

Appendix 3

2013/2014 Annual Monitoring Report Pambalong Nature Reserve

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2013 / 14 Annual Monitoring Report



Donaldson Coal Pty Ltd

Pambalong Nature Reserve
Abel Underground Coal Mine, Beresfield
NSW

July 2014

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2013 / 14 Annual Monitoring Report

Pambalong Nature Reserve
Abel Underground Coal Mine, Beresfield NSW

Kleinfelder Report Number: WB14R_89297_137821

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Document Control:

Version	Description	Date	Author	Technical Reviewer	Peer Reviewer
1.0	Draft for peer review	17/04/2014	Dr Gilbert Whyte (Flora) David Russell (Fauna)	Shawn Capararo	Colin Driscoll
2.0	Draft for client review	19/05/2014			
3.0	Final	25/07/2014			

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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. Hunter Wetlands National Park, which incorporates the previous Kooragang and Hexham Swamp Nature Reserves, the Stockton Sandspit and part of Ash Island protects many associated wetlands in the region. The wetland at Pambalong depends on freshwater 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 wetland could also occur such as weed and/or feral animal invasion (ecobiological 2007).

Underground mining has not yet reached the Blue Gum Creek catchment and monitoring to date has contributed to a robust dataset on baseline ecological 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 sixth annual baseline monitoring event at Pambalong Nature Reserve. Detected during this survey were 101 flora species and 114 fauna species comprising eight frog, 20 mammal (14 bat), one reptile, and 85 bird species. Threatened species recorded included 5 microbats and one bird (Varied Sittella). No new flora species were recorded and no significant changes to the spatial extent of vegetation communities were observed.

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Contents

EXECUTIVE SUMMARY	III
1. INTRODUCTION	1
1.1 LOCATION	2
2. METHODOLOGY	5
2.1 FLORA	5
2.2 FAUNA	6
2.2.1 Arboreal Mammals	8
2.2.2 Terrestrial Mammals	8
2.2.3 Bats	8
2.2.4 Birds	9
2.2.5 Amphibians	9
2.2.6 Introduced Fauna	10
3. RESULTS AND DISCUSSION	1
3.1 WEATHER CONDITIONS AND SURVEY ACTIVITIES	1
3.2 GENERAL ENVIRONMENTAL MONITORING	1
3.3 FLORA RESULTS	4
3.4 WEED SPECIES	12
3.5 VEGETATION COMMUNITIES	19
3.5.1 Coastal Foothills Spotted Gum – Ironbark Forest (Dry Sclerophyll Forest)	21
3.5.2 Paperbark Swamp Forest (Swamp Sclerophyll Forest)	21
3.5.3 Freshwater Wetland Complex (Freshwater Wetland)	22
3.5.4 Altered Vegetation - Swamp Oak Forest (planted)	23
3.5.5 Altered Vegetation - Disturbed/Kikuyu Grassland	23
3.5.6 Endangered Ecological Communities	23
3.6 FAUNA	25
4. CONCLUSIONS AND RECOMMENDATIONS	29
5. REFERENCES	31



Tables

Table 1	Trapping statistics for the subject site	6
Table 2	Fauna survey effort for the subject site	6
Table 3	Weather conditions and survey activities undertaken during the sample period.....	1
Table 4	Monthly rainfall (mm) recorded at Maitland Visitors Centre weather station (long term mean includes East Maitland Bowling Club 1902 to 1994)	2
Table 5	Threatened fauna species recorded in 2013/14	26
Table 6	Fauna species (excluding birds) recorded from trapping and nocturnal survey activities by Kleinfelder 2008-2013 and White (2000)	39
Table 7	Bird species recorded from the North Swamp by Kleinfelder 2008 to 2014	47
Table 8	Bird species recorded from the Main Swamp by Kleinfelder 2008 to 2014.....	51
Table 9	Bird species recorded from the South Swamp by Kleinfelder 2008 to 2014.....	55
Table 10	Roosting bird count results from the Main Swamp 2008 to 2014.....	59

Figures

Figure 1	Locality Map.....	3
Figure 2	Pambalong Nature Reserve	4
Figure 3	Flora and Fauna Survey Effort	7
Figure 4	Monthly rainfall for 2013-14 survey period compared to historical monthly average (1902-2013)	3
Figure 5	Flora species richness within Q1 from 2008 to 2013	5
Figure 6	Flora species richness within Q2 from 2008 to 2013	6
Figure 7	Flora species richness within Q3 from 2008 to 2013	8
Figure 8	Flora species richness within Q4 from 2008 to 2013	9
Figure 9	Flora species richness within T1 from 2008 to 2013.....	11
Figure 10	Weed Species Mapping	13
Figure 11	Vegetation Community Mapping	20
Figure 12	Fauna species richness recorded from 2008 to 2013	25
Figure 13	Fauna species richness by taxon from 2008 to 2013 (excluding birds).....	26
Figure 14	Bird species richness recorded at monitoring points from 2008 to 2013.....	27



Plates

Plate 1	Flora quadrat 1 (Q1) located in Coastal Foothills Spotted Gum - Ironbark Forest (Photograph taken in 2012)	4
Plate 2	Flora quadrat 2 (Q2) located in Freshwater Wetland Complex dominated by Typha (Photograph taken in 2012)	6
Plate 3	Flora quadrat 3 (Q3) located in Paperbark Swamp Forest (Photograph taken in 2012).....	7
Plate 4	Flora quadrat 4 located in Paperbark Swamp Forest (Photograph taken in 2012)	9
Plate 5	Flora transect located in Freshwater Wetland Complex (Photograph taken in 2012)	10
Plate 6	Water Hyacinth at the Northern Swamp inlet in 2008.....	14
Plate 7	Water Hyacinth at the Northern Swamp inlet in 2009 showing the installation of a grate	14
Plate 8	Water Hyacinth at the Northern Swamp inlet in 2010.....	15
Plate 9	Water Hyacinth at the Northern Swamp inlet during the 2011 monitoring event	15
Plate 10	Water Hyacinth at the Northern Swamp inlet during the 2012 monitoring event	16
Plate 11	Stitched photograph of South Swamp taken in November 2011.	60
Plate 12	Stitched photograph of South Swamp taken in March 2012.....	60
Plate 13	Stitched photograph of South Swamp taken in March 2014.....	60
Plate 14	Stitched photograph of Main Swamp taken in November 2011.....	61
Plate 15	Stitched photograph of Main Swamp taken in March 2012.	61
Plate 16	Stitched photograph of Main Swamp taken in March 2014.	61
Plate 17	Stitched photograph of North Swamp taken in November 2011.....	62
Plate 18	Stitched photograph of North Swamp taken in March 2012.	62
Plate 19	Stitched photograph of North Swamp taken in March 2014.	62

Appendices

Appendix 1.	Species List
Appendix 2.	Fauna Species Recorded on the Subject Site
Appendix 3.	Water Body Photographs
Appendix 4.	Staff Contributions
Appendix 5.	Licensing

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1. INTRODUCTION

Donaldson Coal Pty Ltd commenced mining in 2008 at the Abel Underground Coal Mine, located approximately 23 km north-west of Newcastle **Figure 1**. The mine will extract up to 4.5 million tonnes per year over 21 years using high productivity continuous miner based bord and pillar systems, and pillar extraction techniques.

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 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).

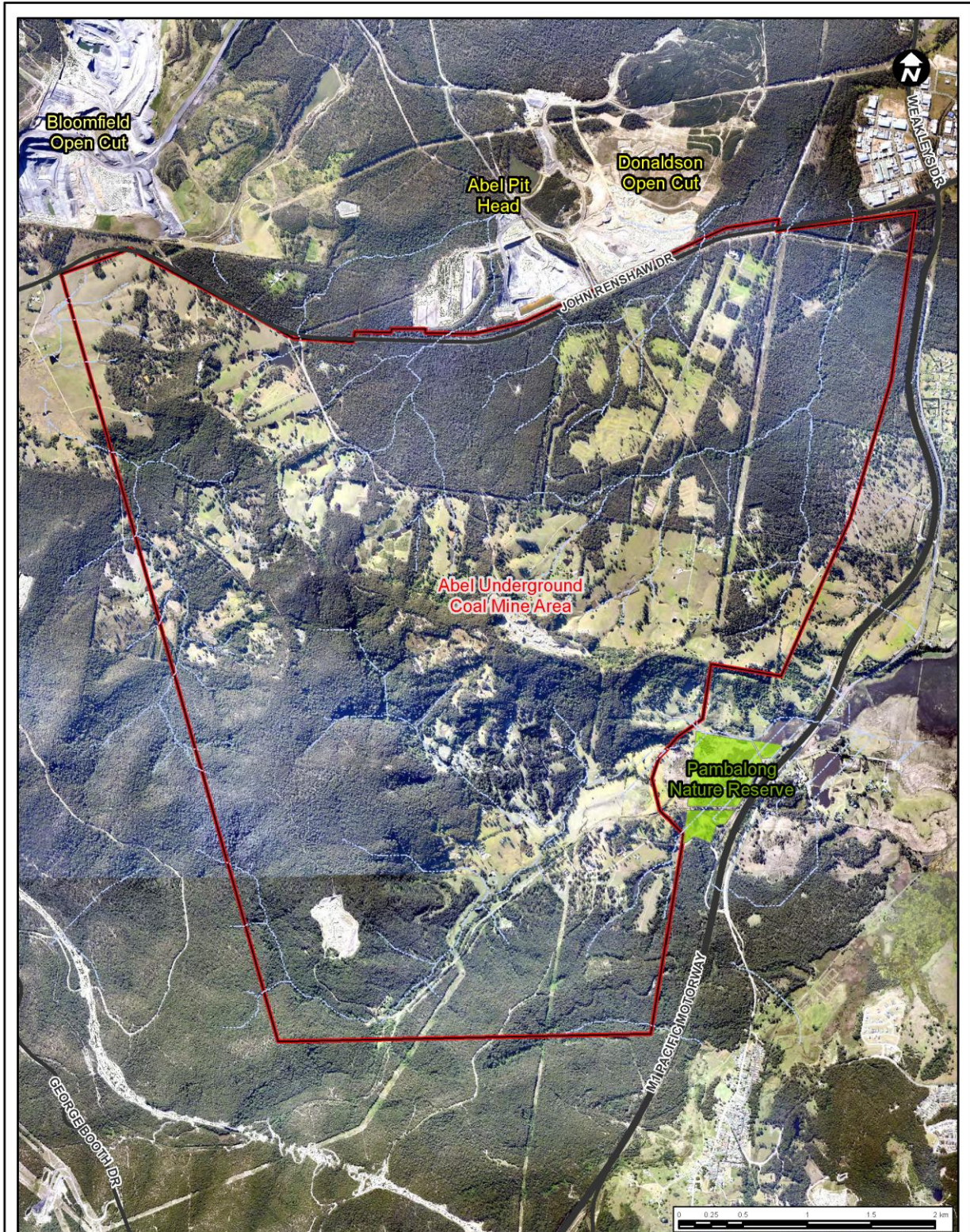


Figure 1 - Locality Map

Legend

- Abel Underground Coalmine Boundary
- Pambalong Nature Reserve
- Waterways



Project Ref:	137821
Plot Date:	16/06/2014 15:50
Revision:	001 (gjoyce)

Map Projection:
GDA 1994 MGA Zone 56

Data Sources:
LPI - 2011
OEH - 2012
Kleinfelder - 2014

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.

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Figure 2: Pambalong Nature Reserve
Legend

- Abel Underground Coalmine Boundary
- Pambalong Nature Reserve
- Major roads
- Minor roads



Project Ref:	137821
Plot Date:	16/06/2014 15:51
Revision:	001 (gjoyce)

Map Projection:	GDA 1994 MGA Zone 56
Data Sources:	LPI - 2011 OEH - 2012 Kleinfelder - 2014
<small>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.</small>	

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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 32 m) floristic quadrats (Q2 & Q4) and a 50 m 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 triglochinooides*, *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.



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 of other fauna survey effort across the subject site. The location of fauna survey activities is shown in Figure 3.

