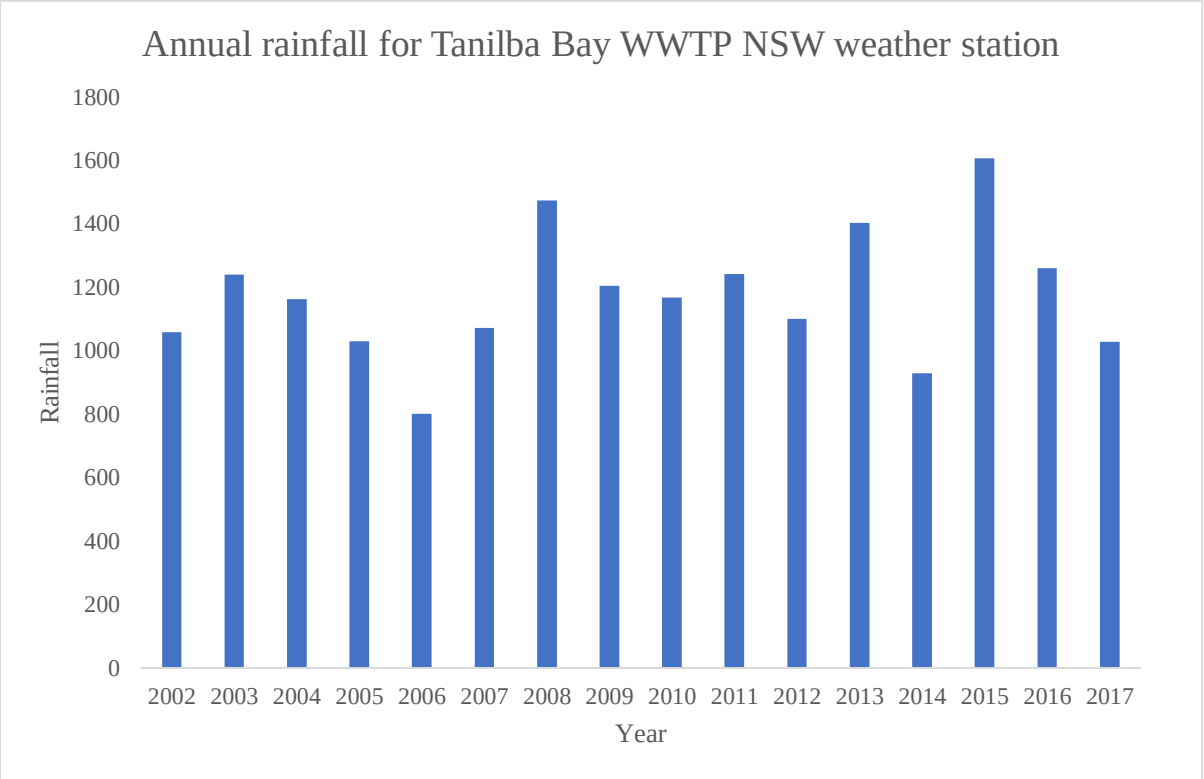
Simpson K, Day N. 2010. Field guide to the birds of Australia, 8th edition. Penguin Group, Australia.

Tilligerry Habitat Reserve. 2017. MAPS and GUIDES. Available from http://www.tilligerryhabitat.org.au/maps-and-guides/ (accessed November 20, 2017).

Zurita G, Pe'Er G, Bellocq MI, Hansbauer MM. 2012. Edge effects and their influence on habitat suitability calculations: a continuous approach applied to birds of the Atlantic forest. Journal of Applied Ecology **49**:503–512.

6 Appendices

Appendix I: Annual rainfall for Tanilba Bay WWTP NSW weather station from 2002-2017 (Bureau of Meteorology 2017)



Appendix II Mean monthly temperature in comparison to the overall mean of weather records for the nearest weather station, Williamtown RAAF from 1999-2017. Green: <1˚C increase, Orange: 1-1.9˚C increase, Red: 2˚C + increase from the Mean (Bureau of Meteorology 2017).

