

Appendix 3

2018/2019 Annual Monitoring Report

Pambalong Nature Reserve

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2018 / 19 Annual Monitoring Report



Yancoal Australia Pty Ltd

Pambalong Nature Reserve
Abel Underground Coal Mine, Beresfield
NSW

03 February 2020

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2018 / 19 Annual Monitoring Report

Pambalong Nature Reserve

Abel Underground Coal Mine, Beresfield NSW

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EXECUTIVE SUMMARY

Donaldson Coal Pty Ltd commenced operations at Abel Underground Coalmine at Beresfield in the lower Hunter Valley, New South Wales in 2008. A Flora and Fauna Management Plan, prepared by Kleinfelder (ecobiological 2007) in accordance with consent conditions, identified the need for ecological monitoring at Pambalong Nature Reserve, a 34 ha freshwater wetland located between the eastern extent of the Abel coal mine lease and the M1 Pacific Motorway.

Pambalong Nature Reserve provides critical habitat for wader and water bird species and is part of a chain of protected wetlands in the lower Hunter floodplains and estuary. The wetland at Pambalong depends on fresh water from Blue Gum Creek to maintain and replenish aquatic and terrestrial habitats in the reserve. Consequently, any changes to the quantity and quality of water delivered from the Blue Gum Creek catchment arising from mining activities or subsidence would compromise the ecological integrity of the wetland (ecobiological 2007).

A decline in the quantity of water could result in a reduction in the area of wetland and a subsequent loss of aquatic and terrestrial flora and fauna habitat. Increased sediment loads in Blue Gum Creek could affect macroinvertebrate numbers and change the depth of waterbodies within the wetland. Other related impacts to the wetland could also occur such as weed and/or feral animal invasion (ecobiological 2007).

The mine is currently in a state of care and maintenance and has not extended to the Blue Gum Creek catchment. Nevertheless, ecological monitoring has contributed to a robust dataset on baseline conditions at the wetland. It is important that data is collected over as many years as possible to determine what constitutes normal variation and enable valid comparisons with post-mining conditions.

*This document reports on results of the 11th annual monitoring event at Pambalong Nature Reserve. Detected during this survey were 109 flora species; and, 104 fauna species comprising six frog, two reptile, 17 mammal (12 bat) and 79 bird species. Threatened species recorded included three bat and three bird species. Twenty-two flora species were recorded this survey that were not recorded in the 2017 survey (nine exotic species and 13 native species). No significant changes to the spatial extent of vegetation communities were observed. Two exotic weed species, *Lantana camara* and *Ambrosia tenuifolia* were recorded as having increased in extent.*

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1. INTRODUCTION

Donaldson Coal Pty Ltd (now owned by Yancoal Australia Pty Ltd) commenced mining at an underground coal mine (known as Abel Underground Coal Mine) in 2008, located approximately 23 kilometres north-west of Newcastle. The mine is currently in a state of care and maintenance, with no coal extraction at this time. Should the mine re-open in the future, the seams that would be mined are located under the rural residential and forested areas at Black Hill. Mine access and associated surface infrastructure is located within the existing open cut void at Beresfield, with transfer of coal to the existing Bloomfield Coal Handling and Preparation Plant (CHPP) immediately to the north for coal washing and rail transport to the Port of Newcastle.

Underground coal mining can cause land subsidence which may result in adverse environmental impacts such as loss of productive land, damage to underground pipelines and above-ground structures, decreased stability of slopes and escarpments, contamination of groundwater by acid drainage and dewatering of streams and groundwater supplies (Bell *et al.* 2000, Sidle *et al.* 2000). The main ecological concern arising from the Abel mine is the effect of subsidence on local and regional hydrology. Surface and sub-surface cracking associated with mining subsidence can alter and create preferential flow paths, causing dewatering and rerouting of surface water and groundwater (Sidle *et al.* 2000). Alterations in channel and drainage morphology may also affect channel erosion, sediment delivery, and routing in streams and riparian habitat.

Development approval for the Abel coal mine was granted with a number of conditions, including a requirement to prepare a Flora and Fauna Management Plan (F&FMP) (ecobiological 2007). The F&FMP is part of a comprehensive Environmental Management System (EMS) for Abel mine and sets out a strategy to monitor the effectiveness of the conservation measures identified in the Environmental Assessment (EA) Statement of Commitments. A Surface Ecological Monitoring Plan (SEMP) produced as part of the strategy focused monitoring effort on three discrete habitat areas:

1. Farm dams that form a belt across the mine site;
2. Subtropical rainforest areas of Long Gully Creek; and
3. Pambalong Nature Reserve.

Baseline and subsequent monitoring data are to be gathered in each of these areas to inform management and future change analysis. Results from the current period continue to contribute to a dataset that documents baseline ecological conditions at Pambalong Nature Reserve and contributes to the overall SEMP.

1.1 LOCATION

The Abel Underground Mine is located within Newcastle, Cessnock and Maitland Local Government Areas (LGAs). The majority of the underground mine and surface infrastructure area is within the Cessnock LGA. The seams to be mined, if mining is to recommence, are located under the Black Hill rural residential and adjoining forested areas. Mine access and associated surface infrastructure is located within the existing Donaldson Coal mine open cut void at Black Hill, with transfer of coal to the existing Bloomfield Coal Handling and Preparation Plant (CHPP) immediately to the north for coal washing and rail transport to the Port of Newcastle (**Figure 1**)

The Abel underground mine covers an area of approximately 2,750 ha that consists of low undulating forested hills with patches of cleared land supporting 110 rural/residential properties. A ridgeline associated with Black Hill runs east-west through the proposed underground mine area. Tributaries of Buttai Creek, Viney Creek, Weakley's Flat Creek and Four Mile Creek drain northwards from this ridgeline. A wide catchment containing Long Gully and Blue Gum Creek drains from the ridgeline providing water to the wet swamp at Pambalong Nature Reserve. Some cliff-lines and steeper gullies are located along sections of the Black Hill ridge.

The underground mine area is bounded on the eastern side by Pambalong Nature Reserve and the M1 Pacific Motorway; the western and southern sides by a tract of forest that extends south to the Central Coast and beyond to Hornsby, and the northern side by existing open cut coal mining activities within the Donaldson and Bloomfield mine leases (**Figure 2**).

Pambalong Nature Reserve consists of 34 ha of predominantly freshwater wetland on the western side of the M1 Pacific Motorway, approximately 20 km north-west of Newcastle (**Figure 2**). The reserve was gazetted in December 2000 over former farmland acquired by the Roads and Traffic Authority during construction of the M1 Pacific Motorway (former F3 Freeway) (DEC 2006).

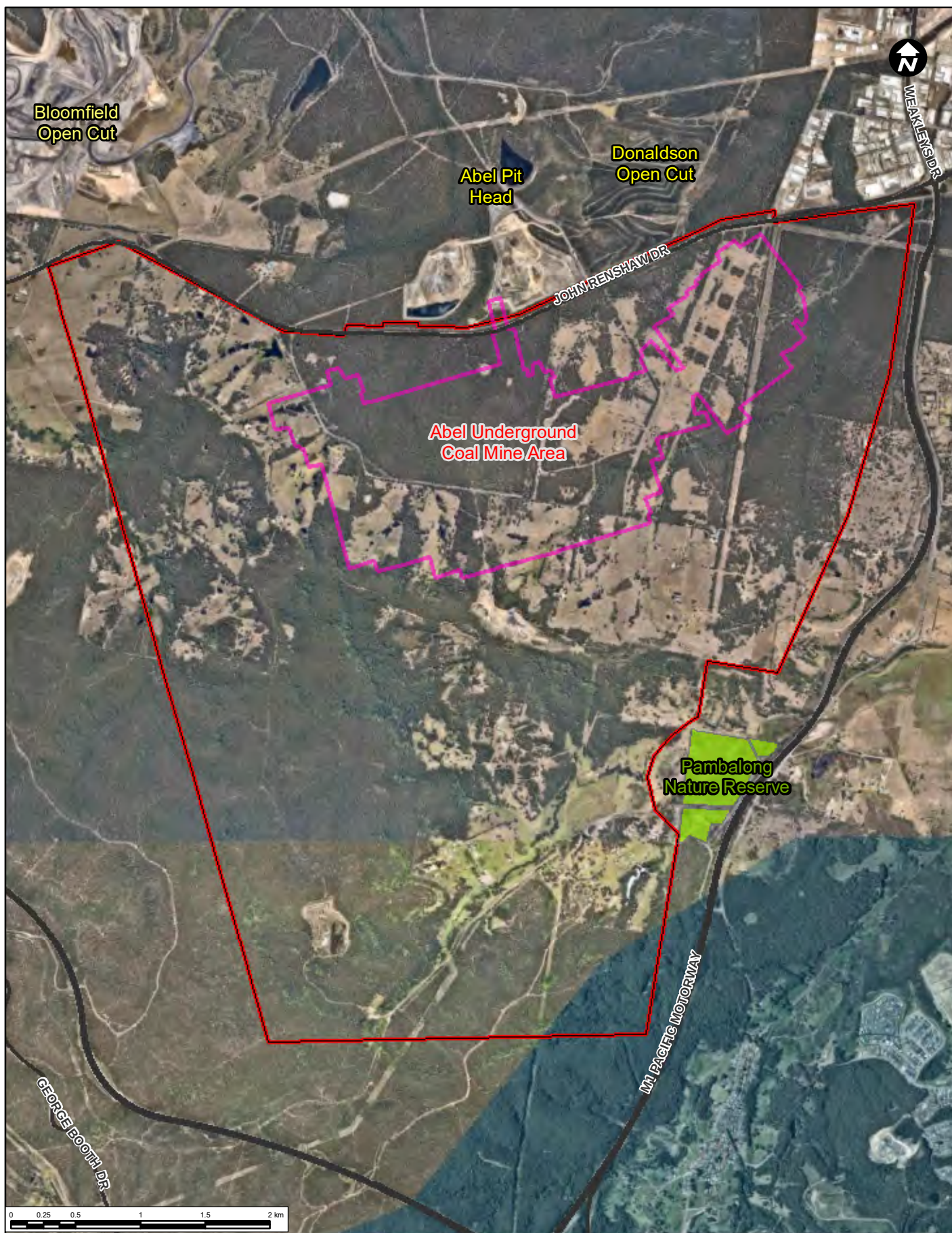


Figure 1 - Locality Map

Legend

- Waterways
- Abel Underground Coalmine Boundary
- Extent of Underground Mine
- Pambalong Nature Reserve



Regional
Location



Project Ref:	20192319
Plot Date:	2/20/2019 16:32
Revision:	001 (THawkins)

Map Projection:

GDA 1994 MGA Zone 56

Data Sources:

LPI - 2017
Nearmap - 2018

Disclaimer: This is not an official or a legal map but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.



Figure 2: Pambalong Nature Reserve
Legend

- Pambalong Nature Reserve
- Abel Underground Coalmine Boundary



Map Projection:

GDA 1994 MGA Zone 56

Data Sources:

LPI - 2017
 Nearmap - 2018

Project Ref: 20192319

Plot Date: 2/20/2019 16:33

Revision: 001 (THawkins)

Disclaimer: This is not an official or a legal map but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.

2. METHODOLOGY

2.1 FLORA

Flora survey and vegetation mapping has been undertaken in accordance with the requirements of the F&FMP. The location of flora survey activities is shown in **Figure 3**.

A base vegetation map of the wetland was prepared for the 2008 annual monitoring report using a combination of aerial photograph interpretation and ground-truthing to delineate community boundaries. Communities were defined based on the type of habitat they formed as well as floristic content and structure. Vegetation community boundaries are monitored and mapped each year to identify any variation in extent.

Two standard 0.04 ha (20 m x 20 m) floristic quadrats (Q1 & Q3), two 0.1024 ha (32 m x 32m) floristic quadrats (Q2 & Q4) and a 50 m long x 2 m wide transect were established in representative areas of identifiable vegetation structure. Data collected in these quadrats each year include total floristic content and the cover abundance index for each species in the plots using the Braun-Blanquet scale (Poore 1995).

Targeted searches for threatened flora species (*Tetratheca juncea*, *Maundia triglochinoides*, *Persicaria elatior* and *Zannichellia palustris*) are also conducted each year in appropriate communities through random meandering. The location of any threatened flora species detected is recorded using a GPS.

Annual surveys also record the presence and distribution of weed species across the subject site. The dominant weed species, outbreak areas and recently treated areas are mapped.

Floristic identification and nomenclature is based on Harden (1992, 1993, 2000 and 2002) with subsequent revisions as published on PlantNET (<http://plantnet.rbgsyd.nsw.gov.au>). Plants listed under the ROTAP scheme (Briggs and Leigh 1995) were also considered in this assessment along with species and vegetation deemed to be of local conservation significance.



Figure 3: Flora & Fauna Survey Effort

Legend

- | | | |
|--|---|--|
| Pambalong Nature Reserve | HarpTrap | Bird Survey Transect |
| ● Water Bird Survey Locations | Anabat | Trapping Transect |
| Flora Quadrats | Amphibian Transect | Flora Meander |
| Flora Quadrats 2008 | Flora Transect 50m | Frog Call Playback |
| ● Owl Call Playback | | |



Project Ref: 20192319
Plot Date: 2/20/2019 16:38
Revision: 001 (THawkins)

Map Projection:

GDA 1994 MGA Zone 56

Data Sources:

LPI - 2016
 Nearmap - 2017
 Kleinfelder - 2017
 OEH - 2012

Disclaimer: This is not an official or a legal map but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.

2.2 FAUNA

The position of observation points and transects has been recorded to ensure that sampling occurs at the same location each year. Systematic fauna monitoring is centred on two transects, one situated in the Spotted Gum – Ironbark open forest fringing the South Swamp and the other situated in the Melaleuca Swamp Forest fringing the Main Swamp.

Table 1 depicts trapping effort at transects, while **Table 2** details other fauna survey effort across the subject site. The location of fauna survey activities is shown in **Figure 3**.

Table 1: Trapping effort for the subject site

Trap type	Traps	Nights	Trap nights
Elliott A	40	4	160
Elliott B Tree	3	4	12
Elliott B Ground	6	4	24
Cage Trap	4	4	16
Harp Trap	2	4	8
Hair Tubes	8	4	32

Table 2: Fauna survey effort for the subject site

Survey method	Days/nights	Locations
Anabat recording	2	4
Spotlighting	2	2
Owl call playback	2	3
Frog transect survey	2	3
Bird transect survey	2	2
Bird water body survey	8	3
Roosting bird abundance estimate	2	1
Opportunistic fauna observations	15	Across entire site

2.2.1 Arboreal Mammals

Three Elliott B traps and eight hair tubes were placed in trees at heights of 3 m or above, along transects and baited with a mixture of rolled oats, honey, peanut butter and treacle. The trunks of trees containing the traps were sprayed with a mixture of honey and water. Traps were checked daily for arboreal species. After 4 nights the sticky wafers from hair tubes were collected and checked for the presence of hair samples. Hair identification methods follow those of Brunner *et al.* (2002). If any hair sample was from a vulnerable or endangered species, the sample was sent to an expert in hair identification for confirmation. Spotlighting was undertaken along each transect for one hour per night on two separate nights.

2.2.2 Terrestrial Mammals

Forty Elliott A, six Elliott B and four cage traps were placed along two transects at regular intervals to capture terrestrial mammal species. Traps were baited with a mix of rolled oats, honey, peanut butter and treacle and set for four consecutive nights with checks for captures occurring each morning.

Opportunistic daytime observations of the signs of recent terrestrial mammal activity such as diggings, droppings or scratch marks were noted.

2.2.3 Bats

Two harp traps were erected on transects at South Swamp and Main Swamp. To increase the likelihood of captures traps were positioned in potential bat 'flyways' such as on tracks or in natural forest openings. Traps were set in position for four consecutive nights and checked each morning. Captured bats were identified in the field and placed in 'soft release' boxes tethered to nearby trees to enable the bats to shelter during the day and exit at nightfall.

Anabat™ bat-call detectors were used passively to record the calls of passing Microchiropteran bats. Two units were set up at dusk and recording occurred for one hour on two separate nights (four hours total). Nocturnal searches of blossoming trees were also undertaken during spotlighting to detect Megachiropteran bats.

2.2.4 Birds

Surveys to detect birds were conducted at two transects in native vegetation fringing wetlands, and three permanent monitoring points overlooking the North, South and Main waterbodies (**Figure 3**).

Transects were surveyed for a period of 20 minutes on two separate days. Species were identified visually with the aid of binoculars or aurally from call identification. Bird surveys were conducted in the morning or late afternoon when bird activity is maximised (Bibby *et al.* 2000). After dark the calls of threatened owl species (Powerful, Masked, Sooty, Barking and Grass Owls) were broadcast over a megaphone at transects on two separate nights in an attempt to encourage a call back response.

Water bird surveys were conducted at permanent monitoring points in spring and autumn. During one season monitoring points are surveyed four times, at dawn and dusk in one week and again approximately 1 week later. All birds detected within a viewing arc overlooking open water bodies in a 20-minute period were recorded. Birds were identified by sight, with the aid of binoculars or a spotting scope, and by their calls.

At the completion of one of the dusk surveys, a count of birds roosting in the Melaleuca Swamp Forest within the Main Swamp was undertaken. This method is repeated at approximately the same time (on nightfall) each year to enable comparison of the composition and abundance of bird species using the roost.

2.2.5 Amphibians

Amphibian surveys were carried out at each of the three main water bodies over four days and nights. Diurnal surveys involved dip netting and visual searches to detect tadpoles in water bodies. Nocturnal surveys involved aural detection of characteristic calls or visual detection of animals with a spotlight or head torch. Call playback for the endangered Green and Golden Bell Frog was carried out due to the species' historical occurrence at the site and the presence of suitable habitat.

Adult frogs encountered were identified by visual confirmation or by their distinct advertisement calls. Tadpoles were identified using diagnostic features including mouthparts (tooth rows, jaw sheaths and papillae), pigmentation, body size, tail structure (musculature, fin depth, fin shape, tip shape), eye direction and spacing, pupil pigmentation, nare shape and spacing, spiracle

height and direction, vent length and direction, and tadpole behaviour according to Anstis (2002).

2.2.6 Introduced Fauna

Introduced species detected during annual field surveys are reported to the NSW National Parks and Wildlife Service to assist with their management.

3. RESULTS

3.1 WEATHER CONDITIONS AND SURVEY ACTIVITIES

Prevailing weather conditions during the spring survey were warm to hot days and cool to mild nights with a light breeze, and clear to partly cloudy skies. Conditions during the autumn bird surveys were mild to warm, little to no breeze and some brief showers (**Table 3**).

Table 3: Weather conditions and survey activities undertaken during the sample period

Date	Min Temp (°C)	Max Temp (°C)	Rain (mm)	Flora survey methods		Fauna survey methods						
				Transect and plot surveys & vegetation mapping	Threatened species & weed search	Trapping	Amphibian survey	Nocturnal spotlighting, call playback, & Anabat	Bird survey (Transects)	Dawn Water Bird survey	Dusk Water Bird survey	Roosting Bird count
22/10/18	16.5	20.1	11.2			+						
23/10/18	12.7	32.0	0.2			+		+				
24/10/18	15.6	22.6	0.2			+		+				
25/10/18	15.5	23.8	0			+						
26/10/18	12.1	25.1	0			+						
14/11/18	15.0	25.6	0						+	+		
20/11/18	12.9	30.6	0	+			+				+	
27/11/18	11.2	27.6	0						+	+		
6/12/18	15.0	27.0	0				+				+	
7/12/18	12.5	29.8	0	+	+							
3/04/19	11.5	26.1	1.2							+	+	
10/04/19	13.4	21.7	0.8							+		
11/04/19	9.2	23.4	0								+	+

Source: Australian Government Bureau of Meteorology, Maitland Airport 061428.

3.2 GENERAL ENVIRONMENTAL MONITORING

Changes in species composition, abundance or distribution within the wetland can result from a variety of external factors not associated with mining. Rainfall, bushfire and nearby development are examples of such factors (ecobiological 2007). During 2018/19 there was no high intensity bushfire events or development activity in the vicinity of the wetland that would impact water flow or quality.

3.2.1 Historical Rainfall

Nearby Bureau of Meteorology (BoM) weather stations at East Maitland Bowling Club (1903 - 1994), and the Maitland Visitors Centre (1995-2015), Maitland Belmore Bridge (2016-2018) provide historical rainfall data for a 114 year period (1903 – 2017). Historical mean monthly rainfall (mm) from 1903 – 2007 and monthly rainfall (mm) from 2008 – 2019 are presented in **Table 4**. Monthly rainfall for the 2018/19 survey period compared to the historical monthly average (1903-2019) is presented in **Figure 4**.