Table 1 Trapping statistics 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

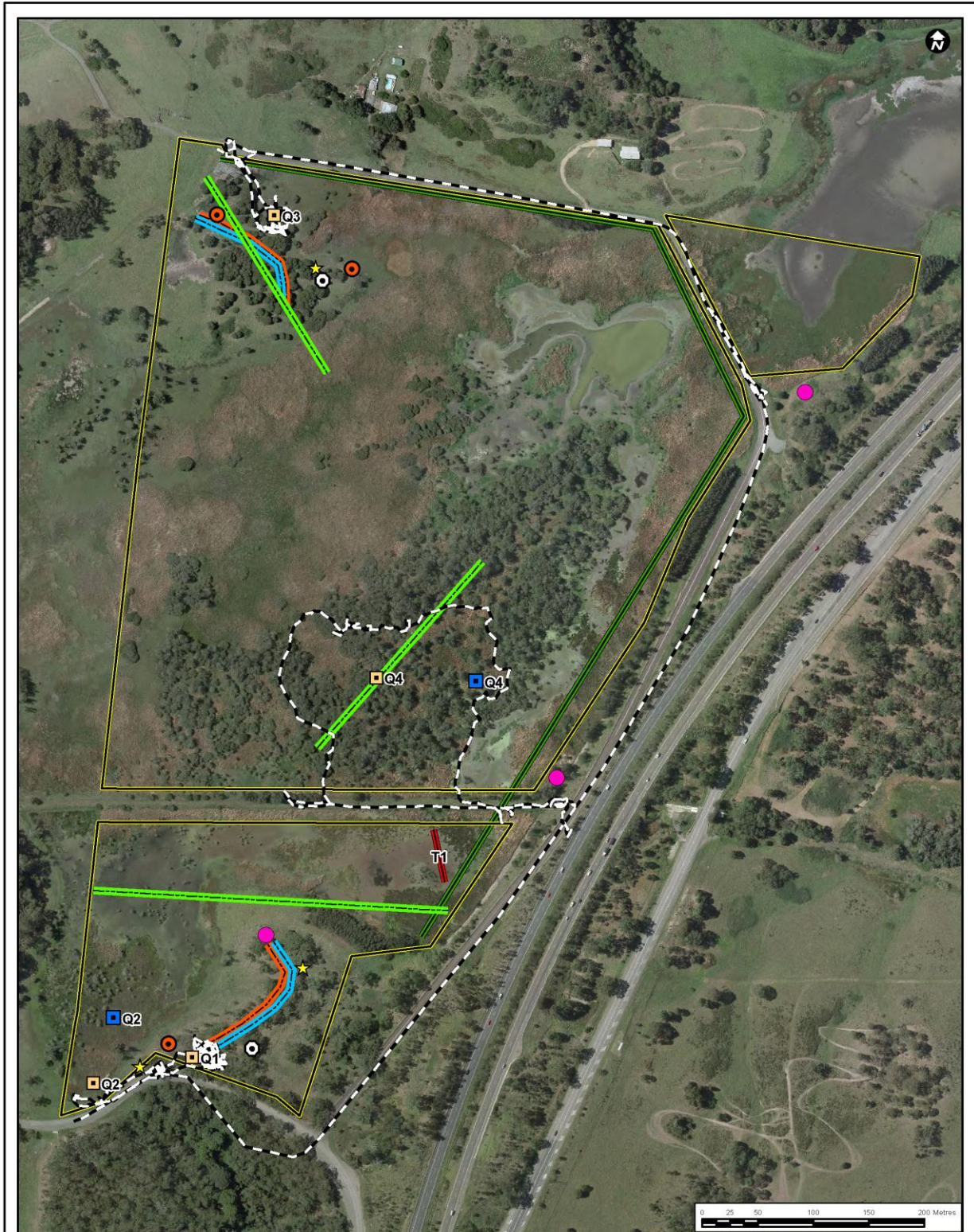


Figure 3: Flora & Fauna Survey Effort
Legend

- | | | |
|-----------------------------|--------------------|----------------------|
| Pambalong Nature Reserve | Harp Trap | Bird Survey Transect |
| Water Bird Survey Locations | Anabat | Trapping Transect |
| Flora Quadrats | Flora Meander 2012 | Frog Call Playback |
| Flora Quadrats 2008 | Amphibian Transect | Flora Transect 50m |
| Owl Call Playback | | |



Map Projection:
GDA 1994 MGA Zone 56

Data Sources:
LPI - 2011
OEH - 2012
Kleinfelder - 2014

Project Ref: 137821
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2.2.1 Arboreal Mammals

Three Elliott B traps and eight hair tubes are 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 are sprayed with a mixture of honey and water. Traps are checked daily for arboreal species. After 4 nights the sticky wafers from hair tubes are 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 is 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 are placed along two transects at regular intervals to capture terrestrial mammal species. Traps are 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 are erected on transects at South Swamp and Main Swamp. To increase the likelihood of captures traps are positioned in potential bat 'flyways' such as on tracks or in natural forest openings. Traps are set in position for four consecutive nights and checked each morning. Bats captured are 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™ II bat-call detectors are used passively to record the calls of passing Microchiropteran bats. Two units are set up at dusk and recording occurs for one hour on two separate nights (four hours total). Nocturnal searches of blossoming trees are also undertaken during spotlighting to detect Megachiropteran bats.



2.2.4 Birds

Surveys to detect birds are conducted at two transects in native vegetation fringing wetlands, and three permanent monitoring points overlooking North, South and Main waterbodies (Figure 3). Transect surveys record species richness only, whereas water body surveys make counts of the number of individuals of water bird species observed or when large estimate relative abundance.

Transects are surveyed for a period of 20 minutes on two separate days. Species are 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) are broadcast over a megaphone at transects on two separate nights in an attempt to encourage a call back response.

Water bird surveys are 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 are 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 or abundance estimate of birds roosting in the Melaleuca Swamp Forest within the Main Swamp is 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 are carried out at each of the three main water bodies over four days and nights. Diurnal surveys involve dip netting and visual searches to detect tadpoles in water bodies. Nocturnal surveys involve 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 is carried out due to the species' historical occurrence at the site and the presence of suitable habitat.



Adult frogs encountered are identified by visual confirmation or by their distinct advertisement calls. Tadpoles are keyed out 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 previously recorded in the reserve include: Black Rat, Rabbit, Fox, Common Myna, Spotted Dove, House Sparrow, Red-whiskered Bulbul and Common Starling have (Hunter Bird Observers Club records 1990 – 2008; Straw 2000; White 2000). The ecological condition of the reserve is negatively impacted by the presence of these species. Introduced species detected by annual field surveys are reported to the NSW National Parks and Wildlife Service to assist with management.



3. RESULTS AND DISCUSSION

3.1 WEATHER CONDITIONS AND SURVEY ACTIVITIES

Prevailing weather conditions during the survey period (20 November 2013 - 22 March 2014) were warm to hot days and mild nights with light winds or calm, and partly cloudy to clear skies with the exception of the period 22-23 November, which was overcast and raining. A full list of the timing of survey activities and corresponding weather conditions is provided in 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 and reptile search	Amphibian survey	Nocturnal Spotlighting, call playback, & Anabat	Bird survey (Transects)	Dusk Water Bird survey	Dawn Water Bird survey		
20/11/13	13.7	26.5	0				X						X
21/11/13	16.5	28.0	0			X			X				
22/11/13	-	25.0	2.0			X							
23/11/13	16.0	25.0	28.0			X					X		
24/11/13	13.0	27.2				X							
27/11/13	14.4	-	0	X									
04/12/13	12.0	34.5	0							X			X
12/12/13	18.0	27.0	0							X			
10/03/14	19.0	29.1	0								X		
14/03/14	17.0	30.0	0										X
21/03/14	19.3	26.7	1.2								X		
22/03/14	15.8	31.0	0										X

Source: Australian Government Bureau of Meteorology. Maitland Visitors Centre Station 061388.

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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 2013 there was no significant bushfire event or development activity in the vicinity of the wetland that would impact water flow or quality.

Nearby Bureau of Meteorology (BoM) weather stations at East Maitland Bowling Club (1902-1994) and the Maitland Visitors Centre (1997 to 2014) provide historical rainfall data for a 112-year period (1902 – 2014). Historical mean monthly rainfall (mm) from 1902 – 2014 and monthly rainfall (mm) from 2008, 2009, 2010, 2011, 2012 and 2013 is presented for comparison in (Table 4).



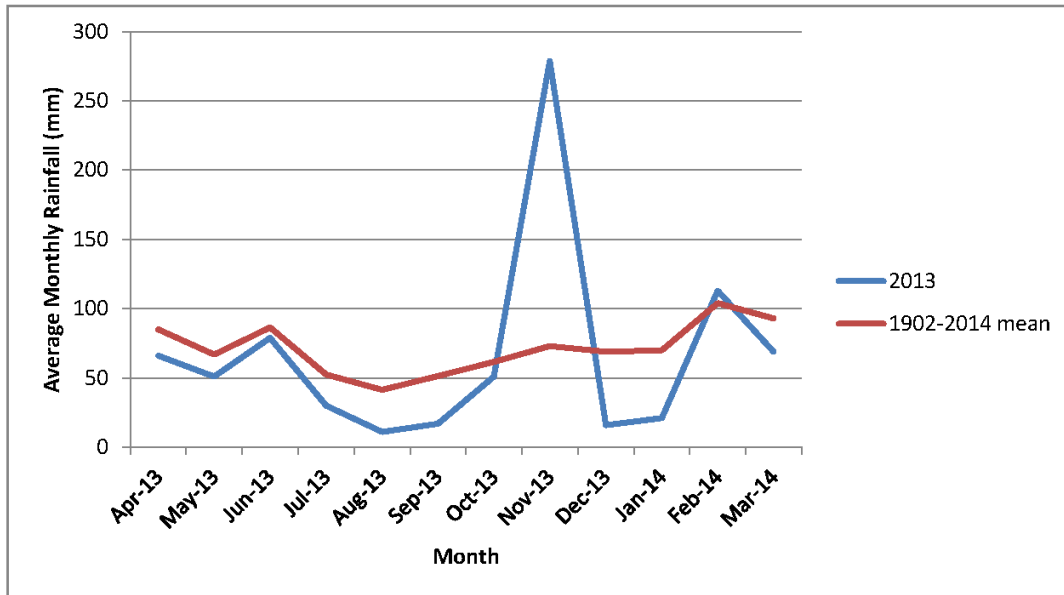
Figure 4 shows monthly rainfall (mm) from each year from 2008-13 and compares it to long-term average.

Table 4 Monthly rainfall (mm) recorded at Maitland Visitors Centre weather station (long term mean includes East Maitland Bowling Club 1902 to 1994)

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
Mean 1902-2014	70	104	93	85	67	87	53	42	52	62	73	69	855



Figure 4 Monthly rainfall for 2013-14 survey period compared to historical monthly average (1902-2013)



Below average rainfall was recorded throughout most of 2013/14 survey period compared with the historical average with the exception of November 2013. In this month there were significant rainfall events of 120 mm on 18 November 2013 and 65 mm on 30 November 2013 as well seven smaller events between 11 and 30 November 2013. February 2014 also had above average falls with three significant falls on 17, 20 and 28 February 2014, the highest being 56 mm on the 28 February 2014. This was followed by 54 mm recorded on 1 March 2014.

Amphibian surveys were carried out two to three days after the 120 mm rainfall event on 18 November 2013. The water level within each of the waterbodies remained relatively high during most of the survey period including the amphibian and waterbird surveys.

The F&FMP (ecobiological 2007) recommends that sufficient weather stations be established in order to record rainfall in the catchment. This would assist in the collection of more accurate rainfall data over the next 10 – 15 years of pre-mining monitoring.

The installation of permanent water depth indicators in the Main and South Swamps would also provide valuable quantitative data on water levels in the Nature Reserve. Permission for installation should be sought from OEH.



3.3 FLORA RESULTS

Flora surveys for this report were conducted during November 2013. A total of 188 species have been identified on the site since monitoring surveys commenced in 2008 (**Appendix 1**).

No threatened flora species were recorded during the field surveys. Three species considered as regionally significant by Eco Logical (2003) were detected in the surveys, including *Cyperus odoratus*, *Melaleuca linariifolia* and *Enydra fluctuans*. All three species have been recorded in previous studies.