	January	February	March	April	May	June	July	August	September	October	November	December
Mean	**28.1**	**27.6**	**26.3**	**23.7**	**20.4**	**17.7**	**17.1**	**18.7**	21.5	**23.8**	**25.6**	**27.3**
1999	28.8	26.9	27.2	21.9	21.6	17.7	17.5	18.9	21.8	24.3	23.3	25.8
2000	26.3	29.6	25.9	23.5	20.0	17.2	17.8	18.4	23.4	24.2	24.6	29.7
2001	30.9	29.4	26.0	24.3	19.2	19.0	17.6	19.3	22.3	24.5	24.6	28.2
2002	29.0	26.7	26.5	24.3	20.2	18.0	18.4	19.8	22.8	27.0	28.3	27.8
2003	29.5	28.2	25.1	22.5	20.5	19.3	17.3	18.9	23.3	22.5	25.2	28.0
2004	30.0	29.5	26.3	24.2	20.7	19.0	17.6	19.5	21.8	23.7	26.9	26.6
2005	28.6	28.2	25.2	24.9	20.4	18.5	18.3	20.0	21.2	25.0	26.2	30.7
2006	29.6	29.9	27.3	24.4	20.1	17.3	17.6	19.5	23.2	25.1	26.5	26.1
2007	29.5	28.6	27.6	23.2	22.3	16.7	17.0	20.3	21.9	26.9	25.1	26.2
2008	27.5	25.3	25.8	21.9	20.5	18.5	17.2	17.6	22.1	24.4	24.7	27.9
2009	30.2	28.4	27.0	23.3	20.6	18.1	17.7	21.6	23.7	23.1	28.5	27.5
2010	30.0	29.6	27.5	24.8	20.8	17.8	17.2	18.3	22.0	23.5	26.0	28.1
2011	29.9	30.9	27.7	23.6	19.9	18.7	17.3	19.7	22.6	23.2	27.1	23.8
2012	27.9	26.4	26.0	23.5	20.7	17.7	17.6	19.7	23.3	24.4	26.6	27.9
2013	29.8	27.6	26.9	23.8	20.9	18.1	19.0	21.6	25.7	27.1	25.3	27.9
2014	29.2	27.7	27.0	24.3	22.3	19.2	18.1	18.6	21.9	26.3	27.1	27.9
2015	29.1	27.8	27.9	23.4	20.4	18.1	17.2	19.5	20.7	27.0	27.3	28.1
2016	28.2	29.1	28.4	25.4	23.1	18.6	18.7	19.1	21.5	24.3	27.7	30.4
2017	31.5	31.0	26.5	23.5	21.3	18.0	19.0	19.8	25.0	25.5		

Appendix III Total fauna list for species observed at Tilligerry Habitat State Reserve.

Fauna Type	Common name	Scientific name
Birds	Australian Magpie	*Cracticus tibicen*
	Australian Raven	*Corvus coronoides*
	Australian White Ibis	*Threskiornis molucca*
	Australian Wood Duck	*Chenonetta jubata*
	Black-Faced Cuckoo-Shrike	*Coracina novaehollandiae*
	Channel-Billed Cuckoo	*Scythrops novaehollandiae*
	Common Myna*	*Acridotheres tristis*
	Corella	*Cacatua spp.*
	Crested Pigeon	*Ocyphaps lophotes*
	Dollarbird	*Eurystomus orientalis*
	Eastern Koel	*Eudynamys orientalis*
	Eastern Rosella	*Platycercus elegans*
	Eastern Spinebill	*Acanthorhynchus tenuirostris*
	Eastern Whipbird	*Psophodes olivaceus*
	Eastern Yellow Robin	*Eopsaltria australis*
	Galah	*Eolophus roseicapillus*
	Golden Whistler	*Pachycephala pectoralis*
	Grey Butcherbird	*Cracticus torquatus*
	Grey Fantail	*Rhipidura albiscapa*
	Laughing Kookaburra	*Dacelo novaeguineae*
	Leaden Flycatcher	*Myiagra rubecula*
	Little Wattlebird	*Anthochaera chrysoptera*
	Long-Billed Corella	*Cacatua tenuirostris*
	Magpie Lark	*Grallina cyanoleuca*
	Masked Lapwing	*Vanellus miles*
	Musk Lorikeet	*Glossopsitta concinna*
	New-Holland Honeyeater	*Phylidonyris novaehollandiae*
	Noisy Friarbird	*Philemon corniculatus*
	Noisy Miner	*Manorina melanocephala*