Table 4: Monthly rainfall (mm) recorded at Maitland Visitors Centre (1995-2015) weather station (long term mean includes East Maitland Bowling Club 1903 to 1994) and at Maitland Belmore Bridge (Hunter River) (2016-19)

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
2008	182	174	45	224	7	123	42	22	183	76	89	74	1241
2009	12	267	53	125	73	75	24	2	24	67	44	58	824
2010	65	53	86	22	73	111	62	32	20	60	192	63	839
2011	36	37	47	140	91	162	86	57	75	104	141	67	1043
2012	84	174	102	79	12	125	45	14	22	7	46	45	753
2013	140	134	79	66	51	79	30	11	17	51	279	16	953
2014	21	113	66	81	30	45	22	111	31	50	22	164	756
2015	155	41	35	358	80	42	15	38	55	44	102	135	1100
2016	380.5	35	48	20.5	5.5	122.5	30	55.5	57.5	43	43	106.5	947.5
2017	58	60	216	75	22.2	94.6	0.6	7.0	10.6	93.2	28.4	29.4	695
2018	9.6	102.6	181.6	35.2	6	78.4	1.2	14.6	49.4	107.6	78.4	96.4	761
2019	9	31	149.5	22.5									
Mean 1903-2019	88	97	95	89	67	86	56	49	54	63	66	79	877

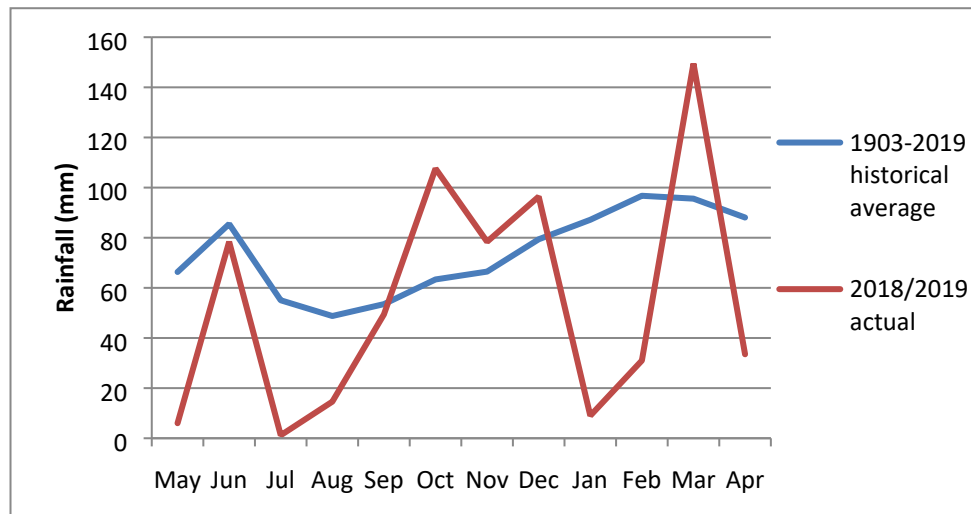


Figure 4: Monthly rainfall for 2018/19 survey period compared to historical monthly average (1903-2017)

Above average rainfall was recorded in October, November and December 2018 with the three months recording well below average rainfall. Above average rainfall was also observed in March 2019 which with 149.5 mm being recorded. However monthly totals were well below the average in May, July, August 2018 and January, February and April of 2019.

3.2.2 Water Quality and Water Level Monitoring

Funding was provided by the Donaldson Conservation Trust to The Tom Farrell Institute for the Environment for the installation of a water quality and water level monitoring station at Pambalong that records a range of data such as pH, electrical conductivity, temperature, dissolved oxygen, turbidity and water level within 15 minute intervals. Water quality monitoring in the Main Swamp commenced in October 2016, however, due to dry to very low water levels and access restrictions, no additional water quality data level is available (**Table 5**). Water level data is available for the period mid January 2017 – mid May 2018 (**Figure 5**). Data generated by this station will be immensely valuable in interpreting the results of future ecological monitoring.

Table 5: Water quality monitoring data from Main Swamp during late 2016 – early 2017

Date	Time	Temp.	pH	Electrical Conductivity	Dissolved Oxygen	Turbidity
		oC	-	µS/cm	mg/L	NTU
18-10-16	10:00	16.4	6.98	1380	8.84	7
25-10-16	10:30	19.8	6.95	1300	7.22	7
01-11-16	10:30	17.8	6.98	1470	1.2	9
08-11-16	11:15	20.9	7.29	1650	1.78	15
15-11-16	11:00	21.2	7.38	1840	2.68	50
22-11-16	10:05	23.7	7.32	1810	2.24	33
29-11-16	9:10	24.4	7.51	1960	6.9	41
04-03-17	9:30	23	7.24	790	7.4	11
04-04-17	10:30	23.1	7.11	815	6.8	9
09-05-17	10:10	22.3	6.94	850	6.4	6

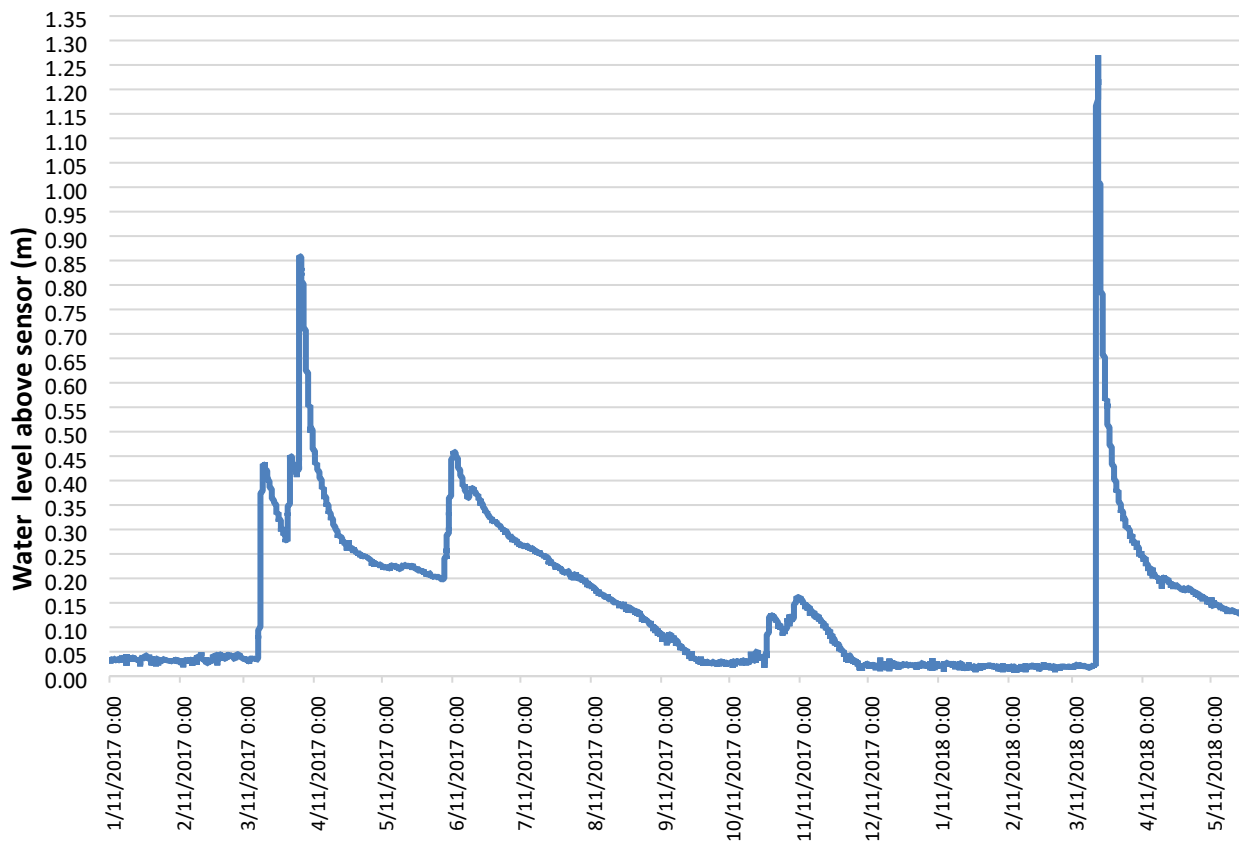


Figure 5: Water levels at Pambalong recorded monthly from the Main Swamp in 2017/18

The water level data reveals that considerable fluctuation occurs in the Main Swamp, with lows of between < 1 – 10 cm recorded during January to mid March 2017, with other extremely dry periods occurring from mid September 2017 through to mid March 2018 (consistent with field observations). Significant rainfall events in mid to late March 2017 resulted in water levels increasing to a high of 86.5 cm in early April, with the highest water level of 1.27 m recorded in late March 2018 after close to 100 mm of rain fell in a 24-hr period (22 and 23 March).

However, two other significant rainfall events (> 50 mm in one day) in late February and early March 2018 had no observable impact on water levels at Pambalong. After the extremely dry spring / summer period of 2017 / 2018 it is not surprising that sporadic rainfall prior to the late March 2018 deluge did not increase water levels as the larger catchment probably acted like a sponge. However, the > 100 mm on the 22nd/23rd March significantly increased water levels and very quickly. Water appears to flow through the Pambalong system after a large rainfall event as reflected in the dropping water levels post rainfall.

General field observations during 2019/2019 surveys indicate that water levels are particularly shallow within the Southern Swamp, generally less than 30cm as surveyors were able to walk through the centre of the waterbody with gumboots.

Analysis and discussion of water quality monitoring data will be included in future reports when a more complete dataset is available.

3.3 FLORA RESULTS

Flora surveys were conducted during December 2018. A total of 109 species were detected in 2018, compared to 90 species in 2017. A total of 200 species have been identified on the site since monitoring surveys commenced in 2008, an increase of four (196) since the last survey (**Appendix 1**). Twenty-two species were recorded in 2018 that were not recorded in 2017 (nine exotic and 13 native species), whereas three species were not recorded in 2018 that were recorded in the previous year's survey - all natives.

No threatened flora species were recorded during the field surveys. Three species considered as regionally significant by Eco Logical (2003) have been detected during the surveys since monitoring began; *Cyperus odoratus*, *Melaleuca linariifolia* and *Enydra fluctuans*.

Coastal Foothills Spotted Gum - Ironbark Forest (Q1)

The Coastal Foothills Spotted Gum - Ironbark Forest quadrat (Q1) has contained the highest species diversity of the four flora plots surveyed in the Reserve (**Plate 1**) during the annual spring surveys since 2008. The 2018 results were consistent with this trend (66 species recorded).

Flora diversity in this quadrat has recovered in 2018 to be near the peak diversity of 67 species recorded in 2014, albeit six of those are exotic species (**Figure 6**). *Corymbia maculata* (Spotted Gum), *Eucalyptus siderophloia* (Grey Ironbark), *Entolasia stricta* (Wiry Panic Grass) and *Aristida vagans* (Three-awned Spear Grass) and *Themeda triandra* (Kangaroo Grass) dominate the Coastal Foothills Spotted Gum - Ironbark Forest community (**Appendix 1**). A total of 13 species (12 native and one exotic) were recorded from the 2018 survey that were not observed in the 2017 survey. These species were entirely in the ground cover and forb layers and their presence or absence can depend on current environmental conditions.

During the 2018 survey, six exotic species were recorded within Quadrat 1; *Bidens pilosa* (Cobblers Peg), *Senecio madagascariensis* (Fireweed), *Sida rhombifolia* (Paddy's Lucerne), *Ehrharta erecta* (Panic Veldtgrass), *Lantana camara* (Lantana) and *Paspalum dilatatum* (Paspalum) - a new species recorded this survey. Five of these species were observed to comprise less than 5% coverage with Lantana increasing to a coverage score of 3 (5-<25%) – a considerable increase from the previous survey.

The vegetation community appears to be in good overall health evident by the increase in species diversity. This could be due to natural fluctuations and/or climatic conditions. However, the increase in Lantana requires control action.



Plate 1: Flora quadrat 1 (Q1) located in Coastal Foothills Spotted Gum - Ironbark Forest (Photograph taken in 2018)

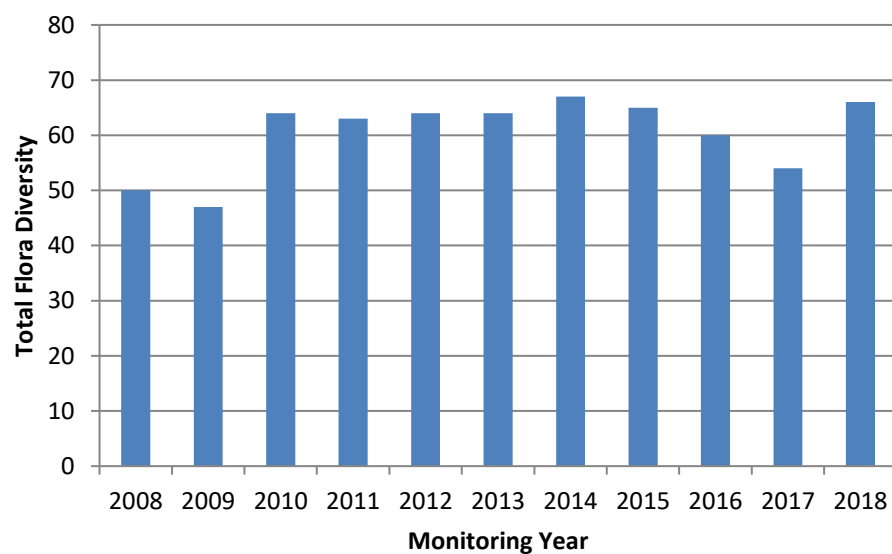


Figure 6: Flora species richness within Q1 from 2008 to 2018

Freshwater Wetland Complex (Q2)

The number of species recorded in the Freshwater Wetland Complex (Q2) since 2009 has fluctuated with a minimum of 18 and a maximum of 26 species recorded. The 2018 survey recorded 25 species, an increase on the previous year's 19 species (**Plate 2, Figure 7**). This quadrat was relocated in 2009 following an OEH recommendation. It was thought that the new location would provide data more relevant to the scope of the survey.

One native species, *Triglochin procerum* were not recorded from the quadrat in 2018.

A total of 12 exotic species were recorded in the 2018 survey, an increase of seven from the 2017 survey. The five species recorded from 2017: *Atriplex prostrata*, *Cassia pendula* subsp. *glabrata*, *Vicia sativa*, *Cenchrus clandestinus* (formerly *Pennisetum clandestinum* [Kikuyu]) and *Rumex conglomeratus* were recorded again during the 2018 survey. *Ageratina adenophora* (Crofton Weed), *Cyclospermum leptophyllum* (Slender Celery), *Lantana camara* (Lantana), *Phytolacca octandra* (Inkweed), *Senecio madagascariensis* (Fireweed), *Solanum nigrum* (Blackberry Nightshade) and *Verbena bonariensis* (Purpletop) were the new weed species recorded in 2018.

All but Kikuyu (increased to between 5% - <25%) were recorded at less than 5 percent coverage. The increase in the exotic species diversity, and the appearance of Crofton Weed indicate that the weeds are beginning to encroach in to the wetland. Whether this trend will be reversed with an increase in water levels following increased rainfall will be determined by subsequent years' monitoring. The weeds have most likely been sourced from the adjacent road side.

Overall, the wetland appears to still be in good health with native species dominating the wettest areas (*Typha orientalis*, *Schoenoplectus subulatus*, *Bolboschoenus caldwellii* and *Eleocharis equisetina*).



Plate 2: Flora quadrat 2 (Q2) located in Freshwater Wetland Complex dominated by Typha (Photograph taken in 2018)

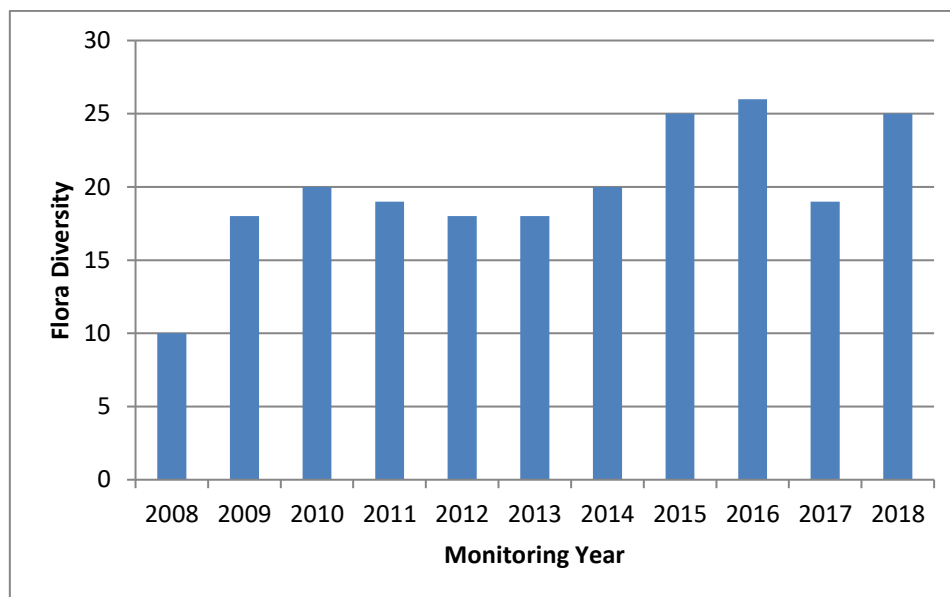


Figure 7: Flora species richness within Q2 from 2008 to 2017

Paperbark Swamp Forest (Q3)

Flora species richness in the Paperbark Swamp Forest (Q3) (**Plate 3**) has remained relatively constant throughout the survey period (between 15-19 species), with two years of high species abundance being 2010 and 2016 (**Figure 8**). This year's survey recorded 23 species, with the increase wholly attributable to exotic species.

Twenty-three species were recorded in the 2018 survey; of these, 12 were exotic. Exotic species recorded this survey (but not 2017) were *Brassica juncea*, *Bidens pilosa* (Cobblers Pegs), *Cirsium vulgare* (Black Thistle), *Conyza spp.* (Fleabane), *Phytolacca octandra* (Inkweed) and *Solanum nigrum* (Blackberry Nightshade). The 2017 survey noted that the exotic species *Atriplex prostrata* (Hastate Orache) had increased dramatically over the previous three surveys. This survey recorded a substantial decrease in cover from 5 (50 - <75%) to 2 (<5%, but many individuals). *Cenchrus clandestinus* (Kikuyu) and *Rubus fruticosus* (Blackberry) remain abundant adjacent to Q3 in the north-east corner of the reserve. One exotic species *Aster subulatus* (Wild Aster) was not recorded this survey.

Native species richness and their cover remain largely unchanged between surveys at Q3.



Plate 3: Flora quadrat 3 (Q3) located in Paperbark Swamp Forest (Photograph taken in 2018)

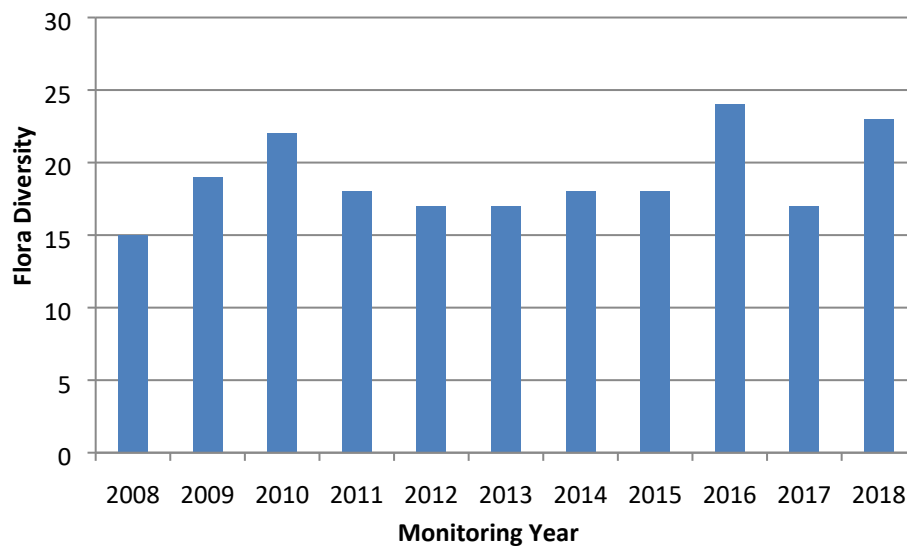


Figure 8: Flora species richness within Q3 from 2008 to 2018

Paperbark Swamp Forest (Q4)

A total of 12 species were recorded in the Paperbark Swamp Forest (Q4) in 2008 (**Figure 9, Plate 4**). This quadrat was relocated in 2009 in response to a request by OEH, as the new location was thought likely to produce more informative seasonal data. There has been a gradual decrease in the number of flora species recorded from 2009 to 2012 with the number of species remaining stable from 2012 to 2015. In 2016 species richness rose slightly to the highest since the 2011 survey before falling again by one species to a total of 14 during the 2017 survey, while in the 2018 survey 16 species were recorded (**Figure 9**). This is likely to be due to natural seasonal variation. Native species richness increased slightly by one species with *Schoenoplectus subulatus* recorded this survey.

The environmental weed *Alternanthera philoxeroides* (Alligator Weed) was first recorded in 2011. The abundance of this weed has fallen somewhat to a cover of two (<5%, many individuals).



Plate 4: Flora quadrat 4 located in Paperbark Swamp Forest (Photograph taken in 2017). Alligator Weed dominates in the foreground.

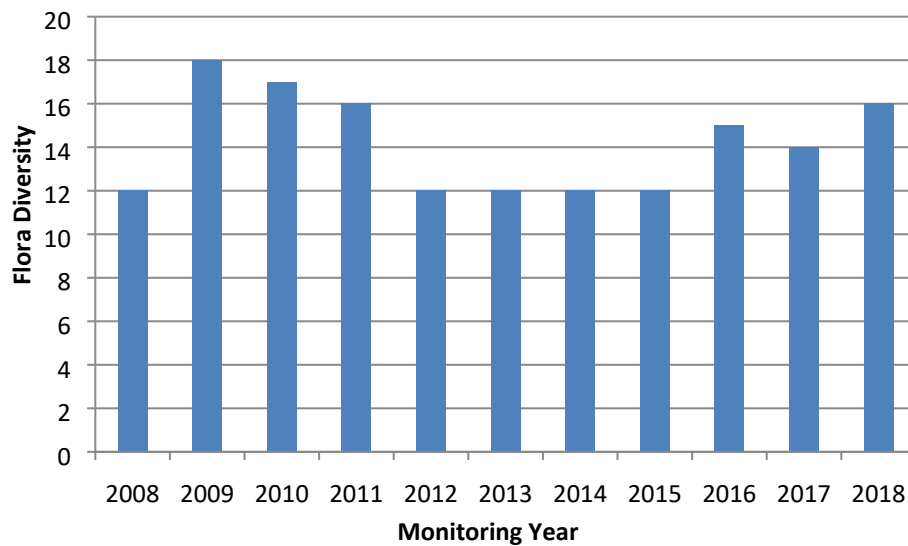


Figure 9: Flora species richness within Q4 from 2008 to 2018

Flora Transect

The flora transect samples a Freshwater Wetland Complex (**Plate 5**). Flora species richness has remained relatively stable since monitoring began (**Figure 10**). The 2018 survey recorded the same number of species as the 2017 survey but recorded a different suite of species. A total of six native and two exotic species were recorded in 2018, compared to seven native species and one exotic in 2017. The major change was the prevalence of open water this year (**Plate 5**), compared to the 2017 survey (**Plate 6**).