Coastal Foothills Spotted Gum - Ironbark Forest (Q1)

The Coastal Foothills Spotted Gum - Ironbark Forest quadrat (Q1) has previously been found to contain the highest species diversity of the flora plots surveyed in the Reserve (**Plate 1**).



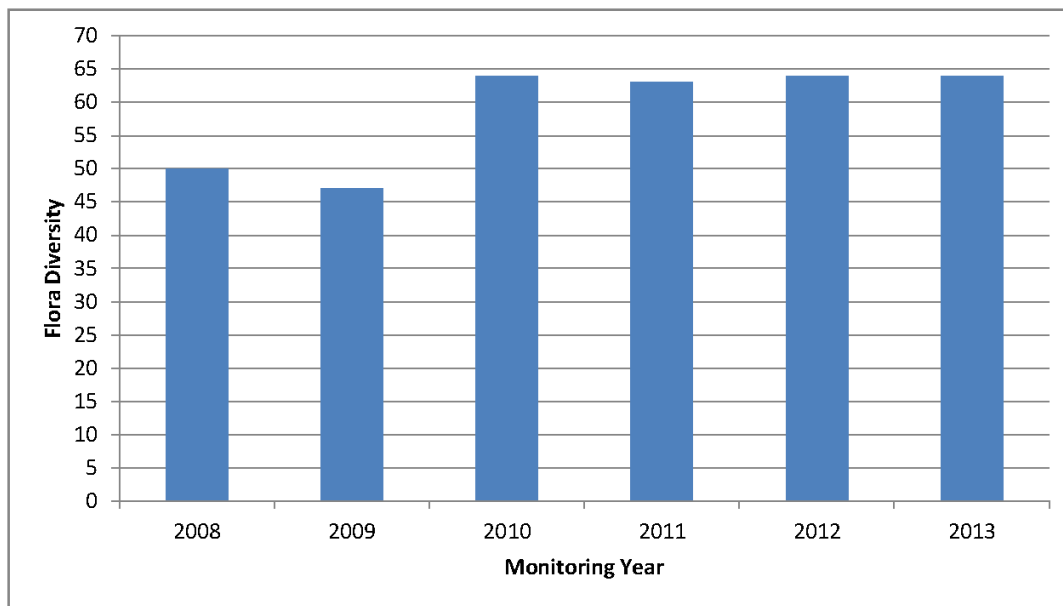
Plate 1 Flora quadrat 1 (Q1) located in Coastal Foothills Spotted Gum - Ironbark Forest (Photograph taken in 2012)

Flora species richness in this quadrat decreased slightly between 2008 and 2009, and increase markedly in 2010 and has been relatively stable ever since (**Figure 5**). No new flora species were recorded in the 2013 survey. The most significant weed recorded in this plot is *Lantana camara* (Lantana).



Overall, the vegetation community appears to be in a relatively good health with no obvious signs of decline.

Figure 5 Flora species richness within Q1 from 2008 to 2013



Freshwater Wetland Complex (Q2)

Ten flora species were recorded in the Freshwater Wetland Complex (Q2) in 2008 (Plate 2). 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.

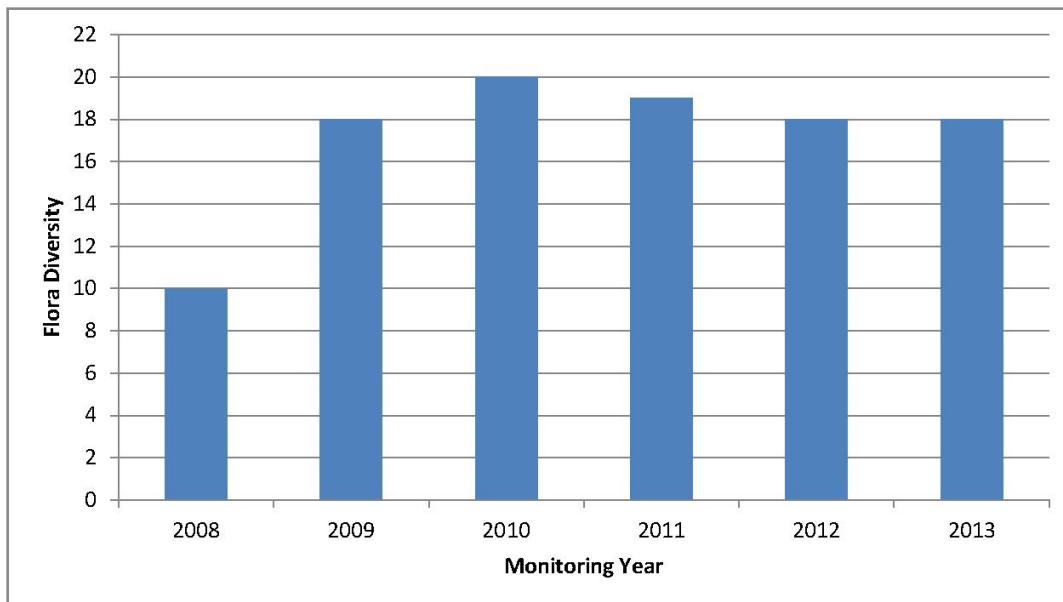
Flora species richness has fluctuated slightly within the quadrat from 2009 to 2013 (Figure 7) which is likely to be a result of natural variation.

Overall the wetland appears to be in good health with native species dominant (*Typha orientalis*, *Bolboschoenus caldwellii* and *Eleocharis equisetina*) whereas the abundance of exotic species is low.



Plate 2 Flora quadrat 2 (Q2) located in Freshwater Wetland Complex dominated by Typha (Photograph taken in 2012)

Figure 6 Flora species richness within Q2 from 2008 to 2013





Paperbark Swamp Forest (Q3)

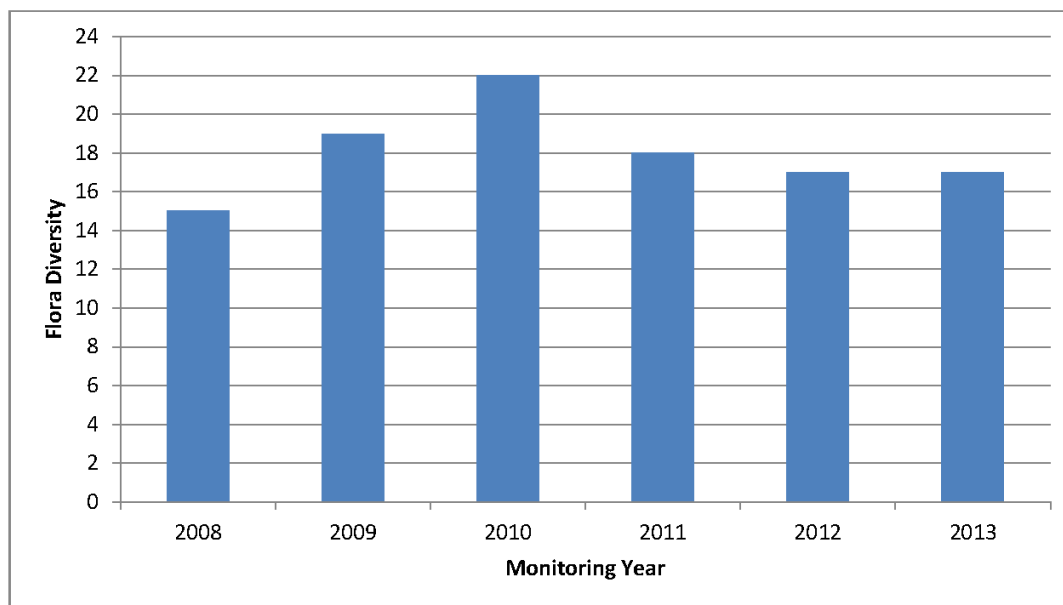
Flora species richness in the Paperbark Swamp Forest (Q3) (Plate 3) increased from 2008 to 2010, then declined from 2011 to 2012 where it has remained stable (Figure 9). This fluctuation is likely to be natural and influenced by changes in the amount of standing water within the swamp. Conditions in 2012 allowed the proliferation of *Sigesbeckia orientalis* subsp. *orientalis* and this species still dominates the ground layer in 2013. There is some debate as to whether this species is native or exotic (Bean 2007), however its abundance is likely to decrease as the swamp returns to a wetter state.



Plate 3 Flora quadrat 3 (Q3) located in Paperbark Swamp Forest (Photograph taken in 2012)



Figure 7 Flora species richness within Q3 from 2008 to 2013



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 stable from 2012 to 2013 (Figure 9). This is likely to be due to natural variation.

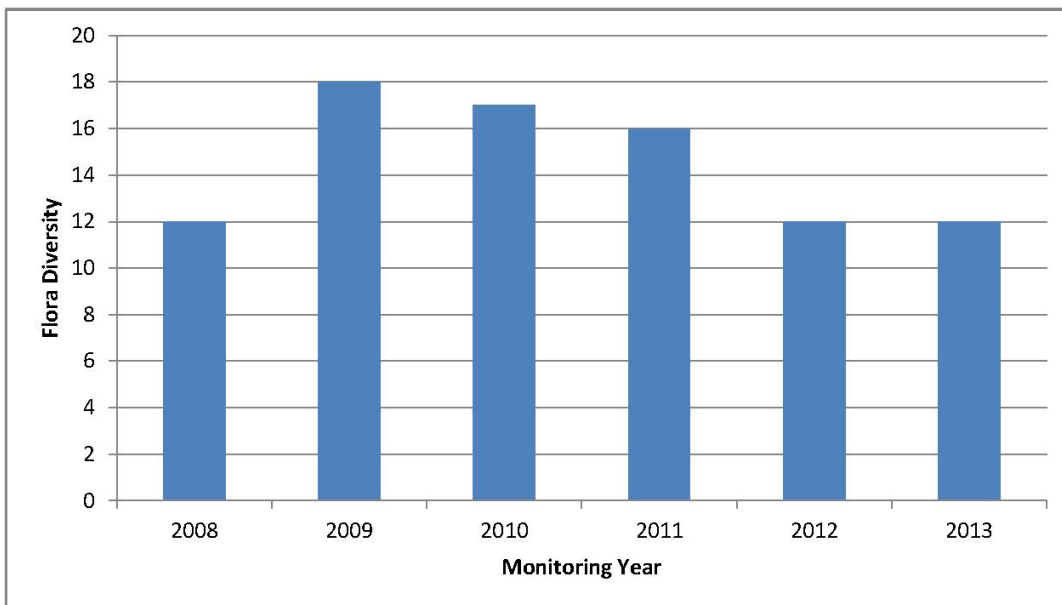
Alternanthera philoxeroides (Alligator Weed) has been recorded in 2011, 2012 and 2013. The abundance of this noxious weed has increased slightly since it was first detected however at this stage it is causing only minor impacts as it does not appear to be out-competing native species.

Water Hyacinth (*Eichhornia crassipes*) continues to persist at the location in moderate densities.



Plate 4 Flora quadrat 4 located in Paperbark Swamp Forest (Photograph taken in 2012)

Figure 8 Flora species richness within Q4 from 2008 to 2013





Flora Transect

The flora transect samples a Freshwater Wetland Complex as can be seen in Plate 5.