Fauna Type	Common name	Scientific name
Birds cont.	Olive-Backed Oriole	*Oriolus sagittatus*
	Pied Butcherbird	*Cracticus nigrogularis*
	Pied Currawong	*Strepera graculina*
	Rainbow Lorikeet	*Trichoglossus haematodus*
	Red Wattlebird	*Anthochaera carunculata*
	Rufous Whistler	*Pachycephala rufiventris*
	Sacred Kingfisher	*Todiramphus sanctus*
	Satin Bowerbird	*Ptilonorhynchus violaceus*
	Scaly-Breasted Lorikeet	*Trichoglossus chlorolepidotus*
	Scarlet Honeyeater	*Myzomela sanguinolenta*
	Silvereye	*Zosterops lateralis*
	Spotted Dove	*Streptopelia chinensis*
	Spotted Pardalote	*Pardalotus punctatus*
	Striated Thornbill	*Acanthiza lineata*
	Superb Fairy Wren	*Malurus coronatus*
	Tawny frogmouth	*Podargus strigoides*
	Variegated Fairy-Wren	*Malurus lamberti*
	Welcome Swallow	*Hirundo neoxena*
	White-Browed Scrubwren	*Sericornis frontalis*
	White-Cheeked Honeyeater	*Phylidonyris niger*
	Willie Wagtail	*Rhipidura leucophrys*
	Yellow-Faced Honeyeater	*Lichenostomus chrysops*
	Yellow-Tailed Black Cockatoo	*Calyptorhynchus lathami*
Mammal	Brushtail Possum	*Trichosurus vulpecula*
	Fox*	*Vulpes vulpes*
	Koala	*Phascolarctos cinereus*
	Microbat	*Microchiroptera*
	Rabbit*	*Oryctolagus cuniculus*
	Ringtail Possum	*Pseudocheirus peregrinus*
Reptile	Eastern Bearded Dragon	*Pogona barbata*
	Southern Grass Skink	*Pseudemoia entrecasteauxii*
	Jacky Lizard	*Amphibolurus muricatus*
Amphibian	Frog species	*Arnua* spp.

Appendix IV Total flora list for species observed at Tilligerry Habitat Peninsula.

Species	TH001	TH002	TH003	TH004	TH005	TH006	Incidental
Acacia elongata		X					
Acacia falcata							X
Acacia linifolia		X	X				
Acacia longifolia	X	X	X	X	X	X	
Acacia suaveolens	X						
Acacia ulicifolia	X	X	X		X	X	
Actinotus helianthi					X	X	
Angophora costata	X		X				
Baloskian tetraphyllum		X	X	X			
Banksia aemula							X
Banksia serrata	X						
Banksia spinulosa							X
Billardiera scandens	X						
Bossiaea rhombifolia	X	X			X		
Breynia oblingifolia	X	X				X	
Callistemon citrinus						X	
Callistemon pachycephalus						X	
Calochlaena dubia			X				
Cheilanthes distans					X		
Commelina cyanea	X						
Darwinia citreodora						X	
Dianella caerulea	X	X	X	X	X	X	
Dillwynia retorta		X					
Dodonaea triquetra			X	X			
Eleocharis sphacelata				X			
Entolasia marginata	X		X				
Epacris pulchella						X	
Eragrostis browneii					X	X	
*Erharta erecta**	X						
Eucalyptus resinifera					X	X	
Eucalyptus robusta	X	X	X	X	X	X	
Eucalyptus spp.						X	
Eucalyptus tereticornis			X				
Euryomyrtus ramosissima					X		
Exocapus cupressiformis		X				X	
Gahnia clarkei		X	X	X			
Gleichenia dicarpa		X					
Glochidion ferdinandi	X	X			X	X	
Gonocarpus micanthus					X		
Gonocarpus teucrioides	X	X					
Hakea teretifolia		X				X	
Hardenbergia violacea			X	X			
Imperata cylindrica	X	X	X	X	X	X	

Species continued	**TH001**	**TH002**	**TH003**	**TH004**	**TH005**	**TH006**	**Incidental**
Kennedia rubicunda		X	X	X			
Lambertia formosa							X
*Lantana camara**	X						
Leptospermum trinervum	X				X	X	
Leucopogan ericoides	X	X			X	X	
Leucopogan lanceolatus	X	X	X				
Leucopogan virgatus					X	X	
Lomandra longifolia	X	X			X	X	
Lycopediella cernua		X					
Melaleuca nodosa							X
Melaleuca quinquinerva		X	X	X	X	X	
Microlaena stipoides	X	X					
Omalanthus populifolius		X		X			
Oxylobium robustum				X			
Pandorea pandorana			X	X			
Parsonsia straminea	X				X		
*Paspalum dilatatum**					X	X	
*Pennisetum clandestinum**	X						
Persoonia lanceolata		X			X		
Persoonia levis					X	X	
Petrophile pulchella					X	X	
Phragmites australis				X			
Pittosporum undulatum	X						
Platysace ericoides					X	X	
Platysace lanceolata			X				
Poaceae				X	X		
Pomax umbellata	X				X	X	
Pteridium esculentum	X		X	X			
Pultanaea blakelyi				X			
Stephania japonica	X						
Telmatoblechnum indicum		X	X	X			
Themeda triandra	X	X			X	X	
*Tibouchina spp.**		X					
Tricoryne elatior					X	X	
Woollsia pungens					X		
Zieria laevigata		X			X		