The exotic plant *Myriophyllum aquaticum* (Parrots Feather) was a new exotic recorded this survey, although its cover is only <5% (cover abundance of 2). Native species not recorded since 2017 were *Paspalum distichum* (Water Couch) and *Persicaria decipiens* (Slender Knotweed), while *Ludwigia peploides* (Water Primrose), *Spirodela punctata* (Duck Weed) and *Triglochin procerum*, all with substantial cover abundances were also not recorded this year. Water Hyacinth (*Eichhornia crassipes*) was recorded at high densities from 2008 to 2011, with a reduction in 2012 following control efforts. As found in the previous two years (2016 and 2017), only a small number of plants were observed in 2018, and these were located around the edges of the swamp.



Plate 5: Flora transect located in Freshwater Wetland Complex (Photograph taken in 2018). Note the extent of open water.



Plate 6: Flora transect located in Freshwater Wetland Complex (Photograph taken in 2017). Note the absence of open water.

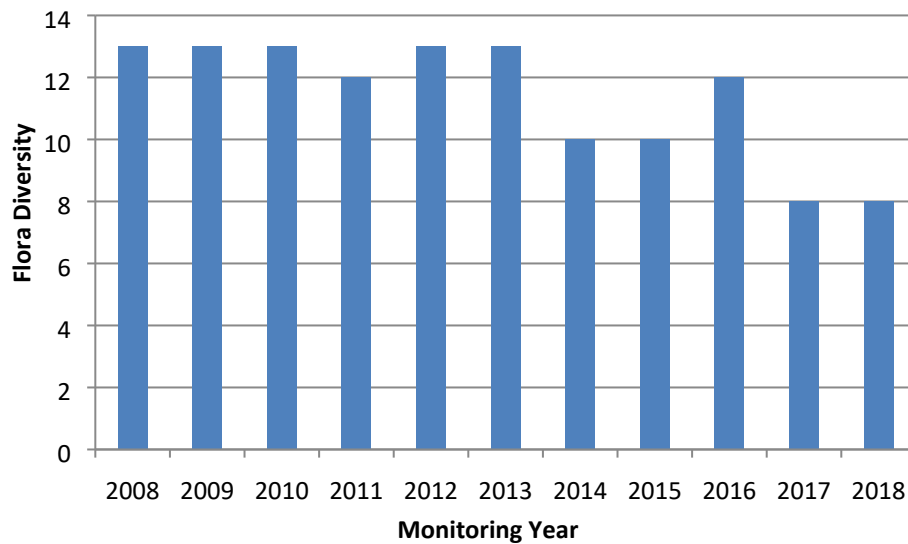


Figure 10: Species richness within the flora transect from 2008 to 2018

3.4 WEED SPECIES

The reserve has significant weed infestations across both disturbed areas and within the natural vegetation (**Figure 11**). The primary weeds at the time of survey were:

- *Eichhornia crassipes* (Water Hyacinth);
- *Alternanthera philoxeroides* (Alligator Weed);
- *Cenchrus clandestinus* (Kikuyu);
- *Rubus fruticosus* sp. aggregate (Blackberry); and
- *Lantana camara* (Lantana).

3.4.1 *Eichhornia crassipes* (Water Hyacinth)

Eichhornia crassipes (Water Hyacinth) can survive for extended periods of time and when conditions are favourable, can spread rapidly and cover large areas of open water. This rapid spread can choke out sunlight for natural inundated plant species and reduce open water access and usage for water birds. The life cycle of this plant means that it will continue to become established from both local and regional sources as it can float downstream and seeds can be delivered by itinerant birdlife.

- This weed dominated the water outlet from the Main Swamp to the North Swamp during the first monitoring event in 2008 (**Plate 7**). Prior to the 2009 monitoring event, some Water Hyacinth had been extracted from the open water and a grate installed to prevent this weed blocking the under-road culvert (**Plate 8**). Subsequent years can be observed in **Plates 9-17**.
- The 2018 monitoring event found that the coverage of *Eichhornia crassipes* on the North Swamp has increased since the previous year (2017). While areas of open water are present in 2018 (**Figure 11**), they are noticeably reduced in area. **Plate 16** shows the increase in weeds surrounding the installed grate when compared to 2016 (**Plate 15**) however this is predominantly *Alternanthera philoxeroides* (Alligator Weed). This is likely to be due to *Eichhornia crassipes* spraying by the Pambalong Nature Reserve Enhancement Project which caused significant reductions of the weed in 2012 (**Plate 11**) and 2013 (**Plate 12**), and appears to have had similar results in 2016.
- Aerial drone photography shows the extent of the Water Hyacinth in the north swamp (**Plate 18**).
- Water Hyacinth is an environmental weed that should be controlled under the General Biosecurity Duty of the *Biosecurity Act 2015* due to its potential biosecurity risk. The NPWS Hunter Region Pest Management Strategy (2002) has identified control of Water Hyacinth

at Pambalong Nature Reserve as a “high priority” and an active program has been operating in the reserve since 2002.



Plate 7: Water Hyacinth at the Northern Swamp inlet in 2008



Plate 8: Water Hyacinth at the Northern Swamp inlet in 2009 showing the installation of a grate



Plate 9: Water Hyacinth at the Northern Swamp inlet in 2010



Plate 10: Water Hyacinth at the Northern Swamp inlet in 2011



Plate 11: Water Hyacinth at the Northern Swamp inlet in 2012



Plate 12: Water Hyacinth at the Northern Swamp inlet in 2013



Plate 13: Water Hyacinth at the Northern Swamp inlet in 2014



Plate 14: Water Hyacinth and Alligator Weed at the Northern Swamp inlet in 2015



Plate 15: Water Hyacinth and Alligator Weed at the Northern Swamp inlet in 2016



Plate 16: Water Hyacinth and Alligator Weed at the Northern Swamp inlet in 2017



Plate 17: Alligator Weed (foreground) and Typha at the Northern Swamp inlet in 2018.



Plate 18: Aerial photography showing the extent of the Water Hyacinth on the north swamp in 2018.

3.4.2 *Alternanthera philoxeroides* (Alligator Weed)

Alternanthera philoxeroides (Alligator Weed) may infest both terrestrial and aquatic environments (**Plate 17**). The abundance of Alligator Weed in 2018 was found to be approximately the same as the 2017 survey, although this has not been quantifiably assessed. Alligator Weed has the potential to form more extensive infestations within the reserve and invade adjoining land. Alligator Weed is easily spread and once established it is virtually impossible to eradicate. Alligator Weed is an environmental weed that should be controlled under General Biosecurity Duty of the *Biosecurity Act 2015* due to its potential biosecurity risk. The NPWS Hunter Region Pest Management Strategy (2002) identifies Alligator Weed as a “high priority” weed.

NSW National Parks and Wildlife have attempted in the past to control Alligator Weed at the site but after a 3-year treatment program, have not made any headway with controlling its spread. Upstream weed sources and the species’ long seed viability has made its control extremely difficult.

3.4.3 *Cenchrus clandestinus* (Kikuyu)

Cenchrus clandestinus (Kikuyu) forms dense, monoculture grassy thickets within disturbed areas of the subject site (**Plate 19**). The thickets are so dense in some areas that they are suppressing native vegetation from regenerating.

- Kikuyu is a species listed under the Key Threatening Process (KTP) ‘Invasion of native vegetation communities by exotic perennial grasses’.
- The boundary of Kikuyu dominance is restricted by the hydrological regime, generally adjacent to the high water mark, and is unlikely to spread into the wetland areas.
- Kikuyu is particularly dense in the north-west and south-east corners of the subject site and along the majority of the roadsides (**Plate 20**).



Plate 19: *Cenchrus clandestinus* (Kikuyu) in the north-west corner of the reserve



Plate 20: Aerial view of transition (from top to bottom) from open water to Typha to Kikuyu to woodland. Kikuyu excludes all other vegetation.

3.4.4 *Rubus fruticosus* sp. aggregate. (Blackberry)

Rubus fruticosus sp. aggregate. (Blackberry) is found in areas of previous disturbance within the reserve, and forms a dense thicket to 1 m high, suppressing natural regeneration. Blackberry thickets can restrict fauna access to the wetland areas and provide shelter for feral animals. Blackberry is listed as a prohibited matter under the *Biosecurity Act 2015* in Newcastle, Cessnock and Maitland local government areas and the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority (the plant may not be imported into the state or sold).

- The NPWS Hunter Region Pest Management Strategy (2002) identifies Blackberry as a “high priority” weed. This species was initially treated by weed control efforts in 2008; however, it was still recorded at low densities on Transect 1 in 2013. Ongoing treatment is required to eradicate/suppress this species and prevent re-establishment as it is still present in patches in certain sections of the reserve (**Plate 21** and **Figure 11**).



Plate 21: *Rubus fruticosus* (Blackberry) – background in the north-west corner of the reserve. *Ambrosia tenuifolia* (Lacy Ragweed) in the foreground.

3.4.5 *Lantana camara* (Lantana)

Lantana camara (Lantana) is a primary weed of the dry sclerophyll woodland at the southern portion of the subject site. Efforts to control the weed in this area have been successful in previous years. As noted in Section 3.3, this weed has increased its cover in the Coastal Foothills Spotted Gum – Ironbark Forest community and requires control efforts.

This species can dominate the shrub and mid stratum if left untreated, effectively out-competing native species and can provide refuge for feral animals.

- The ‘Invasion, establishment and spread of *Lantana camara*’ is listed as a Key Threatening Process (KTP) under the NSW *Biodiversity Conservation Act 2016*.
- Lantana is a Weed of National Significance (WONS). The NPWS Hunter Region Pest Management Strategy (2002) identifies Lantana as a “high priority” weed. Significant efforts were made to control this weed in the southern part of the reserve in 2013 and 2016 with good results.

3.4.6 Environmental Weeds

An environmental weed is a plant species that is not a priority weed and / or WoNs but can still impact on the environment through the degradation of ecosystems by interfering with the growth and spread of other native flora species. Environmental weeds can also impact on native fauna by replacing their natural food sources, making wildlife corridors impenetrable, and/or degrading other important habitat features.

Other weeds found at the subject site are general weeds of disturbed areas, confined to the fringes of the reserve, roadsides and the former rail line and are generally outside the natural vegetation areas. Some naturally occurring species may also present a problem if they become too abundant.

3.4.6.1 *Typha orientalis* (native)

Typha orientalis (Typha) has increased in abundance over the past few years and has spread into areas of open water, restricting the available habitat of open water bird species, such as pelicans, ducks and swans. This is particularly evident in the north swamp inlet (**Plates 13-17**). The extent of Typha within the subject site should continue to be monitored to determine if this high abundance is temporary (e.g. in response to favourable climatic conditions) or relatively

permanent (e.g. in response to changes in the catchment that have affected water levels within the swamp).

3.4.6.2 *Ambrosia tenuifolia*

Ambrosia tenuifolia (Lacy Ragweed) is an environmental weed that has colonised and spread rapidly in the north-west corner of the reserve in the area adjacent to Q3 in the Kikuyu Grassland and disturbed area (**Figure 11, Plate 21**). Under the NSW *Biosecurity Act 2015* this species is required to be managed to prevent, eliminate or minimise any risk it presents as far as is practicable.

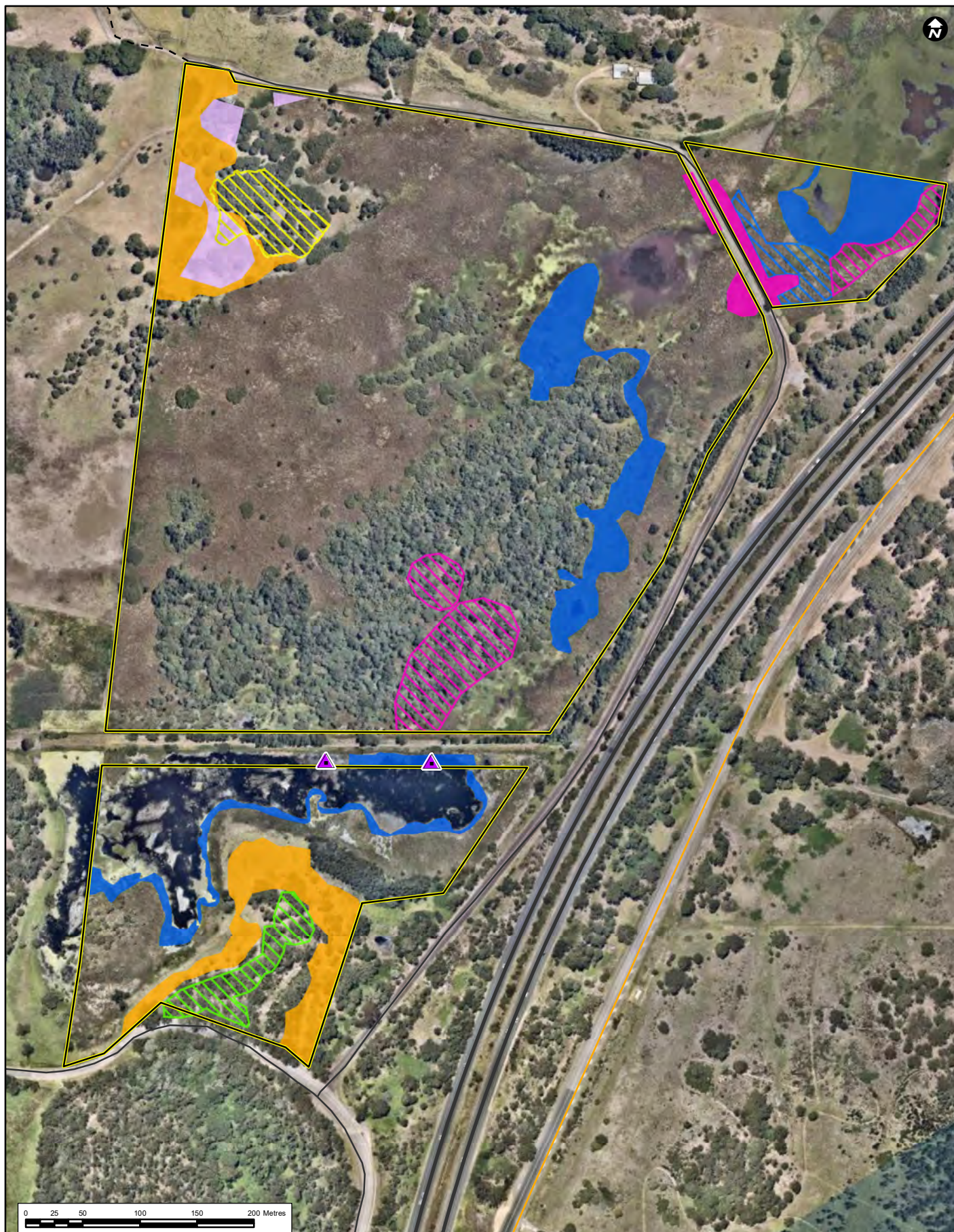


Figure 11: Weed Species Mapping

Legend

- | | | |
|--------------------------|---|---|
| Pambalong Nature Reserve | Alligator Weed | Lantana (Scattered - 10% Cover) |
| Blackberry | Alligator Weed - Scattered | Scattered Weeds - Lantana, Moth Vine, Senna, Ground Asparagus, Blackberry |
| Motorway | Blackberry Treated 2009 | Water Hyacinth |
| Arterial Road | Kikuyu Grassland, Blackberry and Lacy Ragweed | Water Hyacinth - Scattered |
| Local Road | | |
| Track- Vehicular | | |



Map Projection:

GDA 1994 MGA Zone 56

Data Sources:

NSW DFSI - 2017
Nearmap - 2019

Project Ref: 20192319

Plot Date: 5/03/2019 11:49

Revision: 001 (BDeane)

Disclaimer: This is not an official or a legal map but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.

3.5 VEGETATION COMMUNITIES

Three natural vegetation communities and associated variations, and two altered vegetation types were mapped on the subject site in 2008 (**Figure 12**). The distribution of communities did not change in the 2018 surveys.

3.5.1 Coastal Foothills Spotted Gum – Ironbark Forest (Dry Sclerophyll Forest)

This community occurs as an open forest on the knoll at the southern portion of the subject site. The overall community shows significant past disturbance and subsequent weed infestation.

The community is dominated by *Corymbia maculata* and *Eucalyptus siderophloia* with some *Eucalyptus acmenoides* scattered throughout. The mid stratum has a high abundance of *Bursaria spinosa* and *Acacia maidenii*. The shrub layer is dominated by *Daviesia ulicifolia* and the ground cover is grassy with *Themeda australis*, *Dichelachne micrantha*, *Entolasia stricta*, *Echinopogon caespitosus* and *Aristida vagans* common.

This community is not dependent on the wetland and associated hydrology. *Coastal Foothills Spotted Gum – Ironbark Forest* is not listed as a Threatened Ecological Community.

3.5.2 Paperbark Swamp Forest (Swamp Sclerophyll Forest)

The Paperbark community is restricted to more elevated flats and areas bordering the freshwater wetland complex. Patches at the centre of the reserve are the most mature and consist of a scattered *Casuarina glauca* canopy over dense *Melaleuca* sub-canopy. Flora quadrat 3 is located in the northern portion, adjacent to the Water Couch-Triglochin Swamp Meadow community and flora quadrat 4 is located centrally in the core forested area.

The species composition within Q3 is typically dominated by the canopy species *Melaleuca linariifolia* and *M. styphelioides*. One juvenile *Ficus macrophylla* is also located in the quadrat. Some *Melaleuca ericifolia* is present within the quadrat indicating frequent inundation; however, this species is more common in permanent swamp areas at the ecotone between the Paperbark community and the freshwater wetlands. The mid stratum is sparse or absent.

The ground cover within the quadrat comprises *Bolboschoenus caldwellii*, *Eleocharis acuta*, *Atriplex prostrata* and *Lachnagrostis filiformis*.

Within Q4, floristic structure is similar to Q3; however, with the more permanent inundation, several other species are also present. These include *Enydra fluctuans*, *Juncus pallidus*, *Ludwigia peploides* subsp. *montevidensis*, *Typha orientalis* and *Casuarina glauca*. The exotic species *Alternanthera philoxeroides* also dominates the area with scattered Water hyacinth also present. Two epiphytic orchid species, *Dendrobium linguiforme* (Tongue Orchid) and *D. teretifolium* (Rat's Tail Orchid), occur on several *Casuarina glauca* trees.

The Paperbark Swamp Forest and Paperbark Woodland forms part of the NSW BC Act listed *Swamp Sclerophyll Forest on Coastal Floodplains EEC*.

3.5.3 Freshwater Wetland Complex (Freshwater Wetland)

The Freshwater Wetland Complex occurs in deeper depressions having a permanent or periodical inundation of fresh water, such that the species composition is comprised of water tolerant species. At the subject site the Freshwater Wetland Complex consists of three variations: Typha Reedland; Rushland Swamp/Open Water; and Water Couch-Triglochin Swamp Meadow.

Specifically, these mapped freshwater wetland variations range from open water bodies, with tall reeds and sedges, to a mixed reedland, rushland or swamp meadow integrating with the Paperbark Swamp Forest community. The integration is likely to be a dynamic and moving boundary, at the present time directed by seasonal and climatic conditions.

The Freshwater Wetland Complex forms part of the NSW BC Act listed *Freshwater Wetlands on Coastal Floodplains EEC*.

3.5.3.1 Typha Reedland

The Typha Reedland dominates deeper permanently inundated areas within the reserve. The Typha Reedland generally borders the lagoon areas. The extent of Typha relates to the seasons and water levels. Q2 is located within this community variant. The dominant species are *Typha orientalis* (Broadleaf Cumbungi), *Schoenoplectus validus*, *Paspalum distichum* (Water Couch), *Eleocharis equisetina* and *Bolboschoenus caldwellii*.

3.5.3.2 Rushland Swamp/Open Water

The Rushland Swamp is located in shallow semi-permanent and permanent water bodies. Transect 1 is located in this community in the South Swamp and the species diversity within this community is relatively low. The water level varies from deeper water to boggy substrate in the survey transect. The community is dominated by *Eleocharis sphacelata*, *Ludwigia peploides* subsp. *montevidensis*, *Spirodela punctata* and *Triglochin procera*, although these latter three species were recorded this year.

The open water areas occupy large portions of the Main Swamp and the North Swamp. This community is very variable due to seasonal and local climatic conditions and is related to the extent of the Typha Reedland and Rushland Swamp.

3.5.3.3 Water Couch-Triglochin Swamp Meadow

The Water Couch-Triglochin Swamp Meadow is found at the northern end of the Main Swamp. The presence of old fence lines indicates the previous land use of the site for grazing purposes. The composition and structure of flora are indicative of some disturbance. This community is dominated by *Paspalum distichum*, *Triglochin* sp. and *Persicaria* sp. The Swamp Meadow is also fringed on the deeper inundations by Typha Reedland.

3.5.4 Altered Vegetation - Swamp Oak Forest (planted)

Two isolated sections of the subject site contain *Casuarina glauca* stands that have been physically planted. These communities are not natural and their composition does not adequately represent a natural community. *Casuarina glauca* is also found naturally throughout the Paperbark Swamp Forest.

3.5.5 Altered Vegetation - Disturbed/Kikuyu Grassland

The Kikuyu dominated grasslands and disturbed areas have a monoculture of Kikuyu or a weed dominated composition. Kikuyu Grass dominates large areas adjacent to the south swamp and Coastal Foothills Spotted Gum – Ironbark Forest community and north from the main swamp. The rail line between the South Swamp and Main Swamp is infested by weeds; however, this is mainly restricted to the elevated area and is not impacting upon the swamp areas.

3.5.6 Endangered Ecological Communities

The vegetation mapping encompasses two Endangered Ecological Communities: *Freshwater Wetlands on Coastal Floodplains* EEC; and, *Swamp Sclerophyll Forest on Coastal Floodplains* EEC. The EECs occupy the majority of the reserve and their distribution is shown in **Figure 12**.