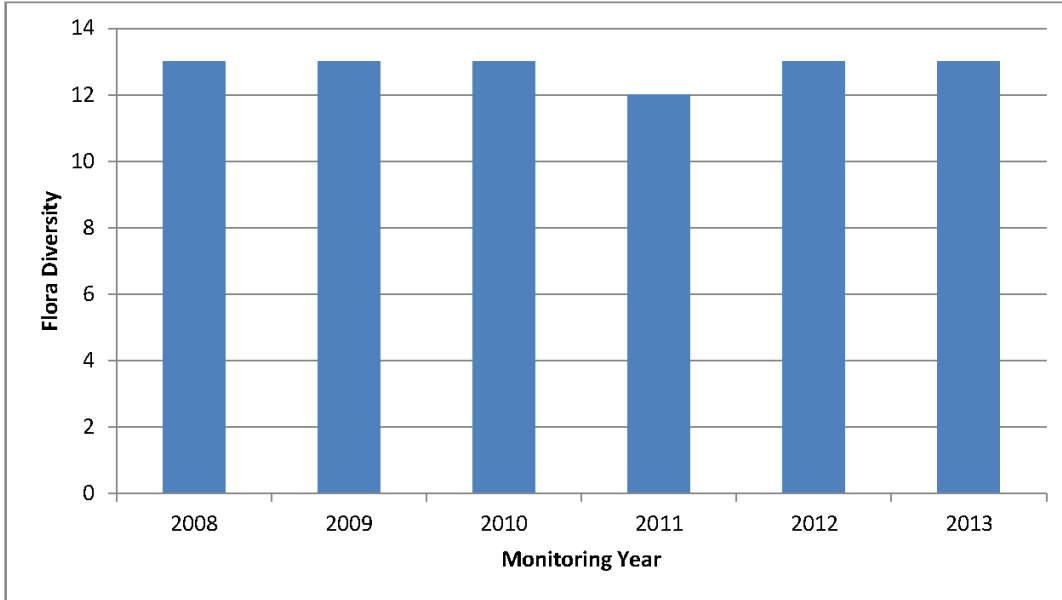
Plate 5 Flora transect located in Freshwater Wetland Complex (Photograph taken in 2012)

Flora species richness recorded on the transect has remained relatively stable since monitoring began (Figure 10). A total of 13 species have been detected during each survey event with the exception of 2011 when *Cynodon dactylon* (Couch) was not detected.

Water Hyacinth (*Eichhornia crassipes*) was recorded at high densities from 2008 to 2011, with a reduction in 2012 following control efforts. It was not recorded at all in 2013.



Figure 9 Flora species richness within T1 from 2008 to 2013





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)** – this species can survive for a long 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 6). 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 7). Plates 8 and 9 also show Water Hyacinth at his location.
 - The 2012 monitoring event found that the coverage of *Eichhornia crassipes* has decreased from the previous year due to weed spraying by the Pambalong Nature Reserve Enhancement Project. The spraying has resulted in more open water present in the North Swamp (Plate 10).
 - In 2013 the Water Hyacinth cover had increased at the Main Swamp outlet to the North Swamp (Plate 11).
 - Water Hyacinth is a declared Class 4 Noxious Weed 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. Ongoing management would need to be coordinated through local government and stakeholders. 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.

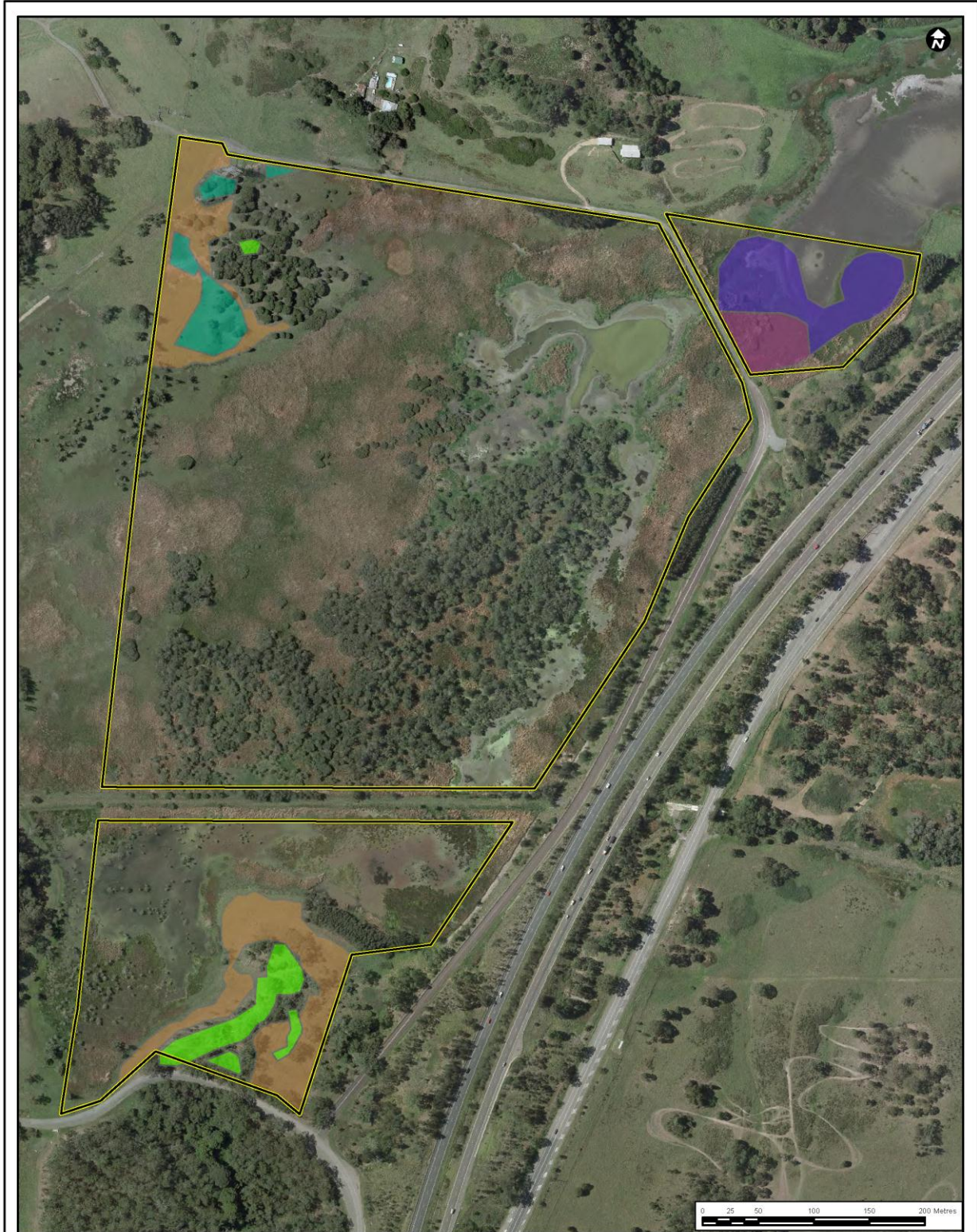








Figure 10: Weed Species Mapping

Legend

- | | | | |
|---|-------------------------------|---|--------------------------|
|  | Pambalong Nature Reserve |  | Water Hyacinth |
|  | Blackberry (Treated 2009) |  | Lantana |
|  | Water Hyacinth (Treated 2009) |  | Kikuyu and Various Weeds |



Map Projection:
 GDA 1994 MGA Zone 56

Data Sources:
 LPI - 2011
 OEH - 2012
 Kleinfelder - 2014

Project Ref: 137821
Plot Date: 16/06/2014 15:50
Revision: 001 (gjoyce)

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.

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Plate 6 Water Hyacinth at the Northern Swamp inlet in 2008



Plate 7 Water Hyacinth at the Northern Swamp inlet in 2009 showing the installation of a grate



Plate 8 Water Hyacinth at the Northern Swamp inlet in 2010



Plate 9 Water Hyacinth at the Northern Swamp inlet during the 2011 monitoring event



Plate 10 Water Hyacinth at the Northern Swamp inlet during the 2012 monitoring event



Plate 11 Water Hyacinth at the Northern Swamp inlet during the 2013 monitoring event



- ***Pennisetum clandestinum* (Kikuyu)** forms dense, monoculture grassy thickets within disturbed areas of the subject site. The thickets are so dense in some areas that they are suppressing native vegetation regeneration.
 - 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 the thickets are unlikely to spread into the wetland areas.
 - Kikuyu is particularly dense in the north-west and south-east corners of the subject site.

- ***Rubus fruticosus* sp. agg. (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 a declared Class 4 Noxious Weed 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 sold, propagated or knowingly distributed).
 - 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.

- ***Lantana camara* (Lantana)** is a primary weed of the dry sclerophyll woodland at the southern portion of the subject site. This species can dominate the shrub and mid stratum, 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 TSC Act.
 - Lantana is a declared Class 4 Noxious Weed in Cessnock and Class 5 Noxious Weed in all of NSW. 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.

- ***Ageratina adenophora* (Crofton Weed)** is tolerant of wet soils and will extend into wetlands if unmanaged. This species is a Noxious Weed and control is required where the weed is found. The NPWS Hunter Region Pest Management Strategy (2002) identifies Crofton Weed as a “high priority” weed. There were no significant outbreaks of this species recorded in the 2013 surveys.
 - Crofton Weed is a declared Class 4 Noxious Weed 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.
- ***Alternanthera philoxeroides* (Alligator Weed)** may infest both terrestrial and aquatic environments. Although only a few small plants were identified, this species is known to have the potential to cause severe impacts and should continue to be closely monitored. The cover of this weed was observed to have increased slightly in 2013. Alligator Weed has the potential to infest waterways and invade adjoining land. Alligator Weed is easily spread and once established it is virtually impossible to eradicate. It is a declared noxious weed and eradication measures are required. The NPWS Hunter Region Pest Management Strategy (2002) identifies Alligator Weed as a “high priority” weed.

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.

Weeds not detected during field surveys but with the potential to invade include:

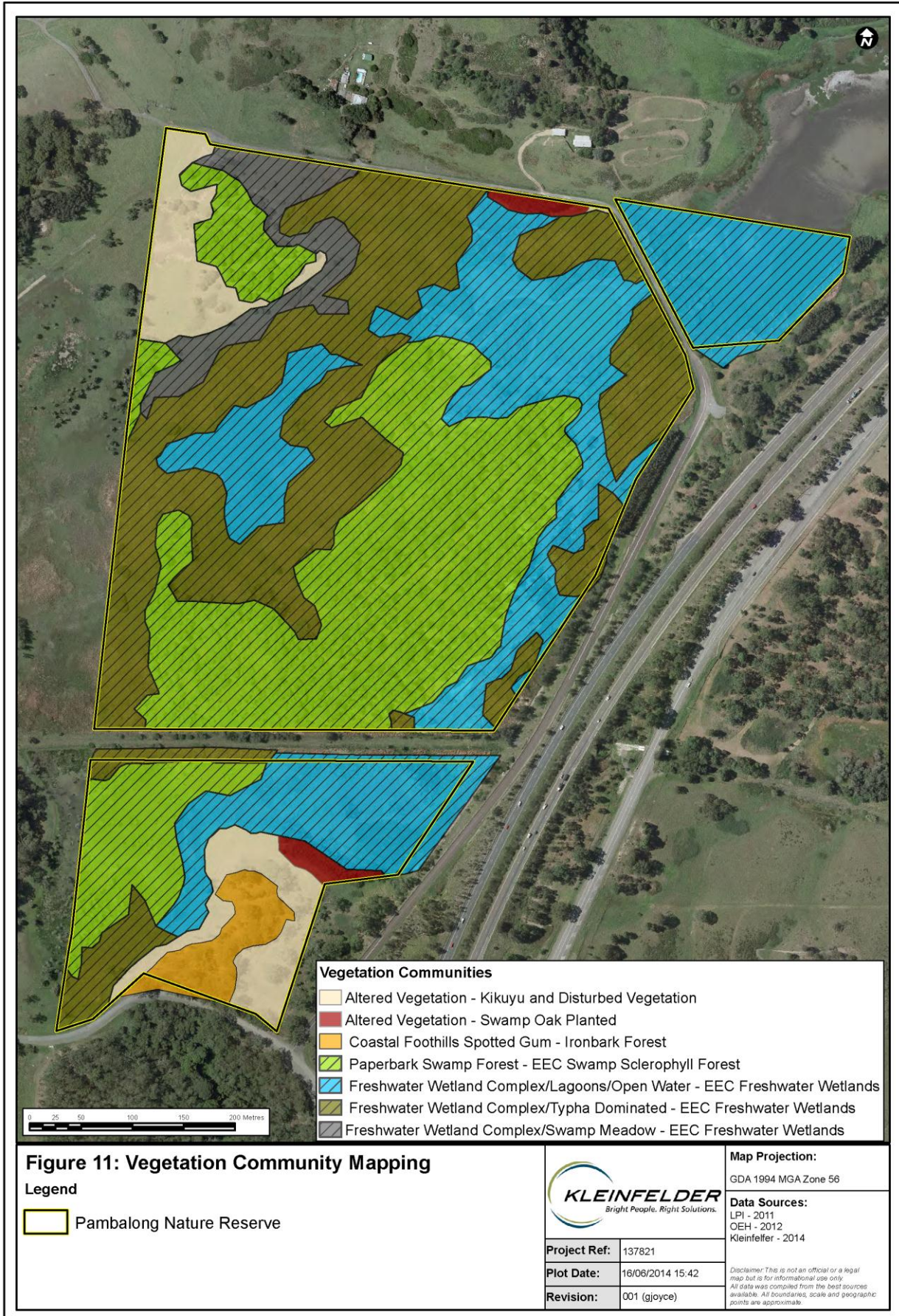
- ***Xanthium occidentale* (Noogoora Burr)**. This species has been identified from previous studies. The NPWS Hunter Region Pest Management Strategy (2002) identifies Noogoora Burr as a “high priority” weed, although at this stage there are no specific control programs for this species in the reserve.