3.5.6.1 Freshwater Wetlands

Freshwater Wetlands are associated with coastal areas subject to periodic flooding and in which standing fresh water persists for at least part of the year in most years. Soils are typically silts, muds or humic loams in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, back-swamps, lagoons and lakes but may also occur in back-barrier landforms where floodplains adjoin coastal sandplains (NSW Scientific Committee 2004).

The species composition of freshwater wetlands at the subject site is indicative of the EEC as they are dominated by herbaceous plants and have few woody species. The vegetation composition (grassland, open water or sedgeland vegetation) is known to vary both spatially and temporally depending on the water regime.

Hexham Swamp and Pambalong Nature Reserve are recognised as important reserves for freshwater wetlands.

3.5.6.2 Swamp Sclerophyll Forests

The Paperbark Swamp Forest is recognised as a Swamp Sclerophyll Forest EEC. The community is dominated by *Melaleuca linariifolia*, *M. ericifolia* and *M. styphelioides* (paperbarks) and scattered *Casuarina glauca*. This is indicative of a sclerophyllous community; however, it does lack a tree layer of eucalypts. Much of the subject site was inundated at the time of surveying; however, previous reports indicate these areas become dry land during extended dry periods.

The groundcover was composed of abundant sedges, ferns, forbs, and grasses which are indicative of the EEC. Within the Lower Hunter district, this community includes 'Swamp Mahogany-Paperbark Swamp Forest' (map unit 37), Riparian Melaleuca Swamp Woodland (map unit 42) and Melaleuca Scrub (map unit 42a) of NPWS (2000).

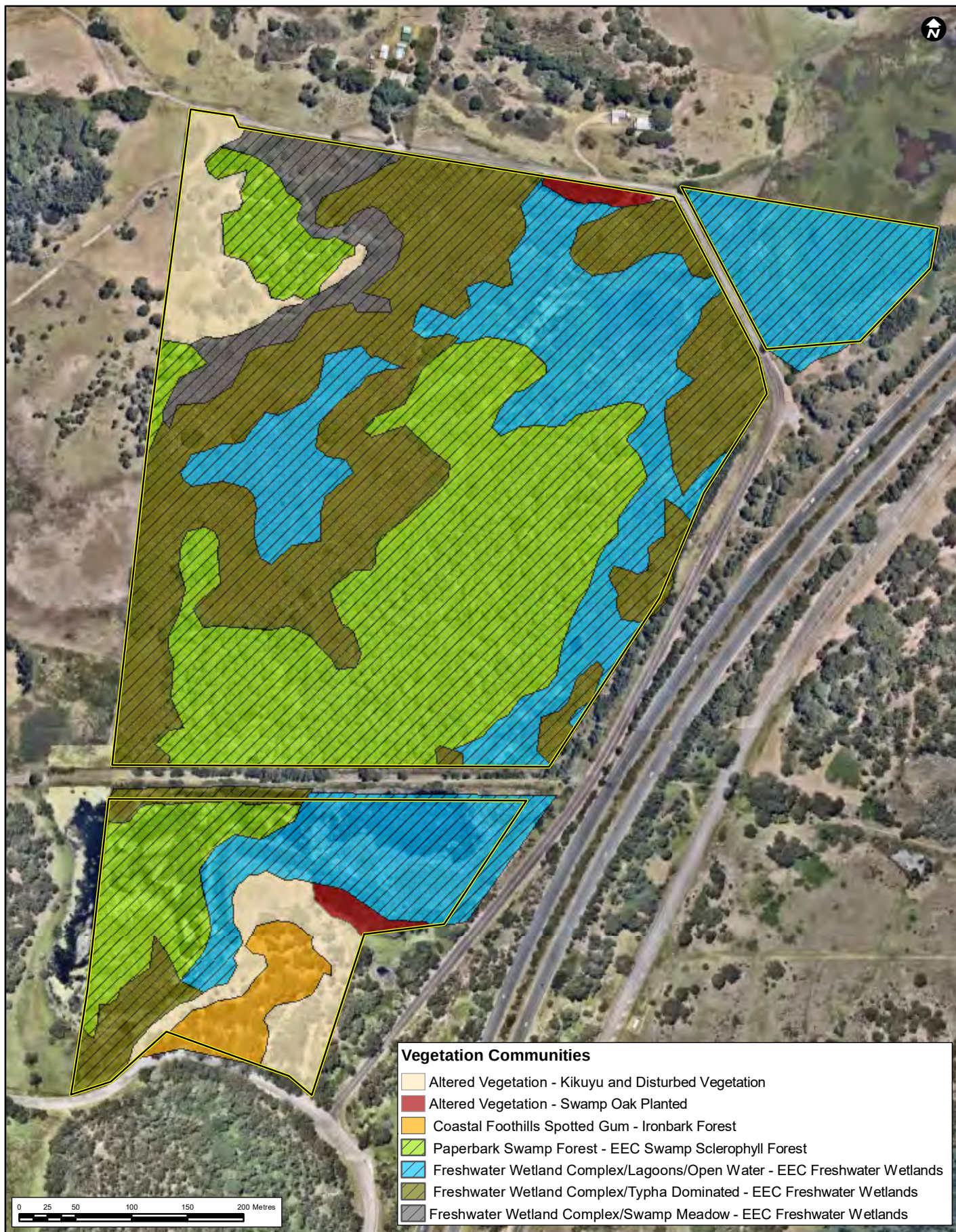


Figure 12: Vegetation Community Mapping

Legend

 Pambalong Nature Reserve



Map Projection:

GDA 1994 MGA Zone 56

Data Sources:

LPI - 2016
Nearmap - 2017

Project Ref: 20192319

Plot Date: 2/20/2019 16:41

Revision: 001 (THawkins)

Disclaimer: This is not an official or a legal map but is for informational use only. All data was compiled from the best sources available. All boundaries, scale and geographic points are approximate.

3.6 FAUNA

A total of 104 fauna species have been recorded during the 2018/19 monitoring period. Total fauna species richness recorded in each monitoring year is shown in **Figure 13**. Species recorded in 2018/19 comprised six frog, two reptile, two arboreal mammal, three terrestrial mammal, 12 bat and 79 bird species. Of these, five are listed as Vulnerable and one is listed as Endangered under the NSW BC Act (**Table 6**). Additionally, two species are listed under the Commonwealth EPBC Act. Total fauna species richness in 2018/19 has returned to similar number observed in 2015/16 after slightly fewer numbers of species were noted in 2016/17 and 2017/2018. Differences in recent years appears to be largely driven by the diversity of birds detected year to year.

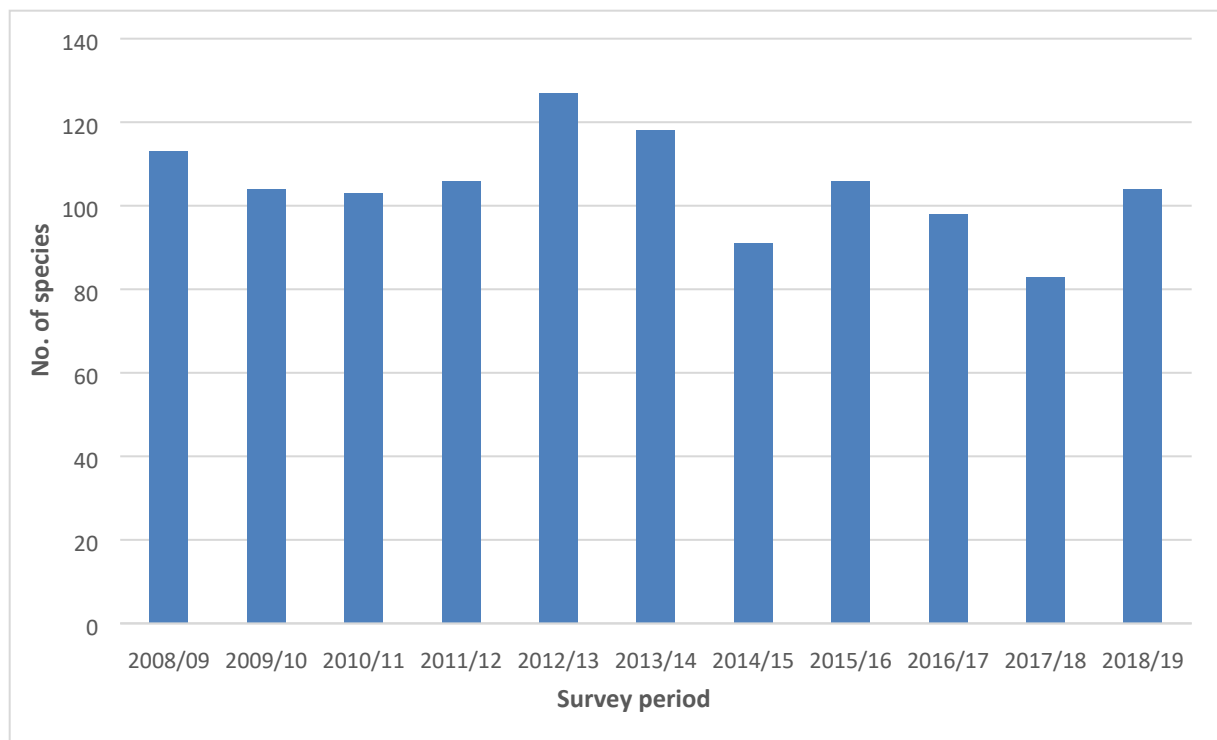


Figure 13: Fauna species richness recorded from 2008/09 to 2018/19.

Table 6: Threatened fauna species recorded in 2018/19

Scientific Name	Common Name	Legal status	Survey Method
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V – BC Act	Anabat recording (probable)
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	V – BC Act	Bird survey
<i>Miniopterus australis</i>	Little Bentwing-bat	V – BC Act	Trapped and Anabat recording (confident)
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V – BC Act / V – EPBC Act	Spotlighting
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E – BC Act / E – EPBC Act	Bird Survey
<i>Glossopsitta pusilla</i>	Little Lorikeet	V – BC Act	Bird Survey

NB: taxonomy for bats follows Churchill (2008). V = vulnerable.

The number of amphibian, reptile, and mammal species detected in each monitoring year is shown in **Figure 14**. The number of mammal and amphibian species recorded each year has remained relatively constant throughout the survey years; however, the number of reptile species detected has been found to fluctuate each year. Two reptile species were recorded in the 2018/19 survey period; Red-bellied Black Snake (*Pseudechis porphyriacus*) and Common Tree Snake (*Dendrelaphis punctulata*). Reptiles are not specifically targeted by the monitoring program.

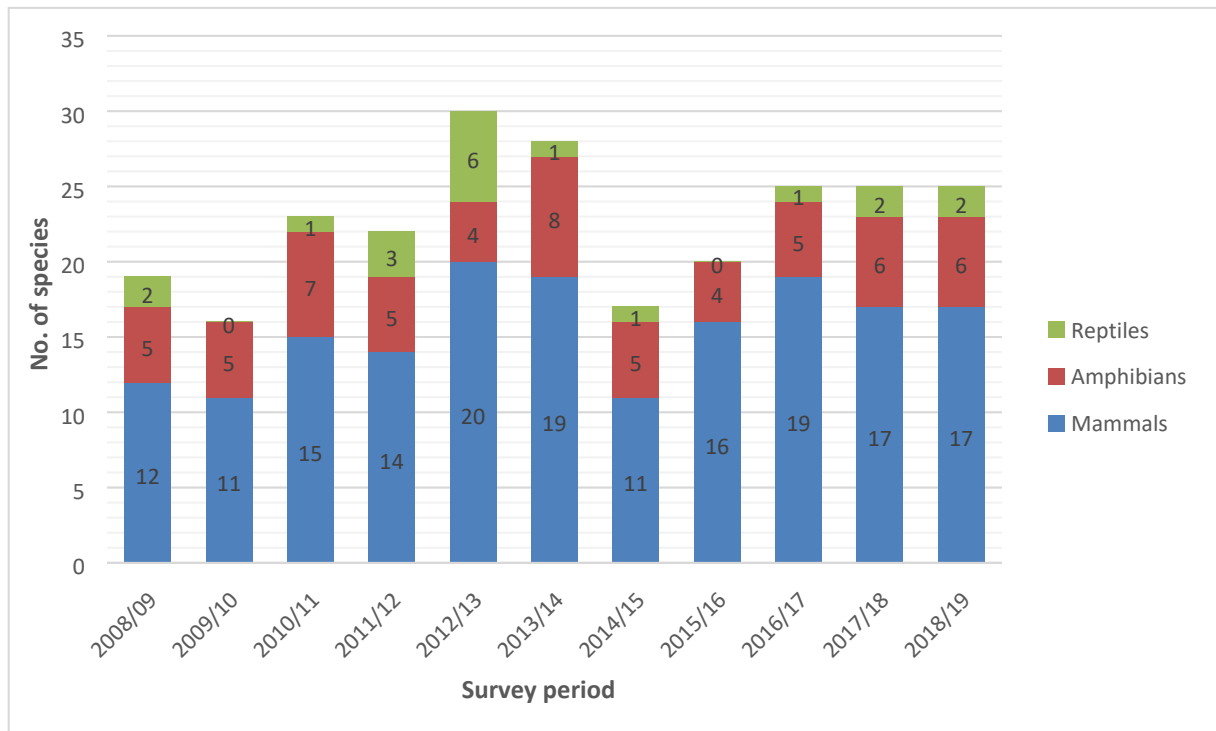


Figure 14: Fauna species richness by taxon from 2008/09 to 2018/19 (excluding birds).

3.6.1 Amphibians

Six species of amphibian were detected during the 2018 surveys. No threatened species were detected; neither were any new species or notable absences detected.

Selected photographs of each water body surveyed for birds and amphibians are provided in **Appendix 8**. Photographs from the Autumn 2012, 2014, 2015, 2017 and 2018 survey periods are provided to enable a visual comparison of the variability of water levels, areas of open water and aquatic vegetation occurring at each of the three water bodies.

3.6.2 Birds

Figure 15 shows changes in bird species richness at each of the five survey locations over time. A total of 79 bird species were recorded during the 2018/19 surveys, which is slightly less the yearly average over the 10 year survey period. The total number of species recorded during each survey period has remained relatively constant, with expected natural fluctuations, over the past 10 years of surveys. Bird numbers appear to rise and fall on a cyclical basis, every 2 years.

Three species not previously detected by Kleinfelder from the study area were detected in 2018/19 which brings the total number of bird species detected over the past 11 years to 137. A Brown Goshawk (*Accipiter fasciatus*) was detected foraging within the southern swamp which then proceeded to perch within the woodland patch. One new threatened species was also detected during surveys, the Australasian Bittern - *Botaurus poiciloptilus* (listed as Endangered under both the BC and EPBC Act) was heard calling at dusk from within emergent vegetation within the northern portion of the Main Swamp (where the road dissects the Main and North Swamps). Detection of an Australasian Bittern is of significance as the species is highly cryptic, hiding amongst dense vegetation and is often missed during targeted searches. Calls of the species are distinct and are described as a deep “ooOOm, ooOOm”. The source of the individual may be from Hexham Swamp which is suspected to be a possible breeding ground.

Australasian Shovelers were once again detected during the 2018/2019 surveys after being periods of absence between 2009 and 2017. A total of 16 Shovelers were observed in the Main Swamp along with 33 Black Swan’s that were recorded during the roosting bird counts.

Twenty-seven species were detected at the North Transect in 2018 which is slightly below the yearly average of 32 species. A decline in species richness at this transect is evident (**Figure 15**) and has been gradually occurring since the Spring 2011 survey. Noticeable absences in the current survey at the North (and South) Transect included spring migrants such as the White-throated Gerygone and Cicadabird, several Cuckoo species, Tawny Grassbird, Pied Currawong and small passerines such as the Variegated Fairy-wren and Yellow Thornbill. Two species not previously detected at the North Transect were recorded in 2018; Brush Cuckoo and Rufous Fantail. A Pheasant Coucal was also observed in 2018 which has not been detected since 2012.

Similarly, slightly less species were observed in the Southern Transect than the yearly average. A total of 24 species were recorded in the Southern Transect which has fluctuated between 36 and 22 species over the past 11 years.

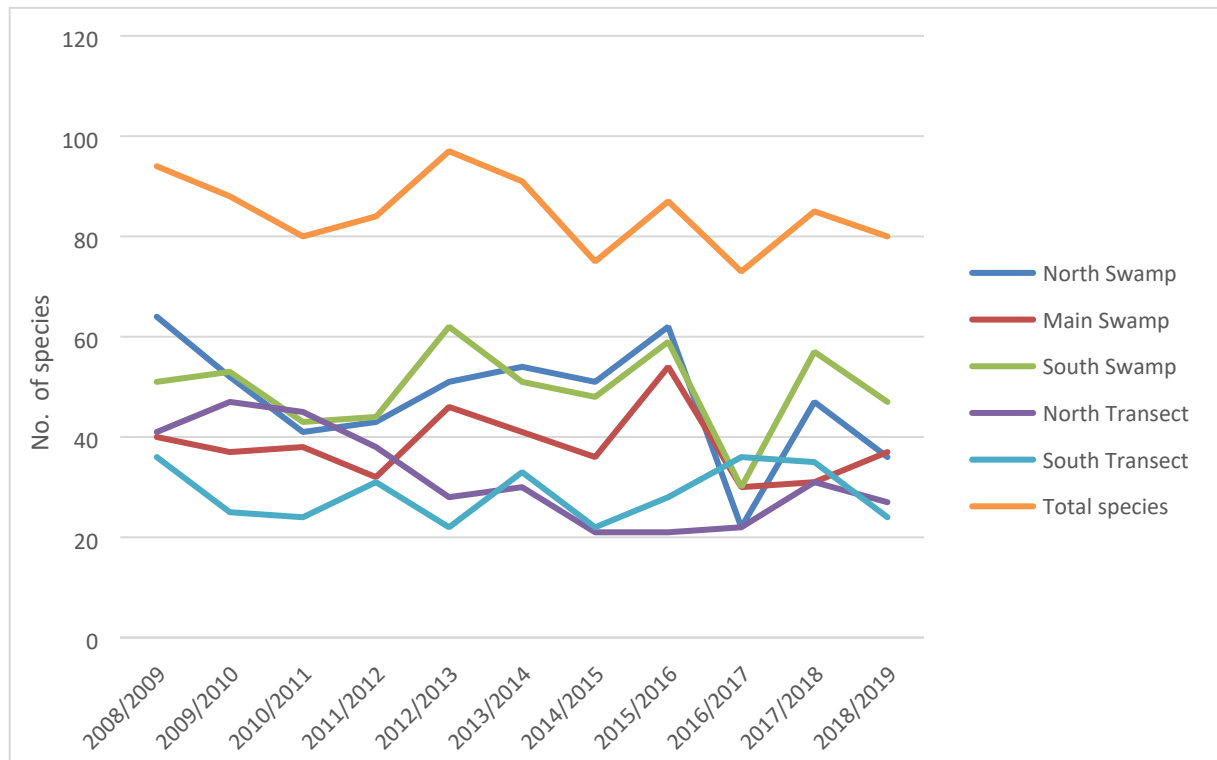


Figure 15: Bird species richness recorded at Pambalong Reserve from 2008 to 2019.

Wetland-specialist species were separated from the total species list for comparison over time. These species were then further separated into waterbirds, (ducks, cormorants and pelicans) and wading birds (ibises, egrets and herons, etc.) to determine if there has been any change in the occurrence of species within these guilds over time. As these groups use different habitat (open deep water versus shallow, vegetated edges), changing conditions at the reserve will affect each group differently.

The number of wetland-specialist bird species recorded during the monitoring events has fluctuated considerably over time (**Figure 16**). A total of 23 wetland-specialist species were detected at the Main Swamp in 2018/19 which is a substantial increase from 9 species detected in 2017/2018. While the waterbody survey location is increasingly becoming overgrown, limiting the field of view, birds that were recorded opportunistically along the northern reaches of the Main Swamp have also been included.

Large numbers of Straw-necked Ibis were detected within the Main Swamp following several years where the species has not been detected. Apart from Ibis, reasonable numbers of Australasian Shovelers and Black Swans were observed on multiple surveys within the Main Swamp. This is the first time Australasian Shovelers have been recorded in the Main Swamp.

The annual number of wetland species within the reserve has remaining relatively stable since the previous year's survey in 2017/2018. While the number of wetland birds detected in the South and North Swamp is lower than the previous year, significantly more species (23) were detected in the North Swamp after only nine species were observed the year previous.



Figure 16: Wetland-specialist bird species recorded at Pambalong Reserve from 2008 to 2019.

The pattern of occurrence of waterbird species that rely on open water for foraging has fluctuated considerably across the three Swamps over the past four years (**Figure 17**). Overall, the number of waterbirds has rebounded to the highest diversity recorded since 2012/2013. Since then, lower than average waterbird species have generally been observed through the three Swamps. In particular, fewer birds have progressively been detected in the North Swamp which is likely to be the result of loss of open water habitat. While the South Swamp is experiencing similar levels of aquatic and riparian weed growth, the number of waterbirds has remained relatively constant. This may be explained by the persistence of an area of open water immediately adjacent to the waterbird survey point. However, closer inspection of the open area of water in the South Swamp during 2018/2019 surveys has revealed that the water level is very low (approximately 30cm) and is being encroached around the periphery by grasses. Loss of open water in future years may result in complete loss of water and wading birds in the South Swamp. Greater numbers of waterbirds and wading birds are being observed

in the northern reaches of the Main Swamp may be due to the loss of open water in the North and South Swamp.

The total number of wading birds at Pambalong has varied over the recent years. Peaks and troughs in diversity appear to occur on alternate years with the 2018/2019 surveys returned slightly less numbers of species than the previous year. Across the three Swamps, the number of wading birds has experienced similar changes throughout the 11 year survey period. In 2017/2018 the greatest difference was observed between numbers of wading birds between Swamps, however, there difference is marginal in 2018/2019.