Some naturally occurring species may also present a problem if they become too abundant. *Typha orientalis* (Typha) and *Phragmites australis* (Phragmites) have the potential to spread into areas of open water, restricting the available habitat of open water bird species, such as pelicans, ducks and swans.



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 2013 surveys.



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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 *Lantana camara* and to a lesser extent, *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 consists 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. The vine *Parsonsia straminea* is found within the quadrat, however, it is more common in mature vegetation. 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*, *Paspalum distichum*, *Persicaria hydropiper* and *Juncus usitatus*.

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*. Two epiphytic orchid species, *Dendrobium linguiforme* (Tongue Orchid) and *D. teretifolium* (Rat's Tail Orchid), occur on several *Casuarina glauca* trees. The weed Water Hyacinth is present in low and scattered numbers in this community.

The Paperbark Swamp Forest and Paperbark Woodland forms part of the NSW TSC 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 TSC 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 T1 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 *Bolboschoenus caldwellii*, *Eleocharis*



acuta and *Paspalum distichum*. *Ludwigia peploides* subsp. *montevidensis*, *Spirodela punctata* and *Triglochin procera*.

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. The results of the 2013 surveys were not significantly different to the 2012 surveys.

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 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 EEC's occupy the majority of the reserve and their distribution is shown in **Figure 11**.

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, backswamps, lagoons and lakes but may also occur in backbarrier 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. 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 were indicative of the EEC.

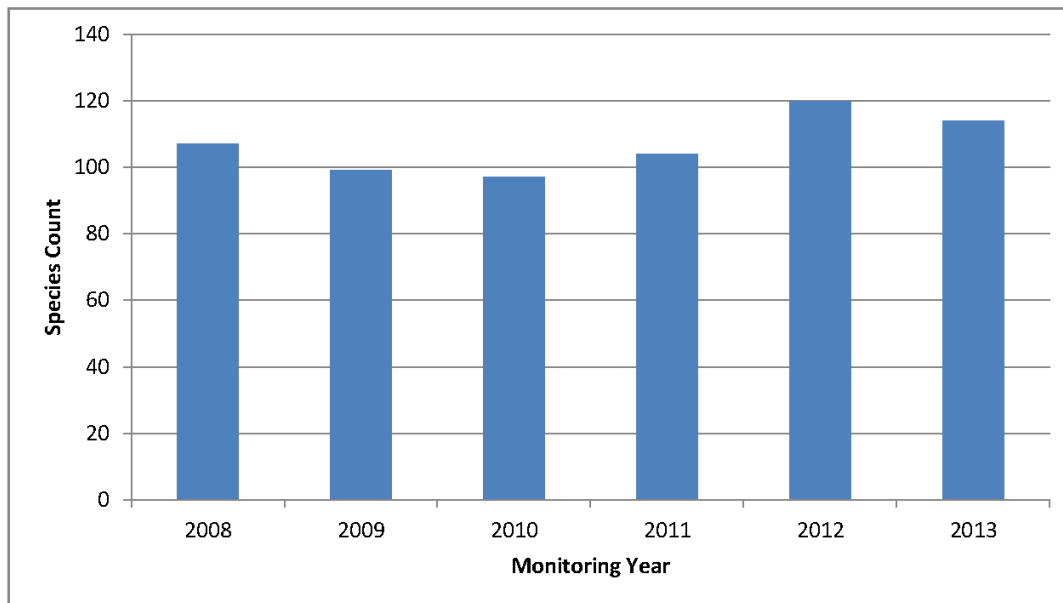
Within the Lower Hunter district, this community includes 'Swamp Mahogany-Paperbark Swamp Forest' (map unit 37), Riparian Melaleuca Swamp Woodland (map unit 42) and Melaleuca Scrub (map unit 42a) of NPWS (2000).



3.6 FAUNA

A total of 114 fauna species were recorded by monitoring surveys on the subject site in the 2013/14 monitoring period (Appendix 2). Total fauna species richness recorded in each monitoring year is shown in Figure 12.

Figure 12 Fauna species richness recorded from 2008 to 2013



Species recorded in 2013 comprised eight frogs, three terrestrial mammals, three arboreal mammal, one reptile, 14 bat and 85 bird species. Of these, six species are listed as threatened (Vulnerable) under the NSW TSC Act (Table 5) including Varied Sittella (*Daphoenositta chrysoptera*) which has not been recorded in any previous survey.

An unidentified *Pteropus* sp detected in 2013 and is possibly the threatened *Pteropus poliocephalus* (Grey-headed Flying Fox), which has permanent camps in the region. This species was also recorded in the 2008 and 2009 surveys.

Latham's Snipe (*Gallinago hardwickii*) which was recorded by Kleinfelder in 2009, 2011 and 2012 was not recorded during surveys in 2013.



Table 5 Threatened fauna species recorded in 2013/14

Scientific Name	Common Name	Legal status	Survey Method
<i>Miniopterus australis</i>	Little Bentwing-bat	V – TSC Act	Trapped and Anabat recording (confident)
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	V – TSC Act	Anabat recording (confident)
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V – TSC Act	Anabat recording (confident)
<i>Myotis macropus</i>	Large-footed Myotis	V – TSC Act	Anabat recording (confident)
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V – TSC Act	Anabat recording (probable)
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V – TSC Act	Observed.

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

Numbers of amphibian, reptile, and mammal species detected in each monitoring year is show in Figure 13. Total species richness has remained relatively stable with the exception of 2009 where total species richness was considerably lower and no reptiles were recorded. Mammal numbers have increased steadily since 2009 with twenty species recorded in 2013/14 which is double that recorded in 2009.

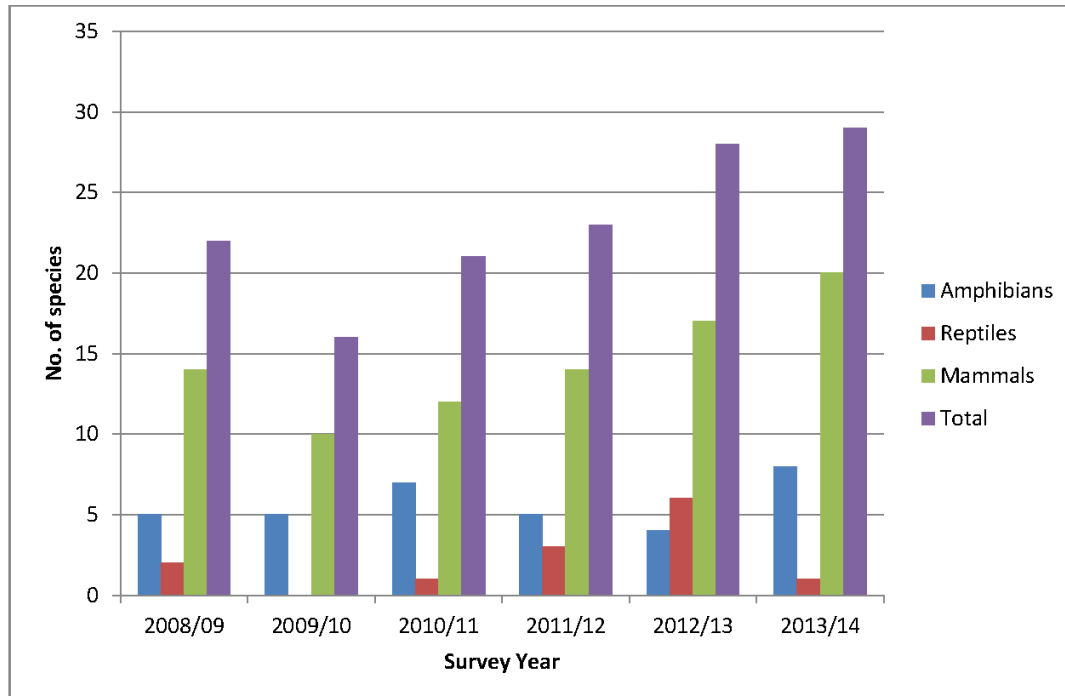


Figure 13 Fauna species richness by taxon from 2008 to 2013 (excluding birds)



Three mammal species recorded from trapping and spotlight surveys have not been recorded in previous years: Sugar Glider (*Petaurus breviceps*), Common Ringtail Possum (*Pseudocheirus peregrinus*) and Swamp Rat (*Rattus lutreolus*). Sugar Glider (*Petaurus breviceps*) was previously recorded by White (2000).

One amphibian recorded in 2013, Spotted Marsh Frog (*Limnodynastes tasmaniensis*), had not been recorded in previous years.

A total of nineteen bat species has been recorded in the nature reserve across all surveys which is considered a high diversity for the local area.

Introduced species such as the House Mouse and Black Rat and predators such as the Red Fox, Feral Cat and Dog have the potential to reduce native mammal populations. In the 2013/14 survey Red Fox and Dog were recorded.

Figure 14 shows changes in bird species richness at each of the five survey locations over time. A total of 85 bird species were recorded on site in 2013/14 compared with 91 bird species were recorded on site in 2012/13, 81 species in 2011/12, 75 species in 2010/11, 83 species in 2009/10 and 84 species in 2008/09.

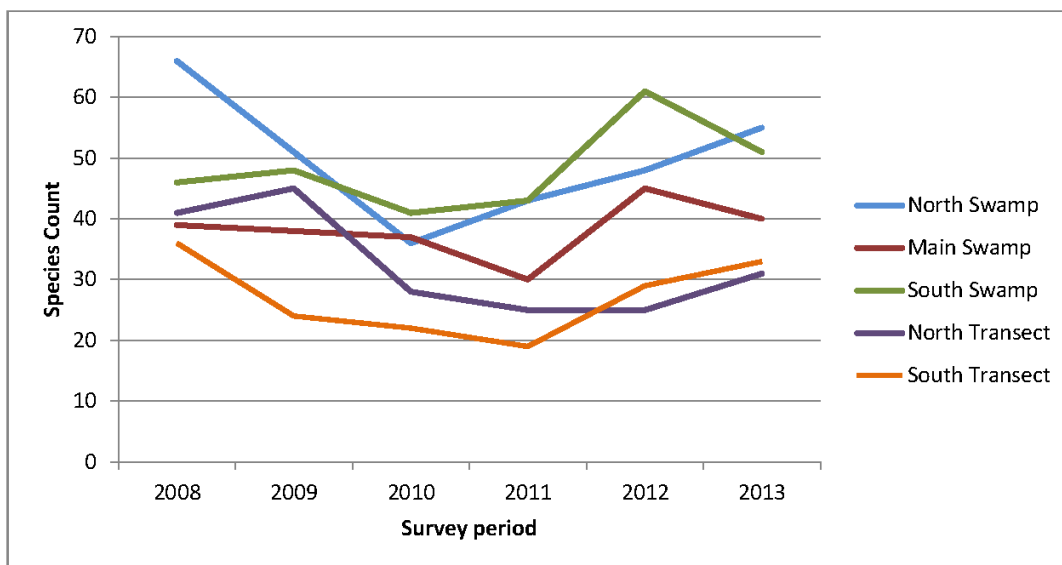


Figure 14 Bird species richness recorded at monitoring points from 2008 to 2013



Seven species not previously detected by monitoring surveys were recorded during the 2013/14 surveys including the Black-shouldered Kite, Dartar, Rufous Fantail, Satin Bowerbird, Varied Sittella, White-cheeked Honeyeater and White-naped honeyeater.