Lower than average annual rainfall conditions have been experienced throughout much of eastern Australia seaboard, particularly since 2016. This trend has also been observed in the Hunter with lower than average annual rainfall recorded at the closest weather station to Pambalong in 2017 and 2018. Previously during periods of low annual rainfall, greater numbers of species have been generally observed at Pambalong. This is suggested to be the result of inland areas drying up, leading to birds seeking water in coastal regions. In 2018/2019 surveys, reasonable rainfall events were recorded immediately prior to surveys in Nov/Dec 2018 and May 2019 in the lower Hunter. Above average rainfall events during these months may have allowed wetland birds to return to inland regions resulting in fewer birds being detected in the current survey year.

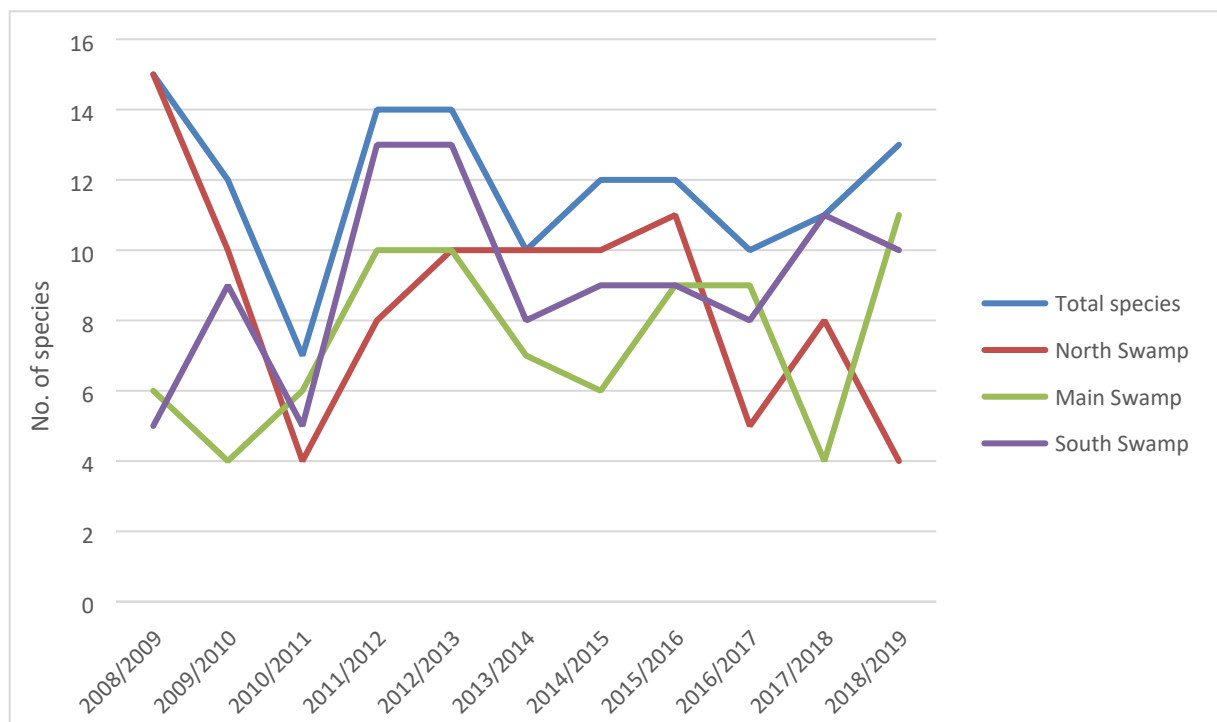


Figure 17: Waterbird species recorded at Pambalong Reserve from 2008 to 2019.

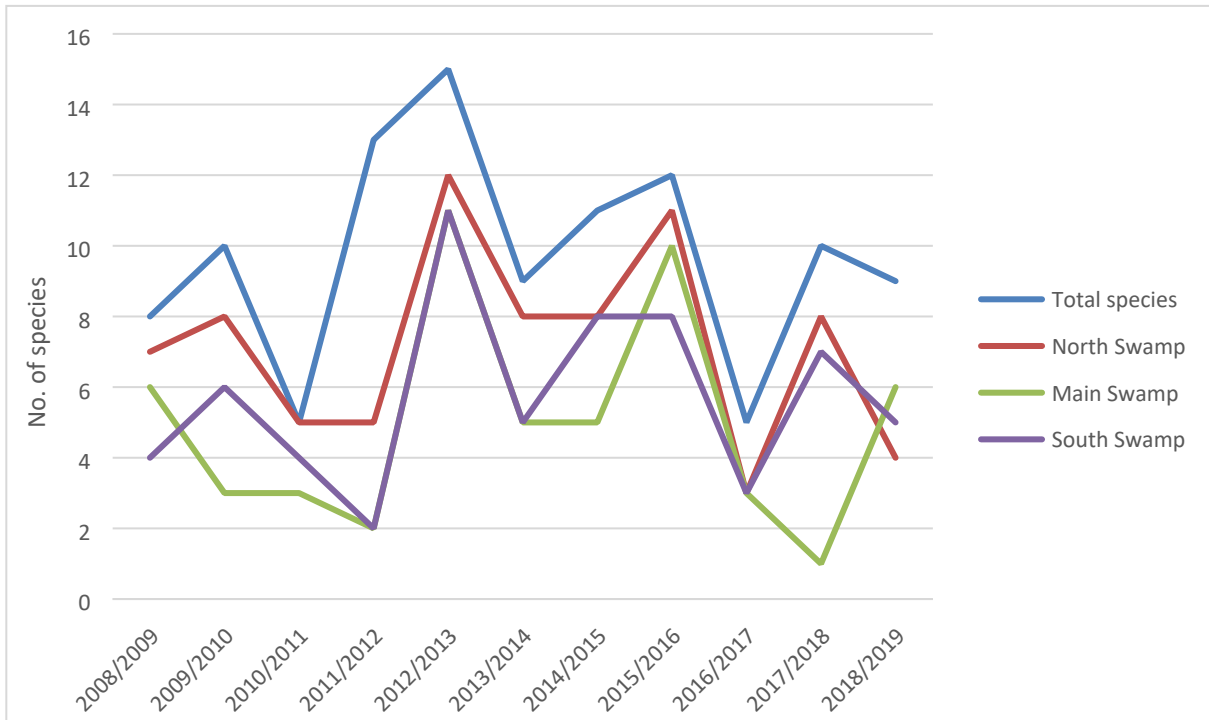


Figure 18: Wading bird species recorded at Pambalong Reserve from 2008 to 2019.

Roosting bird counts have largely reflected the presence of a small number of species that sometimes appear in large numbers. For example, three species (Australian White Ibis, Straw-necked Ibis and Cattle Egret) have contributed 91% of all 2705 individual roosting birds recorded since project initiation in 2008. The highest numbers of roosting birds were observed in 2015 (598 birds), while less than 100 birds have been reported in any survey since to 2015 to 2018. Reasonable numbers of Australian White Ibis (112 birds) were observed in the most recent survey (May 2019) indicating that the stand of Melaleucas and Casuarinas within the Main Swamp are still used as roosting habitats for waterbirds on an intermittent basis.

Other factors likely to affect bird species detection between years include seasonal variations (e.g. arrival times of migratory species), flowering times of foraging resources for nectarivorous species, climatic conditions and individual species ecology (e.g. some species have a large home range and may be absent from the study area during surveys or have cryptic traits which make them more difficult to detect).

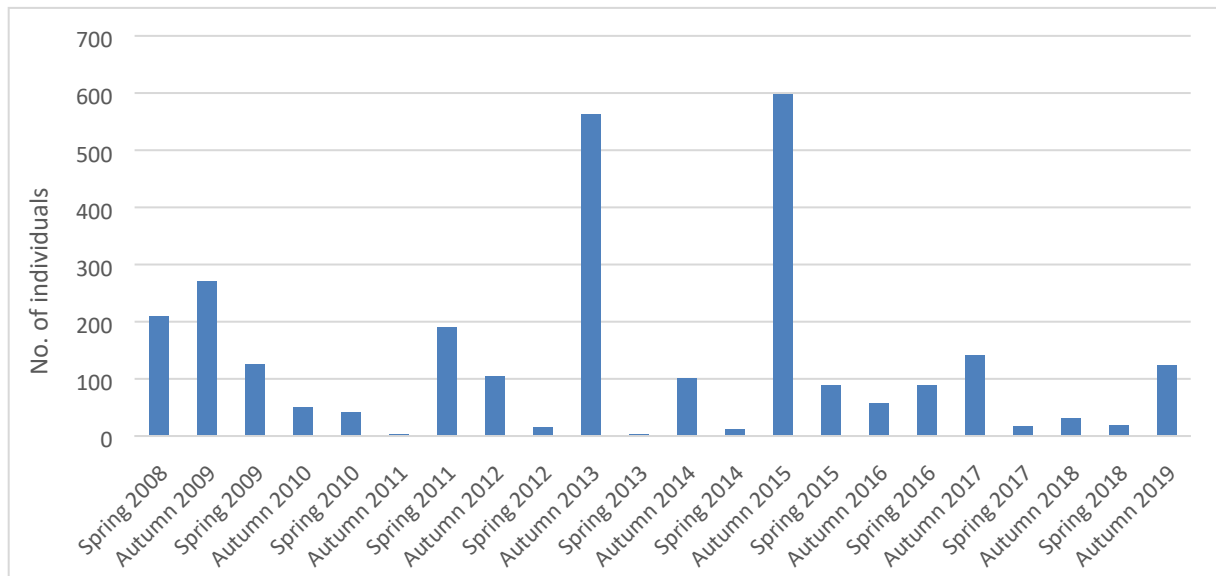


Figure 19: Number of birds recorded roosting in the Melaleuca Swamp Forest of the Main Swamp from 2008 to 2019.

3.6.2.1 Bird Data from Other Sources

Members of the Hunter Bird Observers Club (HBOC) and other similar interest groups make occasional visits to the Reserve. The HBOC was approached for their records of species during the in 2017, however, Kleinfelder was advised that Club records had been provided to Birdlife Australia's database <https://birddata.birdlife.org.au>. A search of records contained within the database from May 2018 to May 2019 returned a total of 99 species. A number of species that were not detected during Kleinfelder surveys within the Reserve include wetland species. These were Hoary-headed Grebe, Black-winged Stilt, Royal Spoonbill in addition to a number of woodland and predatory birds.

3.6.3 Mammals

Two arboreal mammals were detected in 2018/19 (Common Brushtail Possum and Brown Antechinus), both of which have been detected in previous surveys. Three terrestrial mammals were also detected, including two introduced species; European Rabbit (*Oryctolagus cuniculus*), and the Black Rat (*Rattus rattus*) which have been irregularly recorded over the 11 years of annual monitoring.

A total of 12 bat species, including three threatened species, were recorded in 2018/19, which is considered a high diversity for the local area.

The exotic Black Rat has been consistently recorded since 2008/09, with the exception of 2011/12 and 2016/17. This species is known to out-compete native rodent species. This could explain the intermittent detection of native rodents, such as the Swamp Rat, which was only detected in 2013/14 and the Bush Rat, which was detected in 2008/09, and again in 2015/16.

3.6.4 Reptiles

Two reptile species were detected during the 2018 surveys; Red-bellied Black Snake (*Pseudechis porphyriacus*) and the Common Tree Snake (*Dendrelaphis punctulata*). Reptiles are not specifically targeted by the monitoring program.

3.6.5 Introduced Fauna

Introduced species previously recorded in the reserve include: Black Rat, House Mouse, Rabbit, Fox, Wild Dog, Feral Cat, Common Myna, Spotted Dove, Northern Mallard, House Sparrow, Red-whiskered Bulbul and Common Starling (Hunter Bird Observers Club records 1990 – 2008; Straw 2000; White 2000; Kleinfelder 2008 - 2017).

Two introduced fauna species were recorded during the 2018/19 survey period, European Rabbit (*Oryctolagus cuniculus*) and Black Rat (*Rattus rattus*). The ecological condition of the reserve is negatively impacted by the presence of these species and their presence should be monitored and control measures implemented if deemed necessary.

4. CONCLUSION AND RECOMMENDATIONS

Monitoring of the Pambalong Nature Reserve has been undertaken in 2018/19 in accordance with the Flora and Fauna Management Plan for Abel Underground Coalmine (ecobiological 2007).

In total, there were 109 flora species (within the flora survey quadrats and transect) and 98 fauna species comprising six amphibian, two reptile, 17 mammal (12 bat) and 73 bird species recorded in 2018/19. The following threatened species were recorded during field surveys:

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Grey-headed Flying-fox (*Pteropus poliocephalus*);
- Little Bentwing-bat (*Miniopterus australis*); and
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*);

Two feral species were detected in 2018/19:

- European Rabbit (*Oryctolagus cuniculus*);
- Black Rat (*Rattus rattus*).

Control of the aquatic weeds Water Hyacinth and Alligator Weed throughout the reserve is recommended to improve the quality of the habitat for water birds and other native fauna (however, it is acknowledged that continued efforts will unlikely ever eradicate these weeds from the reserve without the cooperation from upstream landholders). Control of terrestrial weeds such as Lantana, Blackberry and Kikuyu should also be undertaken in combination with rubbish removal to make the habitat less suitable for feral fauna species and more suitable for native species.

The 2018/19 survey recorded four new flora species, three of which are native species (*Cheilanthes sieberi* subsp. *sieberi* Mulga Fern, *Desmodium gunnii* Slender Tick-treefoil, *Eremophila debilis* Winter Apple). The fourth new species was the exotic *Myriophyllum aquaticum* (Parrots Feather) at Transect 1, although its cover is still <5% (cover abundance of 2). Flora species richness has remained relatively constant between the monitoring events in Quadrats 1 – 4. Flora species richness at Transect 1 remained the same as in the previous

year's survey. No significant changes to the vegetation community extents were recorded in the 2018 surveys.

Kikuyu grass, blackberry and other weeds continue to cover significant dry areas and any treatment of these areas would require follow up regeneration and rehabilitation. Planting with canopy species such as *Casuarina glauca* (Swamp Oak) or other 'forested wetland' species may provide sufficient shade to prevent reinfestation of these areas once the weeds have been eradicated by herbicidal spray.

In order to maintain the quality and usefulness of data collected on the health of Pambalong Reserve it is recommended that new methods be added where possible to the existing methodology. One evident change in the reserve is the continued encroachment of *Typha orientalis* into areas that were once open water (refer to **Section 3.4.6.1** for details). While *Typha orientalis* is a native species, infestations can interfere with waterflow (restricting access to water by wildlife), reduce water quality and limited establishment of other native emergent vegetation. This encroachment may be due to the lack of water movement throughout the swamps or gradual sedimentation of all swamps (Kathleen Straw, pers. comm.). Bird species, particularly wading species may be a good indicator that this sedimentation is occurring. While the proliferation of *Typha* is simply part of wetland dynamics and changing water levels, if the reserve continues to dry, many species that require areas of open water i.e. ducks, grebes etc. may be forced elsewhere and diversity as a whole will decline. As such, it is recommended that potential annual mapping of aquatic vegetation such as *Typha orientalis* be undertaken and then used in conjunction with data collected by the water quality monitoring station. Such data may provide explanations for changing numbers of waterbird diversity/abundance and need to manage the extent of *Typha* should natural water flows be impeded.

Fauna surveys in 2018/19 recorded 104 species which is marginally below the yearly average ($n = 105$ species). Mammal, amphibian and reptile diversity were similar to recent years. Bird diversity recorded in 2018/2019 was highest observed since 2015/2016. The total diversity of wetland bird species has fallen from the previous year's survey results, however, the trend appears to follow a rise and fall on alternate years. While the diversity of wading and waterbird species within the North and South Swamp are lower than average, diversity within the Main Swamp has increased. Increased in Alligator Weed and *Typha orientalis* within the wetland is clearly reducing open water availability and without targeted management is likely to continue to impact bird diversity.

Annual monitoring in 2018/19 has continued to contribute to a valuable long term data set on the composition, abundance and distribution of flora and fauna within Pambalong Nature Reserve. This information provides a sound basis for evaluating the potential ecological impacts of underground mining which may arise in the future, and the development of appropriate management responses.

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APPENDIX 1. FLORA SPECIES LIST

Table 7: Flora species identified from the 2018 survey

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Acanthaceae	<i>Brunoniella australis</i>	Blue Trumpet	1				
Adiantaceae	<i>Cheilanthes distans</i>	Bristly Cloak Fern	2				
Adiantaceae	<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>	Mulga Fern	2				
Alismataceae	<i>Alisma plantago-aquatica</i>	Water Plantain					
Amaranthaceae	* <i>Alternanthera philoxeroides</i>	Alligator Weed				2	
Amaranthaceae	<i>Alternanthera denticulata</i>	Lesser Joyweed		1	2		
Anthericaceae	<i>Arthropodium milleflorum</i>	Pale Vanilla-lily	2				
Apiaceae	<i>Cyclospermum leptophyllum</i>	Slender Celery		1			
Apiaceae	* <i>Foeniculum vulgare</i>	Fennel					
Apiaceae	* <i>Hydrocotyle bonariensis</i>	Pennywort					
Apiaceae	<i>Centella asiatica</i>	Indian Pennywort					
Apium	<i>Apium prostratum</i>						
Apocynaceae	* <i>Araujia sericifera</i>	Moth Vine					
Apocynaceae	* <i>Gomphocarpus fruticosus</i>	Wild Cotton					
Apocynaceae	<i>Parsonsia straminea</i>	Monkey Rope		1			
Asparagaceae	* <i>Protasparagus aethiopicus</i>	Fern Asparagus					
Asteraceae	* <i>Ageratina adenophora</i>	Crofton Weed		1			
Asteraceae	* <i>Ambrosia psilostachya</i>						
Asteraceae	* <i>Ambrosia tenuifolia</i>	Lacy Ragweed					
Asteraceae	* <i>Aster subulatus</i>	Wild Aster				2	
Asteraceae	* <i>Bidens pilosa</i>	Cobblers peg	2		2		

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Asteraceae	* <i>Cirsium vulgare</i>	Black Thistle			2		
Asteraceae	* <i>Conyza canadensis</i> var. <i>canadensis</i>	Canadian Fleabane					
Asteraceae	* <i>Conyza</i> sp.	Fleabane			2		
Asteraceae	* <i>Conyza sumatrensis</i>	Tall Fleabane					
Asteraceae	* <i>Crassocephalum crepidioides</i>	Thickhead					
Asteraceae	* <i>Euchiton</i> sp.	Cudweed					
Asteraceae	* <i>Hypochaeris radicata</i>	Catsear					
Asteraceae	* <i>Hypochaeris radicata</i>	Catsear					
Asteraceae	* <i>Senecio madagascariensis</i>	Fireweed	1	2	2		
Asteraceae	* <i>Sonchus oleraceus</i>	Milk Thistle		1	2		
Asteraceae	* <i>Tagetes minuta</i>	Stinking Roger					
Asteraceae	<i>Brachycome multifida</i> var. <i>dilatata</i>	Cut-leaf daisy					
Asteraceae	<i>Cotula coronopifolia</i>	Water Buttons					
Asteraceae	<i>Enydra fluctuans</i>					3	
Asteraceae	<i>Euchiton involucratus</i>	Star Cudweed					
Asteraceae	<i>Ozothamnus diosmifolius</i>	White dogwood	1				
Asteraceae	<i>Senecio pterophorus</i>						
Asteraceae	<i>Vernonia cinerea</i> var. <i>cinerea</i>		2				
Asteraceae	<i>Vittadinia cuneata</i> var. <i>cuneata</i>	Fuzzweed	2				
Azollaceae	<i>Azolla filiculoides</i>	Pacific Azolla				2	
Bignoniaceae	<i>Pandorea pandorana</i> subsp. <i>pandorana</i>	Wonga Wonga Vine	2				
Brassica	* <i>Brassica juncea</i>				1		
Campanulaceae	<i>Wahlenbergia gracilis</i>	Native Bluebell					
Caryophyllaceae	* <i>Stellaria media</i>	Chickweed					
Casuarinaceae	<i>Casuarina glauca</i>	Swamp Oak		2		4	
Celastraceae	<i>Denhamia silvestris</i>	Orange Bark	1				
Ceratophyllaceae	<i>Ceratophyllum demersum</i>	Hornwort					
Chenopodiaceae	* <i>Atriplex prostrata</i>	Hastate Orache		1	2		

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Chenopodiaceae	<i>Einadia hastata</i>	Berry Saltbush	1				
Commelinaceae	* <i>Tradescantia albiflora</i>	Wandering Jew					
Commelinaceae	<i>Commelina cyanea</i>		1		2		
Convolvulaceae	* <i>Ipomoea purpurea</i>	Common Morning Glory					
Convolvulaceae	<i>Dichondra repens</i>	Kidney weed	2				
Cyperaceae	* <i>Cyperus difformis</i>						
Cyperaceae	<i>Bolboschoenus caldwellii</i>			3	4	3	
Cyperaceae	<i>Cyperus gracilis</i>	Slender Flat-sedge	2				
Cyperaceae	<i>Cyperus inversa</i>						
Cyperaceae	<i>Cyperus odoratus</i>						
Cyperaceae	<i>Eleocharis acuta</i>	Tall Spike-rush					
Cyperaceae	<i>Eleocharis equisetina</i>			3	3		2
Cyperaceae	<i>Eleocharis sphacelata</i>	Tall Spike-rush					2
Cyperaceae	<i>Fimbristylis dichotoma</i>	Common Fringe-sedge					
Cyperaceae	<i>Schoenoplectus subulatus</i>			5		2	1
Cyperaceae	<i>Schoenoplectus validus</i>			2			
Euphorbiaceae	* <i>Ricinus communis</i>	Castor Oil Plant					
Fabaceae - Caesalpinioideae	* <i>Senna pendula</i> subsp. <i>glabrata</i>	Cassia		1			
Fabaceae - Faboideae	* <i>Trifolium dubium</i>	Yellow Suckling Clover					
Fabaceae - Faboideae	* <i>Trifolium fragiferum</i>	Strawberry Clover					
Fabaceae - Faboideae	* <i>Trifolium repens</i>	White Clover					
Fabaceae - Faboideae	* <i>Vicia sativa</i>	Common Vetch		2			
Fabaceae - Faboideae	<i>Daviesia ulicifolia</i>	Gorse Bitter Pea	3				
Fabaceae - Faboideae	<i>Desmodium gunnii</i>	Slender Tick-trefoil	1				
Fabaceae - Faboideae	<i>Desmodium rhytidophyllum</i>	Tick-trefoil					
Fabaceae - Faboideae	<i>Desmodium varians</i>	Slender Tick-trefoil	1				
Fabaceae - Faboideae	<i>Glycine clandestina</i>	Twining Glycine	1				

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Fabaceae - Faboideae	<i>Glycine tabacina</i>						
Fabaceae - Faboideae	<i>Hardenbergia violacea</i>	Purple Twining Pea	1				
Fabaceae - Faboideae	<i>Kennedia rubicunda</i>	Red Kennedy Pea					
Fabaceae - Mimosoideae	<i>Acacia falcata</i>	Sickle Wattle					
Fabaceae - Mimosoideae	<i>Acacia fimbriata</i>						
Fabaceae - Mimosoideae	<i>Acacia implexa</i>	Hickory					
Fabaceae - Mimosoideae	<i>Acacia irrorata subsp irrorata</i>						
Fabaceae - Mimosoideae	<i>Acacia maidenii</i>	Maidens Wattle	3				
Gentianaceae	* <i>Centaurium erythraea</i>	Common Centaury					
Goodeniaceae	<i>Goodenia heterophylla</i>						
Haloragaceae	* <i>Myriophyllum aquaticum</i>	Parrots Feather					2
Haloragaceae	<i>Myriophyllum variifolium</i>						
Iridaceae	* <i>Freesia laxa</i>						
Juncaceae	<i>Juncus continuus</i>						
Juncaceae	<i>Juncus pallidus</i>	Pale Rush					
Juncaceae	<i>Juncus usitatus</i>	Common Juncus	2	2		1	
Juncaginaceae	<i>Triglochin procerum</i>					2	
Juncaginaceae	<i>Triglochin striata</i>	Streaked Arrowgrass					
Lamiaceae	<i>Plectranthus parviflorus</i>	Cockspur Flower	2				
Lemnaceae	<i>Lemna disperma</i>						
Lemnaceae	<i>Spirodela punctata</i>	Duck Weed				3	
Lobeliaceae	<i>Pratia purpurascens</i>	White root	2				
Lomandraceae	<i>Lomandra filiformis</i>	Wattle Matt Rush	1				
Lomandraceae	<i>Lomandra glauca</i>	Pale Mat-rush					
Lomandraceae	<i>Lomandra multiflora subsp. multiflora</i>	Iron Grass	2				
Loranthaceae	<i>Dendrophthoe vitellina</i>	Mistletoe	1				
Luzuriagaceae	<i>Eustrephus latifolius</i>	Wombat Berry	2				
Luzuriagaceae	<i>Geitonoplesium cymosum</i>	Scrambling Lily	2				

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Malvaceae	<i>*Sida rhombifolia</i>	Paddy's Lucerne	2				
Menispermaceae	<i>Stephania japonica</i> var. <i>discolor</i>	Snake Vine	2				
Moraceae	<i>Ficus macrophylla</i>	Moreton Bay Fig			1		
Myoporaceae	<i>Eremophila debilis</i>	Winter Apple	1				
Myrsinaceae	<i>Myrsine variabilis</i>		2				
Myrtaceae	<i>Corymbia maculata</i>	Spotted Gum	4				
Myrtaceae	<i>Eucalyptus acmenoides</i>	White mahogany	1				
Myrtaceae	<i>Eucalyptus siderophloia</i>	Grey Ironbark	4				
Myrtaceae	<i>Eucalyptus tereticornis</i>	Forest Redgum					
Myrtaceae	<i>Melaleuca ericifolia</i>				3	3	
Myrtaceae	<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark			4	4	
Myrtaceae	<i>Melaleuca styphelioides</i>				4		
Oleaceae	<i>Notelaea longifolia</i>	Mock olive	3				
Onagraceae	<i>*Oenothera stricta</i>	Evening Primrose					
Onagraceae	<i>Epilobium billardierianum</i> subsp. <i>billardierianum</i>						
Onagraceae	<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>	Water Primrose				2	
Orchidaceae	<i>Dendrobium linguiforme</i>	Tongue Orchid					
Orchidaceae	<i>Dendrobium teretifolium</i>	Rat's Tail Orchid					
Oxalidaceae	<i>Oxalis perennans</i>		2				
Passifloraceae	<i>*Passiflora edulis</i>	Common Passionfruit					
Phormiaceae	<i>Dianella caerulea</i>	Blue Flax-lily	3				
Phormiaceae	<i>Dianella revoluta</i> var. <i>revoluta</i>	Blueberry Lily	2				
Phyllanthaceae	<i>Breynia oblongifolia</i>	Coffee Bush	3				
Phyllanthaceae	<i>Phyllanthus hirtellus</i>	Thyme Spurge	2				
Phytolaccaceae	<i>*Phytolacca octandra</i>	Inkweed			2		
Pittosporaceae	<i>Bursaria spinosa</i>	Box Thorn	3				
Pittosporaceae	<i>Pittosporum multiflorum</i>	Orange Thorn	1				
Pittosporaceae	<i>Pittosporum revolutum</i>	Wild Yellow Jasmine	2				

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Plantaginaceae	* <i>Plantago lanceolata</i>	Lambs Tongue					
Plantaginaceae	<i>Veronica plebeia</i>	Trailing Speedwell					
Poaceae	* <i>Andropogon virginicus</i>	Whisky Grass					
Poaceae	* <i>Axonopus fissifolius</i>	Narrow-leafed Carpet Grass					
Poaceae	* <i>Briza maxima</i>	Quaking Grass					
Poaceae	* <i>Bromus catharticus</i>	Prairie Grass			2		
Poaceae	* <i>Cenchrus clandestinus</i>	Kikuyu		3			
Poaceae	* <i>Chloris gayana</i>	Rhodes Grass					
Poaceae	* <i>Cortaderia selloana</i>	Pampas Grass					
Poaceae	* <i>Ehrharta erecta</i>	Panic Veldtgrass	2				
Poaceae	* <i>Eragrostis curvula</i>	African Lovegrass					
Poaceae	* <i>Hyparrhenia hirta</i>	Coolatai Grass					
Poaceae	* <i>Lolium perenne</i>	Perennial Ryegrass					
Poaceae	* <i>Melinis repens</i>	Red Natal Grass					
Poaceae	* <i>Panicum maximum</i>	Guinea Grass					
Poaceae	* <i>Paspalum dilatatum</i>	Paspalum					
Poaceae	* <i>Paspalum urvillei</i>	Tall Paspalum					
Poaceae	* <i>Polypogon monspeliensis</i>	Annual Beardgrass					
Poaceae	* <i>Setaria pumila</i>	Pale Pigeon Grass					
Poaceae	* <i>Setaria sphacelata</i>	South African Pigeon Grass					
Poaceae	* <i>Setaria verticillata</i>	Whorled Pigeon Grass					
Poaceae	* <i>Sporobolus africanus</i>	Parramatta Grass					
Poaceae	<i>Aristida ramosa</i>	Three-awned Spear Grass					
Poaceae	<i>Aristida vagans</i>	Three-awned Spear Grass	4				
Poaceae	<i>Austrostipa</i> sp.	Speargrass	2				
Poaceae	<i>Austrostipa</i> spp	Speargrass	2				
Poaceae	<i>Capillipedium parviflorum</i>	Scented-top Grass					
Poaceae	<i>Cymbopogon refractus</i>	Barbed Wire Grass	2				

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Poaceae	<i>Cynodon dactylon</i>	Couch	2	4	3		2
Poaceae	<i>Dichelachne micrantha</i>	Shorthair Plumegrass	2				
Poaceae	<i>Digitaria ramularis</i>						
Poaceae	<i>Digitaria parviflora</i>	Small-flowered Finger Grass	2				
Poaceae	<i>Echinopogon caespitosus</i>	Tufted Hedgehog Grass					
Poaceae	<i>Entolasia stricta</i>	Wiry panic	4				
Poaceae	<i>Imperata cylindrica</i>	Bladey grass	2				
Poaceae	<i>Lachnagrostis filiformis</i>				3		
Poaceae	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass	2				
Poaceae	<i>Opismenus aemulus</i>	Basket Grass					
Poaceae	<i>Panicum simile</i>	Two Colour Panic					
Poaceae	<i>Paspalidium distans</i>		2				
Poaceae	<i>Paspalum dilatatum</i>	Paspalum	2				
Poaceae	<i>Paspalum distichum</i>	Water Couch				2	2
Poaceae	<i>Rytidosperma tenuius</i>	Wallaby Grass	2				
Poaceae	<i>Sporobolus creber</i>	Western Rat-tail Grass					
Poaceae	<i>Themeda triandra</i>	Kangaroo grass	5				
Polygonaceae	* <i>Polygonum arenastrum</i>	Wireweed					
Polygonaceae	* <i>Rumex conglomeratus</i>	Clustered Dock		2	2		
Polygonaceae	* <i>Rumex crispus</i>	Dock			2		
Polygonaceae	<i>Persicaria attenuata</i> subsp. <i>attenuata</i>					2	
Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed		1			2
Polygonaceae	<i>Persicaria hydropiper</i>	Water Pepper					
Pontederiaceae	* <i>Eichhornia crassipes</i>	Water Hyacinth					2
Ranunculaceae	* <i>Ranunculus plebeius</i>	Creeping Buttercup					
Ranunculaceae	<i>Clematis glycinoides</i>	Old Mans Beard					
Ranunculaceae	<i>Ranunculus inundatus</i>	River Buttercup		2			
Rhamnaceae	<i>Alphitonia excelsa</i>	Red Ash	1				

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Rhamnaceae	<i>Polyscias sambucifolia</i>	Elderberry Panax	1				
Rosaceae	* <i>Rubus fruticosus sp.agg</i>	Blackberry					
Rubiaceae	<i>Opercularia diphylia</i>		1				
Scrophulariaceae	<i>Bacopa monnieri</i>	Bacopa					
Solanaceae	* <i>Solanum mauritianum</i>	Wild Tobacco					
Solanaceae	* <i>Solanum nigrum</i>	Blackberry Nightshade		1	2		
Solanaceae	<i>Solanum brownii</i>	Violet Nightshade	3				
Solanaceae	<i>Solanum prinophyllum</i>	Forest Nightshade					
Typhaceae	<i>Typha orientalis</i>	Broadleaf Cumbungi		6	2	3	
Verbenaceae	* <i>Lantana camara</i>	Lantana	3	1			
Verbenaceae	* <i>Verbena bonariensis</i>	Purpletop		2			
Violaceae	<i>Viola hederacea</i>	Ivy-leaved Violet	2				
Vitaceae	<i>Cayratia clematidea</i>	Native Grape	1				
Total Species			61	24	23	16	8
Exotic			15	14	11	7	3
Native			46	10	12	9	5

* denotes an introduced species

APPENDIX 2. FAUNA SPECIES LISTS (EXCLUDING BIRDS)

Scientific Name	Common Name	White (2000)	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Amphibians													
<i>Crinia signifera</i>	Common Eastern Froglet		+		+	+	+	+	+		+	+	+
<i>Limnodynastes peronii</i>	Striped Marsh Frog		+	+	+	+	+	+		+	+	+	+
<i>Limnodynastes tasmaniensis</i>	Spotted Marsh Frog							+	+			+	+
<i>Litoria fallax</i>	Eastern Dwarf Tree Frog		+	+	+	+	+	+	+	+	+	+	+
<i>Litoria freycineti</i>	Freycinet's Frog	+											
<i>Litoria latopalmata</i>	Broad-palmed Frog	+			+			+					
<i>Litoria peronii</i>	Peron's Tree Frog		+	+	+	+		+	+	+	+	+	+
<i>Litoria tyleri</i>	Southern Laughing Tree Frog		+	+	+	+	+	+	+	+	+	+	+
<i>Litoria verreauxii</i>	Verreaux's Tree Frog			+				+					
<i>Uperoleia laevis</i>	Smooth Toadlet				+								
Total		2	5	5	7	5	4	8	5	4	5	6	6

Scientific Name	Common Name	White (2000)	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Reptiles													
<i>Amphibolurus muricatus</i>	Jacky Lizard	+					+						
<i>Chelodina longicollis</i>	Eastern Long-necked Turtle	+				+		+					
<i>Ctenotus robustus</i>	Robust Ctenotus	+											
<i>Dendrelaphis punctulata</i>	Common Tree Snake												+
<i>Eulamprus quoyii</i>	Eastern Water Skink	+											
<i>Hemiaspis signata</i>	Marsh Snake										+		
<i>Lampropholis delicata</i>	Garden Skink	+					+						
<i>Physignathus lesueurii</i> <i>lesueurii</i>	Eastern Water Dragon		+				+						
<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake	+	+		+	+	+					+	+
<i>Pseudonaja textilis</i>	Eastern Brown Snake					+	+						
<i>Tiliqua scincoides</i>	Eastern Blue-tongued Lizard						+						
<i>Varanus varius</i>	Lace Monitor								+				
Total		6	2	0	1	3	6	1	1	0	1	1	2

Scientific Name	Common Name	White (2000)	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Non-flying Mammals													
<i>Acrobates pygmaeus</i>	Feathertail Glider								+				
<i>Antechinus stuartii</i>	Brown Antechinus	+	+		+	+			+				+
<i>Petaurus breviceps</i>	Sugar Glider	+						+	+		+		
<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum							+			+		
<i>Trichosurus vulpecula</i>	Common Brushtail Possum						+	+	+		+		+
<i>Canis lupus</i>	*Wild Dog						+				+		
<i>Felis catus</i>	*Domestic Cat				+								
<i>Wallabia bicolor</i>	Swamp Wallaby						+				+		
<i>Mus domesticus</i>	*House Mouse		+	+									
<i>Oryctolagus cuniculus</i>	*European Rabbit									+			+
<i>Rattus fuscipes</i>	Bush Rat		+							+			
<i>Rattus lutreolus</i>	Swamp Rat							+					
<i>Rattus rattus</i>	*Black Rat	+	+	+	+		+	+	+	+		+	+
<i>Tachyglossus aculeatus</i>	Short-beaked Echidna											+	+
<i>Vulpes vulpes</i>	*Red Fox	+				+	+	+			+	+	
Total Non-flying Mammals		4	4	2	3	2	5	6	5	3	6	3	5

* denotes an introduced species

Scientific Name	Common Name	White (2000)	2008 /09	2009 /10	2010 /11	2011 /12	2012 /13	2013 /14	2014 /15	2015 /16	2016 /17	2017 /18	2018 /19
Bats													
<i>Chalinolobus dwyeri</i>	# Large-eared Pied Bat										+		
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	+	+	+	+	+	+	+	+	+	+	+	+
<i>Chalinolobus morio</i>	Chocolate Wattled Bat			+	+		+	+	+	+		+	+
<i>Falsistrellus tasmaniensis</i>	# Eastern False Pipistrelle		+		+	+		+		+		+	+
<i>Miniopterus australis</i>	# Little Bentwing-bat	+	+	+	+	+	+	+		+	+	+	+
<i>Miniopterus schreibersii oceanensis</i>	# Eastern Bentwing-bat	+	+			+	+	+		+	+	+	
<i>Mormopterus norfolkensis</i>	# East-coast Freetail-bat	+	+	+		+	+	+		+	+	+	
<i>Mormopterus ridei</i>	Eastern Freetail-bat	+			+	+	+	+		+	+		+
<i>Myotis macropus</i>	# Southern Myotis					+	+			+	+		
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat					+	+	+		+	+	+	+
<i>Nyctophilus gouldii</i>	Gould's Long-eared Bat								+				
<i>Nyctophilus sp.</i>	Unidentified Long-eared Bat	+		+	+	+	+	+					+
<i>Pteropus sp.</i>	Flying-fox						+						
<i>Pteropus poliocephalus</i>	# Grey-headed Flying-fox	+	+					+	+		+		+
<i>Rhinolopus megaphyllus</i>	Eastern Horseshoe-bat				+					+		+	+
<i>Saccolaimus flaviventris</i>	# Yellow-bellied Sheath-tail-bat			+								+	
<i>Scoteanax rueppellii</i>	# Greater Broad-nosed Bat	+					+			+			
<i>Scotorepens orion</i>	Eastern Broad-nosed Bat			+	+		+				+	+	+
<i>Tadarida australis</i>	White-striped Mastiff-bat				+	+	+	+	+		+		+
<i>Vespadelus darlingtoni</i>	Large Forest Bat									+			
<i>Vespadelus pumilus</i>	Eastern Forest Bat	+	+	+	+		+						
<i>Vespadelus regulus</i>	Southern Forest Bat										+		
<i>Vespadelus troughtoni</i>	# Eastern Cave Bat				+	+		+					
<i>Vespadelus vulturnus</i>	Little Forest Bat	+	+	+	+	+	+	+	+	+	+	+	+
Total Bats		10	8	9	12	12	15	13	6	13	13	11	12

* denotes an introduced species; # denotes a threatened species under the NSW BC Act 2016 and/or the Commonwealth EPBC Act 1999; NB: Taxonomy for bats follows Churchill (2008).

APPENDIX 3. BIRD SPECIES LIST - TRANSECTS

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring 2013		Spring 2014		Spring 2015		Spring 2016		Spring 2017		Spring 2018	
			North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Acanthizidae	<i>Acanthiza lineata</i>	Striated Thornbill			+		+						+	+			+							
Acanthizidae	<i>Acanthiza nana</i>	Yellow Thornbill		+	+	+	+								+		+						+	+
Acanthizidae	<i>Acanthiza pusilla</i>	Brown Thornbill			+		+								+		+			+			+	
Acanthizidae	<i>Gerygone mouki</i>	Brown Gerygone	+		+		+	+	+	+	+				+		+		+	+	+			
Acanthizidae	<i>Gerygone olivacea</i>	White-throated Gerygone	+	+	+	+		+		+	+			+										
Acanthizidae	<i>Sericornis frontalis</i>	White-browed Scrubwren	+		+		+		+		+			+	+				+	+	+		+	
Accipitridae	<i>Accipiter novaehollandiae</i>	Grey Goshawk																	+					
Accipitridae	<i>Aquila audax</i>	Wedge-tailed Eagle	+	+										+										
Accipitridae	<i>Aviceda subcristata</i>	Pacific Baza	+	+	+	+	+				+		+	+						+				
Accipitridae	<i>Circus approximans</i>	Swamp Harrier			+		+							+			+							
Accipitridae	<i>Elanus axillaris</i>	Black-shouldered Kite																			+			
Accipitridae	<i>Haliastur spheonurus</i>	Whistling Kite			+		+											+	+	+				
Acrocephalidae	<i>Acrocephalus australis</i>	Australian Reed-Warbler			+		+		+	+	+	+			+		+						+	
Anatidae	<i>Anas superciljosa</i>	Pacific Black Duck	+		+		+		+															

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring 2013		Spring 2014		Spring 2015		Spring 2016		Spring 2017		Spring 2018	
			North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Apodidae	<i>Hirundapus caudacutus</i>	White-throated Needletail												+								+		
Ardeidae	<i>Ardea ibis</i>	Cattle Egret	+										+	+							+			
Ardeidae	<i>Egretta novaehollandiae</i>	White-faced Heron	+																			+		
Artamidae	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	+	+	+	+	+	+	+	+		+	+				+				+			
Artamidae	<i>Cracticus nigrogularis</i>	Pied Butcherbird	+												+				+		+		+	
Artamidae	<i>Cracticus tibicen</i>	Australian Magpie									+		+			+		+		+	+	+	+	
Artamidae	<i>Cracticus torquatus</i>	Grey Butcherbird	+	+	+	+	+		+	+		+	+			+								
Artamidae	<i>Strepera graculina</i>	Pied Currawong	+	+	+		+		+	+	+	+		+										
Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo								+		+	+	+				+		+		+		
Cacatuidae	<i>Cacatua sanguinea</i>	Little Corella	+		+												+							
Cacatuidae	<i>Eolophus roseicapillus</i>	Galah																	+					+
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	+	+	+	+	+	+	+	+	+				+	+	+	+	+	+	+	+	+	+
Campephagidae	<i>Coracina tenuirostris</i>	Cicadabird	+		+	+	+	+	+	+	+													
Charadriidae	<i>Vanellus miles</i>	Masked Lapwing			+		+		+								+	+		+				
Cisticolidae	<i>Cisticola exilis</i>	Golden-headed Cisticola								+		+			+									
Columbidae	<i>Geopelia humeralis</i>	Bar-shouldered Dove											+					+	+		+	+		
Columbidae	<i>Leucosarcia picata</i>	Wonga Pigeon	+		+														+					
Columbidae	<i>Lopholaimus antarcticus</i>	Topknot Pigeon																+						

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring 2013		Spring 2014		Spring 2015		Spring 2016		Spring 2017		Spring 2018	
			North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon		+				+		+														
Columbidae	<i>Phaps chalcoptera</i>	Common Bronzewing																			+			
Coraciidae	<i>Eurystomus orientalis</i>	Dollarbird			+		+		+		+		+		+		+		+		+	+		
Corvidae	<i>Corvus coronoides</i>	Australian Raven		+											+				+	+	+	+		
Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo			+		+		+				+						+				+	
Cuculidae	<i>Cacomantis variolosus</i>	Brush Cuckoo		+									+										+	
Cuculidae	<i>Centropus phasianinus</i>	Pheasant Coucal	+	+	+	+	+	+	+	+		+											+	
Cuculidae	<i>Chalcites basalis</i>	Horsfield's Bronze-Cuckoo	+	+	+		+	+		+														
Cuculidae	<i>Chalcites lucidus</i>	Shining Bronze-Cuckoo	+	+	+	+	+	+	+	+	+	+			+									
Cuculidae	<i>Eudynamis orientalis</i>	Eastern Koel	+	+	+	+	+		+		+			+							+			+
Cuculidae	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo	+	+	+	+	+	+	+	+		+	+				+	+		+	+	+		
Estrildidae	<i>Neochmia temporalis</i>	Red-browed Finch			+		+					+	+	+		+	+			+	+	+		
Estrildidae	<i>Taeniopygia bichenovii</i>	Double-barred Finch		+					+		+													
Falconidae	<i>Falco peregrinus</i>	Peregrine Falcon																			+			
Halcyonidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	+	+	+	+	+	+	+		+						+				+	+		+
Halcyonidae	<i>Todiramphus sanctus</i>	Sacred Kingfisher		+			+		+					+	+	+	+	+		+	+	+	+	+
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow	+	+	+		+						+	+				+						
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren													+	+	+	+	+	+	+	+	+	+