Total bird species richness has remained relatively stable across all sites with slight increases in recent years. While species richness was similar between survey events, species composition is quite variable between seasons and year-to-year. Surveys conducted in spring almost always detect more species than those conducted in autumn.

Factors likely to affect bird species detection between years include seasonality issues (e.g. arrival times of migratory species), flowering times of foraging resources for nectarivorous species, climatic conditions and individual species ecology (eg. 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).

Photographs of each water body surveyed for birds and amphibians are provided in **Appendix 3**. Photographs from the October 2011, March 2012 and March 2014 survey period 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.



4. CONCLUSIONS AND RECOMMENDATIONS

Monitoring of the Pambalong Nature Reserve has been undertaken in 2013/14 in accordance with the Flora and Fauna Management Plan for Abel Underground Coalmine (ecobiological 2007).

In total there were 101 flora species (within the flora survey quadrats and transect) and 114 fauna species comprising eight frog, 20 mammal (14 bat), one reptile, and 85 bird species recorded at Pambalong Nature Reserve by monitoring surveys in 2013. The following threatened species were recorded during field surveys:

- Little Bentwing-bat (*Miniopterus australis*)
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)
- Eastern Freetail-bat (*Mormopterus norfolkensis*)
- Large-footed Myotis (*Myotis macropus*)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*)
- Varied Sittella (*Daphoenositta chrysoptera*)

The 2013 survey recorded no new flora species. Flora species richness has remained relatively constant between the monitoring events in quadrats 1, 2 and 4 and the 50m transect, with a steady increase occurring at Q3. No significant changes to the vegetation community extent were recorded in the 2013 surveys.

Kikuyu grass continues to cover significant areas and any treatment of these areas would require follow up regeneration and rehabilitation. All other significant weed species identified in Pambalong Nature Reserve should continue to be monitored and managed as necessary.

A recommendation made in previous years for water monitoring in the Main and South Swamps remains a high priority. Funding has recently been provided by the Donaldson Conservation Trust to The Tom Farrell Institute for the Environment to install a water quality monitoring station at Pambalong that will record pH, electrical conductivity, temperature, dissolved oxygen, turbidity and water level within 15 minute intervals. The station is expected



to be installed and operating by spring 2014. Data generated by this station will be immensely valuable in interpreting the results of future ecological monitoring.

Annual monitoring in 2013/14 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.



5. REFERENCES

Anstis M 2002, *Tadpoles of South-Eastern Australia: A Guide with Keys*, Reed New Holland, Sydney.

Bean AR 2007, 'A New System for Determining which Plants are Indigenous in Australia', *Australian Systematic Botany* 20(1), pp 1-43.

Bell FG, Stacey TR & Genske DD 2000 'Mining subsidence and its effect on the environment: some differing examples' *Environmental Geology* 40(1-2), pp 135-152.

Bibby CJ, Burgess ND & Hill DA 2000, *Bird Census Techniques*, Academic Press Limited, London.

Briggs JD & Leigh JH 1995, *Rare or Threatened Australian Plants*, CSIRO, Canberra.

Brunner H, Triggs B & Ecobyte Pty Ltd 2002, *Hair ID - An interactive tool for identifying Australia mammalian hair*, CSIRO Publishing, Collingwood.

Churchill S 2008, *Australian Bats 2nd Edition*, Allen & Unwin, Crows Nest.

Department of Environment and Conservation 2006, *Pambalong Nature Reserve Plan of Management*, DEC Hunter Region, May 2006.

ecobiological 2007, *Abel Underground Coalmine Flora and Fauna Management Plan*, prepared for Donaldson Coal Pty Ltd, October 2007.

Eco Logical Australia 2003, *An Investigation and Description of the Vegetation of the Pambalong Swamp (Pambalong Nature Reserve)*, NSW National Parks and Wildlife Service.

Harden GJ (ed) 1992, *Flora of New South Wales Volume 3*, NSW University Press, Sydney.

Harden GJ (ed) 1993, *Flora of New South Wales Volume 4*, NSW University Press, Sydney.

Harden GJ (ed) 2000 *Flora of New South Wales Volume 1*, NSW University Press, Sydney.



Harden GJ (ed) 2002 *Flora of New South Wales Volume 2*, NSW University Press, Sydney.

NPWS 2000, *Vegetation Survey, Classification and Mapping Lower Hunter and Central Coast Region Version 1.2*, A project undertaken for The Lower Hunter and Central Coast Regional Environment Management Strategy CRA Unit Sydney Zone, National Parks and Wildlife Service.

NPWS 2002, *Hunter Region Pest Management Strategy*, NSW National Parks and Wildlife Service, Shortland.

NSW Scientific Committee 2004, *Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions – Endangered Ecological Community Listing*, Office of Environment and Heritage Website, Updated 28 February 2011, Available:

<http://www.environment.nsw.gov.au/determinations/FreshwaterWetlandsEndSpListing.htm>

Poore MED 1955 'The use of phytosociological methods in ecological investigations: The Braun-Blanquet system', *Journal of Ecology*, 43(1), pp 226-244.

Sidle RC, Kamil I, Sharma A & Yamashita S 2000, 'Stream response to subsidence from underground coal mining in central Utah', *Environmental Geology* 39(3-4), pp 279-291.

Straw P 2000, *Birds of Pambalong Nature Reserve – Management Strategy Avifauna*, Avifauna studies for NSW National Parks and Wildlife Service.

Triggs B 1996, *Tracks, Scats and Other Traces: A Field Guide to Australian Mammals*, Oxford University Press.

White A 2000, *Frog, Reptile and Mammal Survey Minmi Swamp Biosphere*, Environmental Consultants for NSW National Parks and Wildlife Service.



APPENDIX 1. SPECIES LIST

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Acanthaceae	<i>Brunoniella australis</i>	Blue Trumpet	1				
Alismataceae	<i>Alisma plantago-aquatica</i>	Water Plantain					
Amaranthaceae	<i>Alternanthera denticulata</i>	Lesser Joyweed					
Amaranthaceae	* <i>Alternanthera philoxeroides</i>	Alligator Weed				3	
Anthericaceae	<i>Arthropodium milleflorum</i>	Pale Vanilla-lily	1				
Apiaceae	* <i>Foeniculum vulgare</i>	Fennel					
Apiaceae	* <i>Hydrocotyle bonariensis</i>	Pennywort					
Apiaceae	<i>Centella asiatica</i>	Indian Pennywort		1			
Apocynaceae	* <i>Araujia sericifera</i>	Moth Vine					
Apocynaceae	* <i>Gomphocarpus fruticosus</i>	Wild Cotton					
Apocynaceae	<i>Parsonsia straminea</i>	Monkey Rope			2		
Asparagaceae	* <i>Asparagus aethiopicus</i>	Fern Asparagus					
Asteraceae	* <i>Ageratina adenophora</i>	Crofton Weed					
Asteraceae	* <i>Ambrosia tenuifolia</i>	Lacy Ragweed					1
Asteraceae	* <i>Aster subulatus</i>	Wild Aster					
Asteraceae	* <i>Bidens pilosa</i>	Cobblers peg	1				
Asteraceae	* <i>Cirsium vulgare</i>	Black Thistle					
Asteraceae	* <i>Conyza canadensis</i> var. <i>canadensis</i>	Canadian Fleabane					
Asteraceae	* <i>Conyza</i> sp.	Fleabane	1				
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	1				1
Asteraceae	* <i>Senecio madagascariensis</i>	Fireweed	1		1		
Asteraceae	* <i>Sonchus oleraceus</i>	Milk Thistle		1			
Asteraceae	* <i>Tagetes minuta</i>	Stinking Roger					
Asteraceae	<i>Brachycome multifida</i> var. <i>dilatata</i>	Cut-leaf daisy	1				
Asteraceae	<i>Cotula coronopifolia</i>	Water Buttons					
Asteraceae	<i>Enhydra fluctuans</i>	-					
Asteraceae	<i>Euchiton involucratus</i>	Star Cudweed					
Asteraceae	<i>Ozothamnus diosmifolius</i>	White dogwood					
Asteraceae	<i>Senecio pterophorus</i>	-					
Asteraceae	<i>Sigesbeckia orientalis</i> subsp. <i>orientalis</i>	Indian Weed			4		
Asteraceae	<i>Vernonia cinerea</i> var. <i>cinerea</i>	-	1				
Asteraceae	<i>Vittadinia cuneata</i> var. <i>cuneata</i>	Fuzzweed	1				



Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Bignoniaceae	<i>Pandorea pandorana</i> subsp. <i>pandorana</i>	Wonga Wonga Vine	2				
Campanulaceae	<i>Wahlenbergia gracilis</i>	Native Bluebell					
Caryophyllaceae	* <i>Stellaria media</i>	Chickweed					
Casuarinaceae	<i>Casuarina glauca</i>	Swamp Oak		1		3	
Celastraceae	<i>Maytenus silvestris</i>	Orange Bark	1				
Ceratophyllaceae	<i>Ceratophyllum demersum</i>	Hornwort					1
Chenopodiaceae	<i>Einadia hastata</i>	Berry Saltbush					
Commelinaceae	* <i>Tradescantia albiflora</i>	Wandering Jew					
Commelinaceae	<i>Commelina cyanea</i>	Scurvy Weed	1				
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	3	1	
Cyperaceae	<i>Cyperus gracilis</i>	Slender Flat-sedge	1				
Cyperaceae	<i>Cyperus inversa</i>	-					
Cyperaceae	<i>Cyperus odoratus</i>	-					1
Cyperaceae	<i>Eleocharis acuta</i>	Tall Spike-rush					
Cyperaceae	<i>Eleocharis equisetina</i>	-		3	2		1
Cyperaceae	<i>Eleocharis sphacelata</i>	Tall Spike-rush					1
Cyperaceae	<i>Fimbristylis dichotoma</i>	Common Fringe-sedge					
Cyperaceae	<i>Schoenoplectus subulatus</i>	-					
Cyperaceae	<i>Schoenoplectus validus</i>	-		3			2
Euphorbiaceae	* <i>Ricinus communis</i>	Castor Oil Plant					
Fabaceae - Caesalpinioideae	* <i>Senna pendula</i> subsp. <i>glabrata</i>	Cassia					
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					
Fabaceae - Faboideae	* <i>Vicia sativa</i>	Common Vetch					
Fabaceae - Faboideae	<i>Daviesia ulicifolia</i>	Gorse Bitter Pea	2				
Fabaceae - Faboideae	<i>Desmodium gunnii</i>	Slender Tick-trefoil					



Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Fabaceae - Faboideae	<i>Desmodium rhytidophyllum</i>	Tick-trefoil	1				
Fabaceae - Faboideae	<i>Desmodium varians</i>	Slender Tick-trefoil					
Fabaceae - Faboideae	<i>Glycine clandestina</i>	Twining Glycine					
Fabaceae - Faboideae	<i>Glycine tabacina</i>	-	1				
Fabaceae - Faboideae	<i>Hardenbergia violacea</i>	Purple Twining Pea	1				
Fabaceae - Faboideae	<i>Kennedia rubicunda</i>	Red Kennedy Pea					
Fabaceae - Faboideae	* <i>Vicia sativa</i>	-		1			
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</i> subsp. <i>irrorata</i>	-					
Fabaceae - Mimosoideae	<i>Acacia maidenii</i>	Maidens Wattle	2				
Gentianaceae	* <i>Centaurium erythraea</i>	Common Centaury					
Goodeniaceae	<i>Goodenia heterophylla</i>	-	2				
Haloragaceae	<i>Myriophyllum variifolium</i>	-					1
Iridaceae	* <i>Freesia laxa</i>	-	1				
Juncaceae	<i>Juncus continuus</i>	-			2		
Juncaceae	<i>Juncus pallidus</i>	Pale Rush					
Juncaceae	<i>Juncus usitatus</i>	Common Juncus	1	1			
Juncaginaceae	<i>Triglochin procerum</i>	-		2	1	1	
Juncaginaceae	<i>Triglochin striata</i>	Streaked Arrowgrass					
Lamiaceae	<i>Plectranthus parviflorus</i>	Cockspur Flower	1				
Lemnaceae	<i>Lemna disperma</i>	-				3	
Lemnaceae	<i>Spirodela punctata</i>	Duck Weed				4	1
Lobeliaceae	<i>Pratia purpurascens</i>	White root	1				
Lomandraceae	<i>Lomandra glauca</i>	Pale Mat-rush	1				
Lomandraceae	<i>Lomandra multiflora</i> subsp. <i>multiflora</i>	Iron Grass	2				
Loranthaceae	<i>Dendrophthoe vitellina</i>	Mistletoe	1				
Luzuriagaceae	<i>Eustrephus latifolius</i>	Wombat Berry	1				
Luzuriagaceae	<i>Geitonoplesium cymosum</i>	Scrambling Lily	1				
Malvaceae	* <i>Sida rhombifolia</i>	Paddy's Lucerne	1				



Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Menispermaceae	<i>Stephania japonica</i> var. <i>discolor</i>	Snake Vine	1				
Moraceae	<i>Ficus macrophylla</i>	Moreton Bay Fig			1		
Myrsinaceae	<i>Myrsine variabilis</i>		2				
Myrtaceae	<i>Corymbia maculata</i>	Spotted Gum	3				
Myrtaceae	<i>Eucalyptus acmenoides</i>	White mahogany	2				
Myrtaceae	<i>Eucalyptus siderophloia</i>	Grey Ironbark	4				
Myrtaceae	<i>Eucalyptus tereticornis</i>	Forest Redgum					
Myrtaceae	<i>Melaleuca ericifolia</i>	-			3	4	
Myrtaceae	<i>Melaleuca linariifolia</i>	Flax-leaved Paperbark		1	5	4	
Myrtaceae	<i>Melaleuca styphelioides</i>	-			4		
Oleaceae	<i>Notelaea longifolia</i>	Mock olive	1				
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		2	1
Orchidaceae	<i>Dendrobium linguiforme</i>	Tongue Orchid				1	
Orchidaceae	<i>Dendrobium teretifolium</i>	Rat's Tail Orchid					
Oxalidaceae	<i>Oxalis perennans</i>	-	1				
Passifloraceae	<i>*Passiflora edulis</i>	Common Passionfruit	1				
Phormiaceae	<i>Dianella caerulea</i>	Blue Flax-lily	1				
Phormiaceae	<i>Dianella revoluta</i> var. <i>revoluta</i>	Blueberry Lily					
Phyllanthaceae	<i>Breynia oblongifolia</i>	Coffee Bush	1				
Phyllanthaceae	<i>Phyllanthus hirtellus</i>	Thyme Spurge					
Pittosporaceae	<i>Bursaria spinosa</i>	Box Thorn	2				
Plantaginaceae	<i>*Plantago lanceolata</i>	Lambs Tongue	1	2			
Poaceae	<i>*Andropogon virginicus</i>	Whisky Grass					
Poaceae	<i>*Axonopus fissifolius</i>	Narrow-leaved Carpet Grass					
Poaceae	<i>*Briza maxima</i>	Quaking Grass					
Poaceae	<i>*Bromus catharticus</i>	Prairie Grass					
Poaceae	<i>*Chloris gayana</i>	Rhodes Grass					
Poaceae	<i>*Cortaderia selloana</i>	Pampas Grass					
Poaceae	<i>Digitaria parviflora</i>	Small-flowered Finger Grass	1				
Poaceae	<i>*Ehrharta erecta</i>	Panic Veldtgrass	1				
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					



Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Poaceae	* <i>Paspalum dilatatum</i>	Paspalum	1				
Poaceae	* <i>Paspalum urvillei</i>	Tall Paspalum					
Poaceae	<i>Paspalidium distans</i>	-	1				
Poaceae	* <i>Pennisetum clandestinum</i>	Kikuyu		2			
Poaceae	* <i>Polypogon monspeliensis</i>	Annual Beardgrass					
Poaceae	* <i>Setaria pumila</i>	Pale Pigeon Grass					
Poaceae	* <i>Setaria sphaecelata</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	1				
Poaceae	<i>Aristida vagans</i>	Three-awned Spear Grass	1				
Poaceae	<i>Austrostipa</i> sp.	-					
Poaceae	<i>Capillipedium parviflorum</i>	Scented-top Grass					
Poaceae	<i>Cymbopogon refractus</i>	Barbed Wire Grass	1				
Poaceae	<i>Cynodon dactylon</i>	Couch		3	3		
Poaceae	<i>Dichelachne micrantha</i>	Shorthair Plumegrass	2				
Poaceae	<i>Digitaria ramularis</i>	-					
Poaceae	<i>Echinopogon caespitosus</i>	Tufted Hedgehog Grass	1				
Poaceae	<i>Entolasia stricta</i>	Wiry panic	4				
Poaceae	<i>Imperata cylindrica</i>	Blady grass	1				
Poaceae	<i>Lachnagrostis filiformis</i>	-	2		1		
Poaceae	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass	1				
Poaceae	<i>Oplismenus aemulus</i>	Basket Grass	1				
Poaceae	<i>Panicum simile</i>	Two Colour Panic	1				
Poaceae	<i>Paspalum distichum</i>	Water Couch		3			
Poaceae	<i>Rytidosperma tenuius</i>	-					
Poaceae	<i>Themeda australis</i>	Kangaroo grass	3				
Polygonaceae	* <i>Polygonum arenastrum</i>	Wireweed					
Polygonaceae	* <i>Rumex conglomeratus</i>	Clustered Dock		1	2		
Polygonaceae	* <i>Rumex crispus</i>	Dock			2		
Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed			2		
Polygonaceae	<i>Persicaria hydropiper</i>	Water Pepper					
Pontederiaceae	* <i>Eichhornia crassipes</i>	Water Hyacinth				1	
Pteridaceae	<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>	Mulga Fern	1				
Ranunculaceae	* <i>Ranunculus repens</i>	Creeping Buttercup					
Ranunculaceae	<i>Clematis glycinoides</i>	Old Man's Beard					



Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Ranunculaceae	<i>Ranunculus inundatus</i>	River Buttercup		2			
Rhamnaceae	<i>Alphitonia excelsa</i>	Red Ash	1				
Rosaceae	* <i>Rubus fruticosus sp.agg</i>	Blackberry					1
Rubiaceae	<i>Opercularia diphylla</i>	-	1				
Salviniaceae	<i>Azolla filiculoides</i>	Pacific Azolla				6	1
Scrophulariaceae	<i>Bacopa monnieri</i>	Bacopa					
Scrophulariaceae	<i>Eremophila debilis</i>	Winter Apple	1				
Solanaceae	* <i>Solanum mauritianum</i>	Wild Tobacco					
Solanaceae	* <i>Solanum nigrum</i>	Blackberry Nightshade					
Solanaceae	<i>Solanum brownii</i>	Violet Nightshade	1				
Solanaceae	<i>Solanum prinophyllum</i>	Forest Nightshade					
Typhaceae	<i>Typha orientalis</i>	Broadleaf Cumbungi		5	2		1
Verbenaceae	* <i>Lantana camara</i>	Lantana	3				
Verbenaceae	* <i>Verbena bonariensis</i>	Purpletop					
Violaceae	<i>Viola hederacea</i>	Ivy-leaved Violet					
Vitaceae	<i>Cayratia clematidea</i>	Native Grape					

* denotes an introduced species



APPENDIX 2. FAUNA SPECIES RECORDED ON THE SUBJECT SITE

Table 6 Fauna species (excluding birds) recorded from trapping and nocturnal survey activities by Kleinfelder 2008-2013 and White (2000)

Scientific Name	Common Name	Method	2008	2009	2010	2011	2012	2013	White (2000)
Amphibians									
<i>Crinia signifera</i>	Common Eastern Froglet	Nocturnal amphibian survey	+		+	+	+	+	
<i>Limnodynastes peronii</i>	Striped Marsh Frog	Nocturnal amphibian survey	+	+	+				
<i>Limnodynastes tasmaniensis</i>	Spotted Marsh Frog	Nocturnal amphibian survey						+	
<i>Litoria fallax</i>	Eastern Dwarf Tree Frog	Nocturnal amphibian survey	+	+	+	+	+	+	
<i>Litoria freycineti</i>	Freycinet's Frog	Nocturnal and diurnal survey							+
<i>Litoria latopalmata</i>	Broad-palmed Frog	Nocturnal and diurnal survey			+			+	+
<i>Litoria peronii</i>	Peron's Tree Frog	Nocturnal amphibian survey	+	+	+	+	+	+	
<i>Litoria tyleri</i>	Southern Laughing Tree Frog	Nocturnal amphibian survey	+	+	+	+	+	+	
<i>Litoria verreauxii</i>	Verreaux's Tree Frog	Nocturnal amphibian survey		+				+	
<i>Uperoleia laevigata</i>	Smooth Toadlet	Nocturnal amphibian survey			+				
TOTALS			5	5	7	5	4	9	2



Scientific Name	Common Name	Method	2008	2009	2010	2011	2012	2013	White (2000)
Reptiles									
<i>Amphibolurus muricatus</i>	Jacky Lizard	Diurnal reptile survey					+		+
<i>Chelodina longicollis</i>	Eastern Long-necked Turtle	Opportunistic sighting				+		+	+
<i>Ctenotus robustus</i>	Robust Ctenotus	Diurnal reptile survey							+
<i>Eulamprus quoyii</i>	Eastern Water Skink	Diurnal reptile survey							+
<i>Lampropholis delicata</i>	Garden Skink	Diurnal reptile survey					+		+
<i>Physignathus lesueurii lesueurii</i>	Eastern Water Dragon	Opportunistic sighting	+				+		
<i>Pseudechis porphyriacus</i>	Red-bellied Black Snake	Opportunistic sighting	+		+	+	+		+
<i>Pseudonaja textilis</i>	Eastern Brown Snake	Opportunistic sighting				+	+		
<i>Tiliqua scincoides</i>	Eastern Blue-tongued Lizard	Diurnal reptile survey					+		
TOTALS			2	0	1	3	6	1	6



Scientific Name	Common Name	Method	2008	2009	2010	2011	2012	2013	White (2000)
Terrestrial/ Scansorial Mammals									
<i>Antechinus stuartii</i>	Brown Antechinus	Trapping	+		+	+			+
<i>Canis lupus</i>	*Wild Dog	Spotlighting					+		
<i>Felis catus</i>	*House Cat	Spotlighting			+				
<i>Macropus sp.</i>	Wallaby sp.	Spotlighting					+		
<i>Mus domesticus</i>	*House Mouse	Trapping	+	+					
<i>Petaurus breviceps</i>	Sugar Glider	Spotlighting						+	+
<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum	Spotlighting						+	
<i>Rattus fuscipes</i>	Bush Rat	Trapping	+						
<i>Rattus lutreolus</i>	Swamp Rat	Trapping						+	
<i>Rattus rattus</i>	*Black Rat	Trapping/spotlighting	+	+	+		+	+	+
<i>Trichosurus vulpecula</i>	Brush-tail Possum	Spotlighting					+	+	
<i>Vulpes vulpes</i>	*Red Fox	Opportunistic sighting/spotlighting (2013)				+	+	+	+
TOTALS			4	2	3	2	5	6	4





Scientific Name	Common Name	Method (2013)	2008	2009	2010	2011	2012	2013	White (2000)
Bats									
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	Anabat analysis/trapping	+	+	+	+	+	+	+
<i>Chalinolobus morio</i>	Chocolate Wattled Bat	Anabat analysis/trapping			+	+		+	+
<i>Falsistrellus tasmaniensis</i>	# Eastern False Pipistrelle	Anabat analysis		+		+	+		
<i>Miniopterus australis</i>	# Little Bentwing-bat	Anabat analysis/trapping	+	+	+	+	+	+	
<i>Miniopterus oceanensis</i>	# Eastern Bentwing-bat	Anabat analysis	+	+			+	+	
<i>Mormopterus norfolkensis</i>	# East-coast Freetail-bat	Anabat analysis	+	+	+	+	+	+	
<i>Mormopterus sp. 2</i>	Eastern Freetail-bat	Anabat analysis	+			+	+	+	
<i>Myotis macropus</i>	# Large-footed Myotis	Anabat analysis					+	+	
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat	Trapping					+	+	
<i>Nyctophilus gouldii</i>	Gould's Long-eared Bat	Trapping							+
<i>Nyctophilus sp.</i>	Unidentified Long-eared Bat	Anabat analysis	+		+	+	(+)	(+)	
<i>Pteropus sp.</i>	Flying-fox	Spotlighting (heard call)						+	
<i>Pteropus poliocephalus</i>	# Grey-headed Flying-fox	Spotlighting (2008) / dead animal observed in 2009	+	+					+
<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat	Anabat analysis				+			
<i>Saccolaimus flaviventris</i>	# Yellow-bellied Sheath-tail-bat	Anabat analysis			+				
<i>Scoteanax rueppellii</i>	# Greater Broad-nosed Bat	Anabat analysis	+					+	
<i>Scotorepens orion</i>	Eastern Broad-nosed Bat	Anabat analysis			+	+		+	
<i>Tadarida australis</i>	White-striped Mastiff-bat	Spotlighting (heard call)				+	+	+	+
<i>Vespertilio pumilus</i>	Eastern Forest Bat	Anabat analysis	+	+	+	+		+	
<i>Vespertilio troughtoni</i>	# Eastern Cave Bat	Anabat analysis				+	+		
<i>Vespertilio vulturinus</i>	Little Forest Bat	Anabat analysis/trapping	+	+	+	+	+	+	+
TOTALS			14	10	12	14	17	14	10

* denotes an introduced species

denotes a threatened species under the NSW TSC Act 1995

NB: Taxonomy for bats follows Churchill (2008).