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring 2013		Spring 2014		Spring 2015		Spring 2016		Spring 2017		Spring 2018	
			North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Maluridae	<i>Malurus lamberti</i>	Variegated Fairy-wren	+		+	+	+	+		+						+	+		+				+	+
Megaluridae	<i>Megalurus gramineus</i>	Little Grassbird					+		+				+											
Megaluridae	<i>Megalurus timoriensis</i>	Tawny Grassbird	+	+	+	+	+	+	+	+			+	+					+				+	
Meliphagidae	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill							+		+						+		+	+				
Meliphagidae	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	+						+		+	+			+	+		+	+	+	+	+		+
Meliphagidae	<i>Manorina melanocephala</i>	Noisy Miner	+	+	+	+			+		+		+	+		+		+						+
Meliphagidae	<i>Manorina melanophrys</i>	Bell Miner											+		+		+	+	+	+		+		+
Meliphagidae	<i>Meliphaga lewinii</i>	Lewin's Honeyeater	+		+		+	+	+	+	+	+				+	+		+	+	+	+	+	+
Meliphagidae	<i>Melithreptus brevirostris</i>	Brown-headed Honeyeater	+	+	+	+	+	+	+	+	+	+	+											
Meliphagidae	<i>Melithreptus lunatus</i>	White-naped Honeyeater									+		+	+					+		+		+	
Meliphagidae	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater												+	+	+	+	+		+	+	+		
Meliphagidae	<i>Philemon corniculatus</i>	Noisy Friarbird	+	+	+	+	+	+	+	+	+	+	+	+				+				+		
Meliphagidae	<i>Phylidonyris niger</i>	White-cheeked Honeyeater												+					+		+			
Meliphagidae	<i>Plectorhyncha lanceolata</i>	Striped Honeyeater												+										
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater		+		+		+	+	+	+													
Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-lark	+	+	+	+	+	+	+	+	+	+	+	+					+			+	+	+
Monarchidae	<i>Monarcha melanopsis</i>	Black-faced Monarch											+											
Monarchidae	<i>Myiagra rubecula</i>	Leaden Flycatcher																	+					

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring 2013		Spring 2014		Spring 2015		Spring 2016		Spring 2017		Spring 2018	
			North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Nectariniidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird							+		+		+	+		+						+		
Neosittidae	<i>Daphoenositta chrysoptera</i>	# Varied Sittella	+	+	+	+	+	+		+		+	+	+				+				+		
Oriolidae	<i>Oriolus sagittatus</i>	Olive-backed Oriole	+	+	+	+	+		+		+				+	+					+	+		+
Oriolidae	<i>Sphecotheres vieilloti</i>	Australasian Figbird	+		+		+		+		+													
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Shrike-thrush	+	+	+		+		+					+								+		
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler	+		+		+	+		+					+	+					+	+	+	+
Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler												+	+	+	+	+	+	+	+	+	+	+
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote	+		+		+		+				+	+										
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin	+	+			+		+		+				+		+		+		+			
Phasianidae	<i>Coturnix ypsilophora</i>	Brown Quail																	+					
Psittacidae	<i>Alisterus scapularis</i>	Australian King-Parrot																	+		+		+	
Psittacidae	<i>Glossopsitta pusilla</i>	# Little Lorikeet																	+					+
Psittacidae	<i>Platycercus eximius</i>	Eastern Rosella	+	+	+		+		+	+	+	+	+		+	+		+		+		+	+	+
Psittacidae	<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted Lorikeet																	+			+		
Psittacidae	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet		+	+	+	+	+	+	+		+	+	+		+		+	+	+		+		+
Psophodidae	<i>Psophodes olivaceus</i>	Eastern Whipbird					+	+	+	+		+	+		+	+	+	+	+	+	+	+	+	+
Ptilonorhynchidae	<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird		+		+		+		+		+							+		+	+	+	
Ptilonorhynchidae	<i>Sericulus chrysocephalus</i>	Regent Bowerbird																						+

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring 2013		Spring 2014		Spring 2015		Spring 2016		Spring 2017		Spring 2018	
			North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South	North	South
Rallidae	<i>Porphyrio porphyrio</i>	Purple Swampphen											+	+			+					+		
Rhipiduridae	<i>Rhipidura albiscapa</i>	Grey Fantail	+	+	+	+								+	+	+	+	+	+	+	+	+	+	+
Rhipiduridae	<i>Rhipidura leucophrys</i>	Willie Wagtail			+		+									+		+		+	+	+		
Rhipiduridae	<i>Rhipidura rufifrons</i>	Rufous Fantail		+																			+	
Strigidae	<i>Ninox strenua</i>	# Powerful Owl																+						
Sturnidae	<i>Sturnus tristis</i>	*Common Myna																						
Sturnidae	<i>Sturnus vulgaris</i>	*Common Starling	+		+		+		+		+		+	+										
Threskiornithidae	<i>Threskiornis spinicollis</i>	Straw-necked Ibis																						
Timaliidae	<i>Zosterops lateralis</i>	Silvereye		+		+			+	+	+	+			+		+		+	+	+	+	+	
TOTALS			41	36	47	25	45	24	38	31	28	22	30	33	21	22	21	28	22	36	31	35	27	24

* denotes an introduced species; # denotes a threatened species under the NSW BC Act 2016 and/or the Commonwealth EPBC Act 1999.

APPENDIX 4. BIRD SPECIES LIST – NORTH SWAMP

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Acanthizidae	<i>Acanthiza lineata</i>	Striated Thornbill							+				
Acanthizidae	<i>Acanthiza nana</i>	Yellow Thornbill	+			+	+	+	+	+			
Acanthizidae	<i>Acanthiza pusilla</i>	Brown Thornbill				+		+	+	+			+
Acanthizidae	<i>Sericornis frontalis</i>	White-browed Scrubwren	+	+	+	+	+	+		+		+	+
Accipitridae	<i>Accipiter novaehollandiae</i>	Grey Goshawk											+
Accipitridae	<i>Aquila audax</i>	Wedge-tailed Eagle	+			+	+	+				+	
Accipitridae	<i>Circus approximans</i>	Swamp Harrier	+	+	+	+		+		+		+	
Accipitridae	<i>Elanus axillaris</i>	Black-shouldered Kite						+				+	
Accipitridae	<i>Haliaeetus leucogaster</i>	# White-bellied Sea-Eagle			+			+	+	+		+	+
Accipitridae	<i>Haliastur sphenurus</i>	Whistling Kite	+					+		+	+	+	
Acrocephalidae	<i>Acrocephalus australis</i>	Australian Reed-Warbler	+	+	+	+	+	+	+	+		+	+
Alcedinidae	<i>Ceyx azureus</i>	Azure Kingfisher						+		+			
Anatidae	<i>Anas castanea</i>	Chestnut Teal	+	+	+	+	+	+	+	+	+	+	+
Anatidae	<i>Anas gracilis</i>	Grey Teal	+	+			+		+			+	
Anatidae	<i>Anas platyrhynchos</i>	* Northern Mallard	+										
Anatidae	<i>Anas rhynchotis</i>	Australasian Shoveler	+	+								+	
Anatidae	<i>Anas superciliosa</i>	Pacific Black Duck	+	+	+	+	+	+	+	+	+	+	+
Anatidae	<i>Aythya australis</i>	Hardhead	+	+		+			+				
Anatidae	<i>Chenonetta jubata</i>	Australian Wood Duck	+				+					+	
Anatidae	<i>Cygnus atratus</i>	Black Swan	+	+	+	+	+	+	+	+	+	+	+
Anatidae	<i>Dendrocygna arcuata</i>	Wandering Whistling-Duck	+										
Anhingidae	<i>Anhinga melanogaster</i>	Australasian Darter	+			+		+	+	+			
Ardeidae	<i>Ardea ibis</i>	Cattle Egret	+	+	+	+	+	+	+	+		+	+

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Ardeidae	<i>Ardea intermedia</i>	Intermediate Egret		+			+	+	+	+		+	+
Ardeidae	<i>Ardea modesta</i>	Eastern Great Egret					+	+		+			
Ardeidae	<i>Ardea pacifica</i>	White-necked Heron					+	+	+	+		+	
Ardeidae	<i>Egretta garzetta</i>	Little Egret								+			
Ardeidae	<i>Egretta novaehollandiae</i>	White-faced Heron	+	+	+	+	+	+	+	+		+	+
Artamidae	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	+		+	+	+	+		+	+	+	+
Artamidae	<i>Cracticus nigrogularis</i>	Pied Butcherbird	+	+	+	+			+	+	+	+	+
Artamidae	<i>Cracticus tibicen</i>	Australian Magpie		+	+	+	+	+		+	+	+	
Artamidae	<i>Cracticus torquatus</i>	Grey Butcherbird	+	+		+		+				+	
Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	+	+				+				+	+
Cacatuidae	<i>Cacatua sanguinea</i>	Little Corella	+										
Cacatuidae	<i>Calyptorhynchus funereus</i>	Yellow-tailed Black-Cockatoo									+		
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	+	+	+	+	+	+	+	+		+	
Charadriidae	<i>Vanellus miles</i>	Masked Lapwing	+	+	+	+	+	+	+	+	+		
Ciconiidae	<i>Ephippiorhynchus asiaticus</i>	# Black-necked Stork							+				
Cisticolidae	<i>Cisticola exilis</i>	Golden-headed Cisticola		+		+	+		+	+	+	+	
Columbidae	<i>Geopelia humeralis</i>	Bar-Shouldered Dove								+			+
Columbidae	<i>Leucosarcia picata</i>	Wonga Pigeon	+										
Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon	+	+			+	+					
Columbidae	<i>Streptopelia chinensis</i>	*Spotted Dove	+			+							
Coraciidae	<i>Eurystomus orientalis</i>	Dollarbird							+	+			
Corvidae	<i>Corvus coronoides</i>	Australian Raven	+	+	+		+	+	+	+	+	+	
Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	+		+	+	+	+	+			+	
Cuculidae	<i>Cacomantis variolosus</i>	Brush Cuckoo	+	+									
Cuculidae	<i>Centropus phasianinus</i>	Pheasant Coucal		+			+	+					
Cuculidae	<i>Eudynamys orientalis</i>	Eastern Koel	+	+					+				

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Cuculidae	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo				+		+				+	
Estrildidae	<i>Neochmia temporalis</i>	Red-browed Finch	+	+	+	+	+	+	+	+			+
Falconidae	<i>Falco longipennis</i>	Australian Hobby			+								
Halcyonidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	+	+	+	+	+	+	+	+		+	
Halcyonidae	<i>Todiramphus sanctus</i>	Sacred Kingfisher	+	+	+	+	+	+	+	+	+	+	+
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow	+	+	+	+	+	+	+	+		+	+
Hirundinidae	<i>Petrochelidon ariel</i>	Fairy Martin								+		+	
Jacaniidae	<i>Irediparra gallinacea</i>	# Comb-crested Jacana					+						
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren	+	+	+	+	+	+	+	+	+	+	+
Maluridae	<i>Malurus lamberti</i>	Variiegated Fairy-wren	+		+				+				
Maluridae	<i>Stipiturus malachurus</i>	Southern Emu-wren							+				
Megaluridae	<i>Megalurus gramineus</i>	Little Grassbird	+	+	+	+	+	+	+	+	+	+	+
Megaluridae	<i>Megalurus timoriensis</i>	Tawny Grassbird							+				+
Meliphagidae	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill					+	+		+			
Meliphagidae	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	+	+	+			+	+	+		+	
Meliphagidae	<i>Manorina melanocephala</i>	Noisy Miner	+										
Meliphagidae	<i>Manorina melanophrys</i>	Bell Miner	+	+	+					+		+	
Meliphagidae	<i>Meliphaga lewinii</i>	Lewin's Honeyeater	+	+	+	+	+	+	+	+			
Meliphagidae	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater			+		+		+	+	+		+
Meliphagidae	<i>Philemon corniculatus</i>	Noisy Friarbird			+					+			
Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-lark	+	+	+	+	+	+	+	+			
Nectariniidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird			+	+			+	+		+	
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler	+	+					+				+
Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler	+	+			+		+	+			
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote	+										
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican		+						+			

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin	+	+	+	+	+	+	+	+			+
Phalacrocoracidae	<i>Microcarbo melanoleucos</i>	Little Pied Cormorant	+	+				+		+			
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant						+		+			
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	+	+	+	+	+	+	+	+			
Phalacrocoracidae	<i>Phalacrocorax varius</i>	Pied Cormorant	+			+	+			+		+	+
Phasianidae	<i>Coturnix ypsilophora</i>	Brown Quail									+		+
Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	+	+		+	+	+	+	+	+	+	
Psittacidae	<i>Platycercus eximius</i>	Eastern Rosella	+	+			+			+			
Psittacidae	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet		+	+			+		+			+
Psophodidae	<i>Psophodes olivaceus</i>	Eastern Whipbird	+	+	+	+	+	+	+	+		+	+
Rallidae	<i>Fulica atra</i>	Eurasian Coot					+	+	+	+			
Rallidae	<i>Gallinula tenebrosa</i>	Dusky Moorhen	+				+	+	+		+	+	
Rallidae	<i>Porphyrio porphyrio</i>	Purple Swamphe	+	+	+	+	+	+	+	+	+	+	+
Recurvirostridae	<i>Himantopus himantopus</i>	Black-winged Stilt					+	+				+	
Rhipiduridae	<i>Rhipidura albiscapa</i>	Grey Fantail	+	+	+	+	+	+	+	+	+	+	+
Rhipiduridae	<i>Rhipidura leucophrys</i>	Willie Wagtail	+	+	+	+	+	+	+	+	+	+	
Rhipiduridae	<i>Rhipidura rufifrons</i>	Rufous Fantail											+
Sturnidae	<i>Sturnus tristis</i>	*Common Myna	+		+	+				+			
Sturnidae	<i>Sturnus vulgaris</i>	*Common Starling	+	+									
Threskiornithidae	<i>Platalea flavipes</i>	Yellow-billed Spoonbill		+									
Threskiornithidae	<i>Platalea regia</i>	Royal Spoonbill	+	+			+			+	+		
Threskiornithidae	<i>Threskiornis molucca</i>	Australian White Ibis	+	+	+	+	+			+		+	+
Threskiornithidae	<i>Threskiornis spinicollis</i>	Straw-necked Ibis	+				+		+	+		+	
Timaliidae	<i>Zosterops lateralis</i>	Silvereye	+	+	+	+	+	+	+	+		+	+
TOTALS			64	52	41	43	51	54	51	62	22	47	36

* denotes an introduced species; # denotes a threatened species under the NSW BC Act 2016 and/or the Commonwealth EPBC Act 1999.

APPENDIX 5. BIRD SPECIES LIST – MAIN SWAMP

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Acanthizidae	<i>Acanthiza lineata</i>	Striated Thornbill										+	
Acanthizidae	<i>Acanthiza nana</i>	Yellow Thornbill	+	+	+	+	+	+	+	+	+		
Acanthizidae	<i>Acanthiza pusilla</i>	Brown Thornbill		+		+	+	+					
Acanthizidae	<i>Gerygone mouki</i>	Brown Gerygone								+			
Acanthizidae	<i>Gerygone olivacea</i>	White-throated Gerygone							+				
Acanthizidae	<i>Sericornis frontalis</i>	White-browed Scrubwren		+	+	+	+	+	+	+	+	+	+
Accipitridae	<i>Accipiter novaehollandiae</i>	Grey Goshawk	+						+			+	
Accipitridae	<i>Aquila audax</i>	Wedge-tailed Eagle		+									
Accipitridae	<i>Circus approximans</i>	Swamp Harrier	+	+	+	+	+			+			
Accipitridae	<i>Haliaeetus leucogaster</i>	# White-bellied Sea-Eagle								+	+		+
Accipitridae	<i>Haliastur sphenurus</i>	Whistling Kite	+		+					+	+	+	
Acrocephalidae	<i>Acrocephalus australis</i>	Australian Reed-Warbler	+	+		+	+	+	+	+	+	+	+
Anatidae	<i>Anas castanea</i>	Chestnut Teal	+	+	+	+	+	+	+	+	+	+	+
Anatidae	<i>Anas gracilis</i>	Grey Teal				+	+		+				+
Anatidae	<i>Anas superciliosa</i>	Pacific Black Duck	+	+	+	+	+	+	+	+	+	+	+
Anatidae	<i>Aythya australis</i>	Hardhead				+					+		+
Anatidae	<i>Chenonetta jubata</i>	Australian Wood Duck					+				+		
Anatidae	<i>Cygnus atratus</i>	Black Swan	+	+	+	+	+	+	+	+	+	+	+
Anatidae	<i>Spatula rhynchotis</i>	Australasian Shoveler											+
Anhingidae	<i>Anhinga melanogaster</i>	Australasian Darter				+				+			
Ardeidae	<i>Ardea ibis</i>	Cattle Egret	+	+	+		+	+	+	+	+		+
Ardeidae	<i>Ardea intermedia</i>	Intermediate Egret					+						+
Ardeidae	<i>Ardea modesta</i>	Eastern Great Egret		+			+			+			
Ardeidae	<i>Ardea pacifica</i>	White-necked Heron					+						

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Ardeidae	<i>Botaurus poiciloptilus</i>	# Australasian Bittern											+
Ardeidae	<i>Egretta garzetta</i>	Little Egret								+			
Ardeidae	<i>Egretta novaehollandiae</i>	White-faced Heron	+		+	+	+	+	+	+	+		+
Artamidae	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	+		+				+	+	+	+	
Artamidae	<i>Cracticus nigrogularis</i>	Pied Butcherbird			+	+			+	+			
Artamidae	<i>Cracticus tibicen</i>	Australian Magpie		+	+				+	+			
Artamidae	<i>Cracticus torquatus</i>	Grey Butcherbird	+	+	+		+	+	+				
Artamidae	<i>Strepera graculina</i>	Pied Currawong					+						
Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	+			+							+
Cacatuidae	<i>Cacatua sanguinea</i>	Little Corella						+		+			
Cacatuidae	<i>Calyptorhynchus funereus</i>	Yellow-tailed Black-Cockatoo									+		
Cacatuidae	<i>Eolophus roseicapillus</i>	Galah					+					+	+
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike		+				+	+	+	+	+	
Campephagidae	<i>Coracina tenuirostris</i>	Cicadabird		+	+	+							
Charadriidae	<i>Vanellus miles</i>	Masked Lapwing	+					+		+			+
Cisticolidae	<i>Cisticola exilis</i>	Golden-headed Cisticola	+	+	+	+							
Climacteridae	<i>Cormobates leucophaea</i>	White-throated Treecreeper							+				
Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon										+	
Coraciidae	<i>Eurystomus orientalis</i>	Dollarbird			+		+	+	+	+		+	+
Corvidae	<i>Corvus coronoides</i>	Australian Raven	+	+			+	+	+	+		+	+
Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	+			+		+	+				
Cuculidae	<i>Cacomantis variolosus</i>	Brush Cuckoo	+					+					
Cuculidae	<i>Chalcites lucidus</i>	Shining Bronze-Cuckoo	+										
Cuculidae	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo		+			+	+		+			
Estrildidae	<i>Neochmia temporalis</i>	Red-browed Finch	+	+	+		+	+	+	+	+	+	
Halcyonidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	+									+	
Halcyonidae	<i>Todiramphus sanctus</i>	Sacred Kingfisher	+	+	+			+				+	

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow	+	+	+	+	+	+	+	+	+	+	+
Hirundinidae	<i>Petrochelidon ariel</i>	Fairy Martin	+	+	+			+					+
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren	+	+	+	+	+	+	+	+	+	+	+
Maluridae	<i>Malurus lamberti</i>	Variegated Fairy-wren	+	+			+						
Megaluridae	<i>Megalurus gramineus</i>	Little Grassbird		+	+	+	+	+		+			+
Megaluridae	<i>Megalurus timoriensis</i>	Tawny Grassbird		+						+			
Meliphagidae	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill			+			+		+		+	
Meliphagidae	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	+	+		+	+	+		+		+	+
Meliphagidae	<i>Manorina melanocephala</i>	Noisy Miner	+	+									
Meliphagidae	<i>Manorina melanophrys</i>	Bell Miner	+	+					+		+	+	+
Meliphagidae	<i>Meliphaga lewinii</i>	Lewin's Honeyeater			+	+				+			
Meliphagidae	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater			+	+	+		+		+	+	+
Meliphagidae	<i>Philemon corniculatus</i>	Noisy Friarbird								+			
Meliphagidae	<i>Phylidonyris niger</i>	White-cheeked Honeyeater								+			
Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-lark	+	+	+		+	+	+	+		+	
Monarchidae	<i>Myiagra rubecula</i>	Leaden Flycatcher	+										
Nectariniidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird			+			+			+		
Oriolidae	<i>Oriolus sagittatus</i>	Olive-backed Oriole		+				+					
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler					+			+			
Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler			+								
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican								+			
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin			+	+	+	+	+	+		+	
Phalacrocoracidae	<i>Microcarbo melanoleucos</i>	Little Pied Cormorant	+			+	+	+		+	+		+
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant			+		+	+		+			+
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant			+			+		+			+
Phalacrocoracidae	<i>Phalacrocorax varius</i>	Pied Cormorant					+						+
Phasianidae	<i>Coturnix ypsilophora</i>	Brown Quail								+			

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	+			+					+		+
Psittacidae	<i>Platycercus eximius</i>	Eastern Rosella						+			+		
Psittacidae	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet		+					+	+	+	+	+
Psophodidae	<i>Psophodes olivaceus</i>	Eastern Whipbird					+	+		+			
Rallidae	<i>Fulica atra</i>	Eurasian Coot				+	+		+	+	+		
Rallidae	<i>Gallinula tenebrosa</i>	Dusky Moorhen	+	+	+	+	+	+	+		+	+	+
Rallidae	<i>Porphyrio porphyrio</i>	Purple Swamphen	+	+	+	+	+	+	+	+	+	+	+
Recurvirostridae	<i>Himantopus himantopus</i>	Black-winged Stilt					+			+			
Rhipiduridae	<i>Rhipidura albiscapa</i>	Grey Fantail	+	+	+	+	+	+	+	+	+	+	
Rhipiduridae	<i>Rhipidura leucophrys</i>	Willie Wagtail	+	+	+	+	+	+	+	+		+	+
Scolopacidae	<i>Gallinago hardwickii</i>	^M Latham's Snipe					+						
Sturnidae	<i>Sturnus tristis</i>	*Common Myna			+	+							
Sturnidae	<i>Sturnus vulgaris</i>	*Common Starling			+					+			
Threskiornithidae	<i>Platalea flavipes</i>	Royal Spoonbill								+	+		
Threskiornithidae	<i>Plegadis falcinellus</i>	Glossy Ibis					+						
Threskiornithidae	<i>Threskiornis molucca</i>	Australian White Ibis	+				+		+	+			+
Threskiornithidae	<i>Threskiornis spinicollis</i>	Straw-necked Ibis	+				+	+	+	+			+
Timaliidae	<i>Zosterops lateralis</i>	Silvereye	+	+	+		+	+	+	+		+	+
TOTALS			40	37	38	32	46	41	36	54	30	31	37

* denotes an introduced species; # denotes a threatened species under the NSW BC Act 2016 and/or the Commonwealth EPBC Act 1999; ^M denotes a migratory species listed under the Commonwealth EPBC Act 1999.

APPENDIX 6. BIRD SPECIES LIST – SOUTH SWAMP

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Acanthizidae	<i>Acanthiza lineata</i>	Striated Thornbill						+					
Acanthizidae	<i>Acanthiza nana</i>	Yellow Thornbill					+				+		
Acanthizidae	<i>Acanthiza pusilla</i>	Brown Thornbill	+					+		+			
Acanthizidae	<i>Gerygone olivacea</i>	White-throated Gerygone								+			
Acanthizidae	<i>Sericornis frontalis</i>	White-browed Scrubwren				+	+			+		+	
Accipitridae	<i>Accipiter fasciatus</i>	Brown Goshawk											+
Accipitridae	<i>Aviceda subcristata</i>	Pacific Baza			+								
Accipitridae	<i>Circus approximans</i>	Swamp Harrier	+		+				+	+		+	
Accipitridae	<i>Haliaeetus leucogaster</i>	# White-bellied Sea-Eagle			+		+	+		+			+
Accipitridae	<i>Haliastur sphenurus</i>	Whistling Kite	+	+	+		+			+		+	
Accipitridae	<i>Pandion haliaetus cristatus</i>	Eastern Osprey							+				
Acrocephalidae	<i>Acrocephalus australis</i>	Australian Reed-Warbler	+	+	+	+	+	+	+	+		+	+
Alcedinidae	<i>Alcedo azurea</i>	Azure Kingfisher				+	+				+		
Anatidae	<i>Anas castanea</i>	Chestnut Teal	+	+	+	+	+	+	+	+	+	+	+
Anatidae	<i>Anas gracilis</i>	Grey Teal		+		+	+		+		+	+	+
Anatidae	<i>Anas platyrhynchos</i>	Domestic Duck					+						
Anatidae	<i>Anas superciliosa</i>	Pacific Black Duck	+	+	+	+	+	+	+	+	+	+	+
Anatidae	<i>Aythya australis</i>	Hardhead				+						+	+
Anatidae	<i>Chenonetta jubata</i>	Australian Wood Duck			+		+	+	+		+	+	+
Anatidae	<i>Cygnus atratus</i>	Black Swan	+	+	+	+	+	+	+	+	+	+	+
Anhingidae	<i>Anhinga melanogaster</i>	Australasian Darter				+		+					
Apodidae	<i>Hirundapus caudacutus</i>	White-throated Needletail										+	
Ardeidae	<i>Ardea ibis</i>	Cattle Egret		+	+		+	+		+		+	+

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Ardeidae	<i>Ardea intermedia</i>	Intermediate Egret					+	+	+	+			
Ardeidae	<i>Ardea modesta</i>	Eastern Great Egret					+		+	+			
Ardeidae	<i>Ardea pacifica</i>	White-necked Heron	+	+			+		+			+	+
Ardeidae	<i>Egretta garzetta</i>	Little Egret					+	+					
Ardeidae	<i>Egretta novaehollandiae</i>	White-faced Heron	+	+	+	+	+	+	+	+	+	+	+
Artamidae	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow	+	+	+	+	+	+	+	+	+	+	+
Artamidae	<i>Cracticus nigrogularis</i>	Pied Butcherbird	+	+					+				+
Artamidae	<i>Cracticus tibicen</i>	Australian Magpie	+	+	+	+	+	+		+		+	
Artamidae	<i>Cracticus torquatus</i>	Grey Butcherbird	+	+	+	+		+	+				
Artamidae	<i>Strepera graculina</i>	Pied Currawong	+										
Cacatuidae	<i>Cacatua galerita</i>	Sulphur-crested Cockatoo	+	+				+		+		+	
Cacatuidae	<i>Cacatua sanguinea</i>	Little Corella					+		+	+		+	+
Cacatuidae	<i>Eolophus roseicapillus</i>	Galah			+			+		+			+
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike		+	+	+	+		+	+	+	+	+
Campephagidae	<i>Coracina tenuirostris</i>	Cicadabird	+	+									
Campephagidae	<i>Lalage tricolor</i>	White-winged Triller					+	+					
Charadriidae	<i>Vanellus miles</i>	Masked Lapwing	+	+	+				+	+	+	+	+
Ciconiidae	<i>Ephippiorhynchus asiaticus</i>	# Black-necked Stork									+		
Cisticolidae	<i>Cisticola exilis</i>	Golden-headed Cisticola	+	+	+		+	+	+			+	
Climacteridae	<i>Cormobates leucophaea</i>	White-throated Treecreeper							+	+			
Columbidae	<i>Geopelia humeralis</i>	Bar-shouldered Dove										+	
Columbidae	<i>Geopelia striata</i>	Peaceful Dove									+		
Columbidae	<i>Leucosarcia picata</i>	Wonga Pigeon						+					
Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon										+	
Coraciidae	<i>Eurystomus orientalis</i>	Dollarbird	+		+	+	+	+	+	+			
Corvidae	<i>Corvus coronoides</i>	Australian Raven	+	+	+	+	+	+	+	+	+		

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Cuculidae	<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo	+	+		+	+	+		+	+	+	
Cuculidae	<i>Cacomantis variolosus</i>	Brush Cuckoo	+	+	+			+					
Cuculidae	<i>Centropus phasianinus</i>	Pheasant Coucal		+	+								+
Cuculidae	<i>Chalcites lucidus</i>	Shining Bronze-Cuckoo	+										
Cuculidae	<i>Chrysococcyx basalis</i>	Horsfield's Bronze-Cuckoo					+						
Cuculidae	<i>Eudynamys orientalis</i>	Eastern Koel	+				+	+					
Cuculidae	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo		+				+	+				
Estrildidae	<i>Neochmia temporalis</i>	Red-browed Finch	+				+		+	+		+	+
Halcyonidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	+	+		+	+	+	+	+	+	+	+
Halcyonidae	<i>Todiramphus sanctus</i>	Sacred Kingfisher	+	+	+	+	+	+	+	+	+	+	+
Hirundinidae	<i>Hirundo neoxena</i>	Welcome Swallow	+	+	+	+	+	+	+	+	+	+	+
Hirundinidae	<i>Petrochelidon ariel</i>	Fairy Martin		+	+			+		+		+	
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren	+	+	+	+	+	+	+	+	+	+	+
Maluridae	<i>Malurus lamberti</i>	Variegated Fairy-wren				+	+						
Maluridae	<i>Stipiturus malachurus</i>	Southern Emu-wren											+
Megaluridae	<i>Megalurus gramineus</i>	Little Grassbird	+	+	+	+	+	+	+		+	+	+
Megaluridae	<i>Megalurus timoriensis</i>	Tawny Grassbird	+	+						+			
Meliphagidae	<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill					+						
Meliphagidae	<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater	+	+	+		+	+		+	+	+	+
Meliphagidae	<i>Lichenostomus leucotis</i>	White-eared Honeyeater					+						
Meliphagidae	<i>Manorina melanocephala</i>	Noisy Miner	+	+	+	+			+	+			
Meliphagidae	<i>Manorina melanophrys</i>	Bell Miner	+	+	+	+	+	+	+	+	+	+	
Meliphagidae	<i>Meliphaga lewinii</i>	Lewin's Honeyeater	+	+	+	+	+	+		+		+	
Meliphagidae	<i>Melithreptus lunatus</i>	White-naped Honeyeater								+		+	
Meliphagidae	<i>Myzomela sanguinolenta</i>	Scarlet Honeyeater							+	+		+	+
Meliphagidae	<i>Philemon corniculatus</i>	Noisy Friarbird	+						+	+			

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Meliphagidae	<i>Phylidonyris niger</i>	White-cheeked Honeyeater								+		+	
Meliphagidae	<i>Plectorhyncha lanceolata</i>	Striped Honeyeater	+	+									
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater	+										
Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-lark	+	+	+	+	+	+	+	+		+	+
Monarchidae	<i>Myiagra rubecula</i>	Leaden Flycatcher	+										
Nectariniidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird				+		+	+	+			+
Neosittidae	<i>Daphoenositta chrysoptera</i>	Varied Sittella						+		+			
Oriolidae	<i>Oriolus sagittatus</i>	Olive-backed Oriole		+	+		+	+			+	+	+
Oriolidae	<i>Sphecotheres vieilloti</i>	Australasian Figbird			+								
Pachycephalidae	<i>Colluricincla harmonica</i>	Grey Shrike-thrush					+	+					
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler	+	+					+			+	
Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler	+	+	+	+		+				+	+
Pardalotidae	<i>Pardalotus punctatus</i>	Spotted Pardalote	+	+								+	
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican					+						
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin		+		+				+			+
Phalacrocoracidae	<i>Microcarbo melanoleucos</i>	Little Pied Cormorant	+	+		+	+		+	+	+	+	+
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant				+				+			
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant		+		+	+		+	+		+	+
Phalacrocoracidae	<i>Phalacrocorax varius</i>	Pied Cormorant				+	+						+
Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe		+		+	+	+		+		+	+
Psittacidae	<i>Alisterus scapularis</i>	Australian King-Parrot				+				+			
Psittacidae	<i>Platycercus eximius</i>	Eastern Rosella	+	+	+	+	+	+	+	+	+	+	+
Psittacidae	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	+	+	+	+	+		+	+		+	+
Psophodidae	<i>Psophodes olivaceus</i>	Eastern Whipbird	+	+	+	+	+	+	+	+		+	+
Rallidae	<i>Fulica atra</i>	Eurasian Coot		+		+	+	+	+	+	+	+	+
Rallidae	<i>Gallinula tenebrosa</i>	Dusky Moorhen	+	+	+	+	+	+	+	+	+	+	

Family	Scientific Name	Common Name	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019
Rallidae	<i>Porphyrio porphyrio</i>	Purple Swamphen	+	+	+	+	+	+	+	+	+	+	+
Recurvirostridae	<i>Himantopus himantopus</i>	Black-winged Stilt										+	
Rhipiduridae	<i>Rhipidura albiscapa</i>	Grey Fantail	+	+		+	+	+	+	+	+	+	+
Rhipiduridae	<i>Rhipidura leucophrys</i>	Willie Wagtail	+	+	+	+	+	+	+	+	+	+	+
Scolopacidae	<i>Gallinago hardwickii</i>	^M Latham's Snipe					+			+		+	+
Sturnidae	<i>Sturnus tristis</i>	*Common Myna			+								
Sturnidae	<i>Sturnus vulgaris</i>	*Common Starling			+								
Threskiornithidae	<i>Platalea regia</i>	Royal Spoonbill		+			+		+	+			
Threskiornithidae	<i>Plegadis falcinellus</i>	Glossy Ibis					+						
Threskiornithidae	<i>Threskiornis molucca</i>	Australian White Ibis					+		+			+	+
Timaliidae	<i>Zosterops lateralis</i>	Silvereye					+	+				+	+
TOTALS			51	53	43	44	62	51	48	59	30	57	47

* denotes an introduced species; # denotes a threatened species under the NSW BC Act 2016 and/or the Commonwealth EPBC Act 1999; ^M denotes a migratory species listed under the Commonwealth EPBC Act 1999.

APPENDIX 7. ROOSTING BIRD COUNTS FROM THE MAIN SWAMP

Family	Scientific Name	Common Name	15/10/2008	5/03/2009	18/11/2009	23/03/2010	23/12/2010	23/03/2011	19/10/2011	20/03/2012	2/11/2012	5/03/2013	4/12/2013	12/12/2013	10/03/2014	26/03/2015	13/12/2015	21/04/2016	24/10/2016	7/12/2017	30/04/2018	6/12/2018	11/04/2019
Anhingidae	<i>Anhinga melanogaster</i>	Australasian Darter													1								
Ardeidae	<i>Ardea ibis</i>	Cattle Egret	57	170	67		26		188	80		120		80		280	22		88	15	2	1	
Ardeidae	<i>Ardea pacifica</i>	White-necked Heron	1																				
Ardeidae	<i>Egretta garzetta</i>	Little Egret															7						
Ardeidae	<i>Egretta novaehollandiae</i>	White-faced Heron								4		20				29	1						
Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-lark													1			3					
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant					2			15		2		3	7							2	
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	17	10	5		14		1	5	15			8	2		6					4	
Phalacrocoracidae	<i>Microcarbo melanoleucos</i>	Little Pied Cormorant			8	3						6	1	10								4	
Phalacrocoracidae	<i>Phalacrocorax varius</i>	Pied Cormorant										10											
Rallidae	<i>Porphyrio porphyrio</i>	Purple Swamphen											2										
Threskiornithidae	<i>Threskiornis molucca</i>	Australian White Ibis	9	50	37	44		2	1			5				276	53	36		1	8	3	112
Threskiornithidae	<i>Threskiornis spinicollis</i>	Straw-necked Ibis	125	40	8	3						400				13		18			20	3	11
Ardeidae	<i>Ardea intermedia</i>	Intermediate Egret																				2	
Total No. of Individuals			209	270	125	50	42	2	190	104	15	563	3	101	11	598	89	57	88	16	30	19	123

APPENDIX 8. SELECTION OF WATER BODY PHOTOGRAPHS



Plate 22: **Stitched photograph of South Swamp taken in March 2012.**



Plate 23: **Stitched photograph of South Swamp taken in March 2015**



Plate 24: **Stitched photograph of South Swamp taken in April 2018**



Figure 20: Stitched photograph of South Swamp taken in April 2019

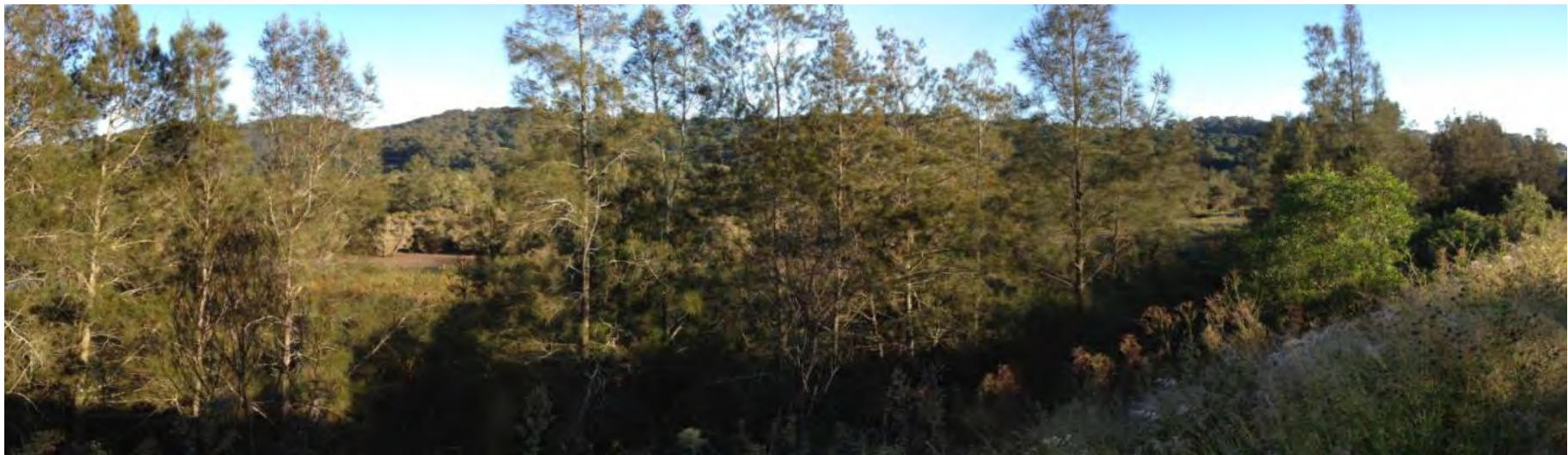


Plate 25: Stitched photograph of Main Swamp taken in March 2012.



Plate 26: **Stitched photograph of Main Swamp taken in March 2014.**

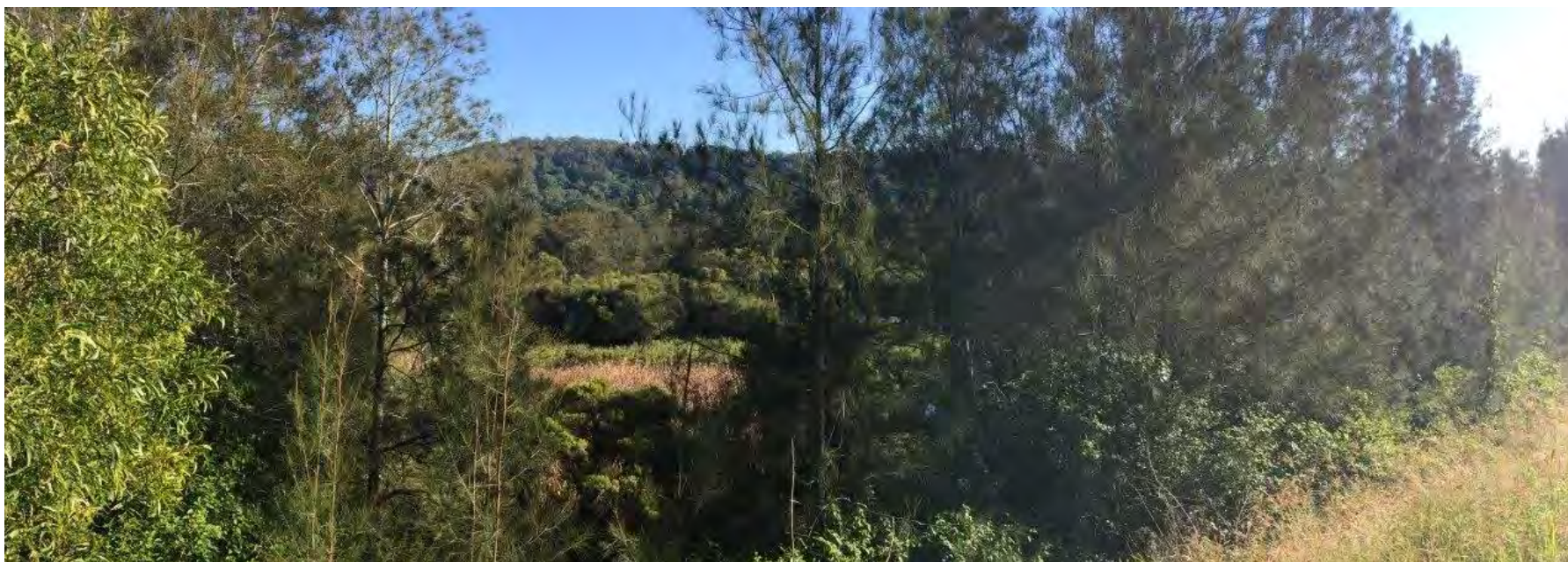


Plate 27: **Stitched photograph of Main Swamp taken in April 2018.**



Figure 21: **Stitched photograph of Main Swamp taken in April 2019.**



Plate 28: **Stitched photograph of North Swamp taken in March 2012.**



Plate 29: **Stitched photograph of North Swamp taken in March 2015.**



Plate 30: **Stitched photograph of North Swamp taken in April 2018.**



Figure 22: **Stitched photograph of North Swamp taken in April 2019.**

APPENDIX 9. STAFF CONTRIBUTIONS

The following staff were involved in the compilation of this report.

Name	Qualification	Title/Experience	Contribution
Bradley Deane	BBioCons / MWldMgmt	Environmental Consultant / GIS Support	Map preparation
Gayle Joyce	BSc (Forestry) (Hons)	GIS Specialist	Map preparation
Kristy Peters	B.ParkMgt/BSc. (Hons)	Senior Ecologist	Bird surveys, report review
Nigel Fisher	BSc (Hons), PhD	Restoration Ecologist	Flora survey, report writing
Elise Connolly	Dip Cons Land Mgt, AdvDip EnvMgt	Ecologist	Flora survey
Mark Dean	BEnvSc&Mgt	Ecologist	Fauna survey, report writing
Daniel O'Brien	BEnvSc&Mgt (Hons)	Ecologist	Fauna survey, report writing
Ben Stewart	MMarSc&Mgt	Ecologist	Report amendment

APPENDIX 10. LICENSING

Kleinfelder employees involved in the current study are licensed or approved under the *Biodiversity Conservation Act 2016* (License Number: SL100730, Expiry: 31 March 2020) and the *Animal Research Act 1985* to harm/trap/release protected native fauna and to pick for identification purposes native flora and to undertake fauna surveys.