Table 2 Bird species recorded in transect surveys by Kleinfelder 2008 to 2013

Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring/Summer 2013	
			North	South	North	South	North	South	North	South	North	South	North	South
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>Aquila audax</i>	Wedge-tailed Eagle												
Accipitridae	<i>Aviceda subcristata</i>	Pacific Baza			+		+		+		+			
Accipitridae	<i>Circus approximans</i>	Swamp Harrier											+	
Accipitridae	<i>Haliastur sphenurus</i>	Whistling Kite											+	
Acrocephalidae	<i>Acrocephalus australis</i>	Australian Reed-Warbler	+		+		+		+		+			
Anatidae	<i>Anas superciliosa</i>	Pacific Black Duck												
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	+		+		+		+		+		+	





Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring/Summer 2013	
			North	South	North	South	North	South	North	South	North	South	North	South
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>Ocyphaps lophotes</i>	Crested Pigeon	+				+		+					
Coraciidae	<i>Eunystomus 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 phasiananus</i>	Pheasant Coucal	+		+		+		+					
Cuculidae	<i>Chalcites basalus</i>	Horsfield's Bronze-Cuckoo	+		+		+		+					
Cuculidae	<i>Chalcites lucidus</i>	Shining 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	+		+		+		+				+	+
Estrildidae	<i>Taeniopygia bichenovii</i>	Double-barred Finch			+		+		+					
Eupetidae	<i>Psophodes olivaceus</i>	Eastern Whippbird							+				+	+
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	+		+		+		+				+	+
Maluridae	<i>Malurus lamberti</i>	Variiegated Fairy-wren	+		+		+		+					
Megaluridae	<i>Megalurus gramineus</i>	Little Grassbird	+		+		+		+				+	



Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring/Summer 2013	
			North	South	North	South	North	South	North	South	North	South	North	South
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												+
Nectariniidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird		+										+
Neositidae	<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	+	+	+	+	+	+	+	+	+	+	+	+
Pardalidae	<i>Acanthiza lineata</i>	Striated Thornbill	+	+	+	+	+	+	+	+	+	+	+	+
Pardalidae	<i>Pardalotus punctatus</i>	Spotted Pardalote	+	+	+	+	+	+	+	+	+	+	+	+



Family	Scientific Name	Common Name	Spring 2008		Spring 2009		Summer 2010		Spring 2011		Spring 2012		Spring/Summer 2013	
			North	South	North	South	North	South	North	South	North	South	North	South
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin	+	+									+	+
Psittacidae	<i>Alisterus scapularis</i>	Australian King-Parrot			+		+							
Psittacidae	<i>Platycercus eximius</i>	Eastern Rosella	+	+	+	+	+	+					+	
Psittacidae	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet	+	+	+	+	+							+
Ptilonorhynchidae	<i>Ptilonorhynchus violaceus</i>	Satin Bowerbird												+
Rallidae	<i>Porphyrio porphyrio</i>	Purple Swamphen	+											
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>Threskiornis spinicollis</i>	Straw-necked Ibis		+	+	+								
Timaliidae	<i>Zosterops lateralis</i>	Silvereye	+										+	+
TOTALS			41	36	47	25	45	24	38	31	28	22	31	33

The list follows the taxonomy of Christidis & Boles (2008).
* = introduced species



Table 7 Bird species recorded from the North Swamp by Kleinfelder 2008 to 2014

Family	Scientific Name	Common Name	Spng 2008	Autumn 2008	Spng 2009	Autumn 2009	Spng 2010	Autumn 2010	Summer 2010	Autumn 2010	Spng 2011	Autumn 2011	Spng 2012	Autumn 2012	Spng 2013	Autumn 2013	Spng 2013	Autumn 2013	Spng 2014	Autumn 2014
Acanthizidae	<i>Acanthiza nana</i>	Yellow Thornbill	+								+		+	+	+		+		+	+
Acanthizidae	<i>Acanthiza pusilla</i>	Brown Thornbill												+						+
Acanthizidae	<i>Sericornis frontalis</i>	White-browed Scrubwren		+				+			+	+	+	+						+
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 rhynchos</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	+	+										+						+
Anhingidae	<i>Anhinga melanogaster</i>	Darter																		+
Ardeidae	<i>Ardea alba</i>	Great Egret																		+
Ardeidae	<i>Ardea ibis</i>	Cattle Egret																		+
Ardeidae	<i>Ardea intermedia</i>	Intermediate Egret																		+
Ardeidae	<i>Ardea modesta</i>	Eastern Great Egret																		+



Family	Scientific Name	Common Name	Spring 2008	Autumn 2008	Spring 2009	Autumn 2009	Spring 2010	Autumn 2010	Summer 2010	Autumn 2011	Spring 2011	Autumn 2011	Spring 2012	Autumn 2012	Spring 2012	Autumn 2012	Spring 2013	Autumn 2013	Spring 2013	Autumn 2013	Spring 2014	Autumn 2014	
Ardeidae	<i>Ardea pacifica</i>	White-necked Heron																					
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			+																		
Campephagidae	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike	+		+																		
Charadriidae	<i>Vanellus miles</i>	Masked Lapwing	+		+																		
Cisticolidae	<i>Cisticola exilis</i>	Golden-headed Cisticola			+																		
Columbidae	<i>Leucosarcia picata</i>	Wonga Pigeon	+																				
Columbidae	<i>Ocyphaps lophotes</i>	Crested Pigeon	+																				
Columbidae	<i>Streptopelia chinensis</i>	*Spotted Dove	+																				
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 phasianianus</i>	Pheasant Coucal			+																		
Cuculidae	<i>Eudynamys orientalis</i>	Eastern Koel	+		+																		
Cuculidae	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo																					
Estrildidae	<i>Neochmia temporalis</i>	Red-browed Finch	+																				
Eupetidae	<i>Psophodes olivaceus</i>	Eastern Whipbird	+		+																		
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	+																				



Family	Scientific Name	Common Name	Sprng 2008	Autumn 2008	Sprng 2009	Autumn 2009	Sprng 2009	Autumn 2009	Summer 2010	Autumn 2010	Sprng 2010	Autumn 2010	Sprng 2011	Autumn 2011	Sprng 2012	Autumn 2012	Sprng 2012	Autumn 2012	Sprng 2013	Autumn 2013	Sprng 2013	Autumn 2013	Sprng 2014	Autumn 2014
Jacaniidae	<i>Irediparra gallinacea</i>	Comb-crested Jacana																						
Maluridae	<i>Malurus cyaneus</i>	Superb Fairy-wren	+		+				+															
Maluridae	<i>Malurus lamberti</i>	Variagated Fairy-wren			+				+															
Megaluridae	<i>Megalurus gramineus</i>	Little 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 hirsutinaceum</i>	Mistletoebird							+															
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler	+		+																			
Pachycephalidae	<i>Pachycephala rufiventris</i>	Rufous Whistler	+		+																			
Pardalidae	<i>Pardalotus punctatus</i>	Spotted Pardalote			+																			
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican																						
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin																						
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant																						
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	+		+				+															
Phalacrocoracidae	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	+		+																			
Phalacrocoracidae	<i>Phalacrocorax varius</i>	Pied Cormorant	+		+																			
Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	+		+																			
Psittacidae	<i>Platycercus eximius</i>	Eastern Rosella	+		+																			



Family	Scientific Name	Common Name	Spring 2008	Autumn 2009	Spring 2009	Autumn 2010	Summer 2010	Autumn 2011	Spring 2011	Autumn 2012	Spring 2012	Autumn 2013	Spring 2013	Autumn 2014
Psittacidae	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet				+		+						+
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	+	+	+	+	+	+		+				
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			50	35	42	39	31	25	27	34	39	27	39	37



Family	Scientific Name	Common Name	Spring 2008	Autumn 2008	Spring 2009	Autumn 2009	Spring 2010	Autumn 2010	Summer 2010	Autumn 2011	Spring 2011	Autumn 2011	Spring 2012	Autumn 2012	Spring 2012	Autumn 2012	Spring 2013	Autumn 2013	Spring 2013	Autumn 2013	Spring 2014	Autumn 2014
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 roseicapilla</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			+																	
Coraciidae	<i>Eunystomus 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>Platycercus eximius</i>	Eastern Rosella																				
Cuculidae	<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo																				
Estrildidae	<i>Neochmia temporalis</i>	Red-browed Finch				+																
Eupetidae	<i>Psophodes olivaceus</i>	Eastern Whipbird																				
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																				
Megaluridae	<i>Megalurus gramineus</i>	Little Grassbird																				
Megaluridae	<i>Megalurus timoriensis</i>	Tawny Grassbird																				
Melephagidae	<i>Acanthorhynchus</i>	Eastern Spinebill										+										





Family	Scientific Name	Common Name	Spring 2008	Autumn 2008	Spring 2009	Autumn 2009	Spring 2009	Autumn 2009	Spring 2010	Autumn 2010	Spring 2010	Autumn 2010	Spring 2011	Autumn 2011	Spring 2011	Autumn 2011	Spring 2012	Autumn 2012	Spring 2012	Autumn 2012	Spring 2013	Autumn 2013	Spring 2013	Autumn 2013	Spring 2014	Autumn 2014
	<i>tenuirostris</i>																									
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																								
Monarchidae	<i>Grallina cyanoleuca</i>	Maggie-lark	+							+																
Monarchidae	<i>Myiagra rubecula</i>	Leadend 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																								
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin																								
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant																								
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant																								
Phalacrocoracidae	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant	+																							
Phalacrocoracidae	<i>Phalacrocorax varius</i>	Pied Cormorant																								
Podicipedidae	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe	+																							
Psittacidae	<i>Trichoglossus haematodus</i>	Rainbow Lorikeet																								
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	+																							



Family	Scientific Name	Common Name	Spring 2008	Autumn 2009	Spring 2009	Autumn 2010	Summer 2010	Autumn 2011	Spring 2011	Autumn 2012	Spring 2012	Autumn 2013	Spring 2013	Autumn 2014
Scolopacidae	<i>Gallinago hardwickii</i>	Latham's Snipe			+									
Sturnidae	<i>Sturnus tristis</i>	*Common Myna				+								
Sturnidae	<i>Sturnus vulgaris</i>	*Common Starling				+								
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			31	22	26	22	32	12	22	17	30	32	32	20





Table 9 Bird species recorded from the South Swamp by Kleinfelder 2008 to 2014

Family	Scientific Name	Common Name	Spring 2008	Autumn 2008	Spring 2009	Autumn 2009	Spring 2010	Summer 2010	Autumn 2010	Spring 2011	Autumn 2011	Spring 2012	Autumn 2012	Spring 2012	Autumn 2012	Spring 2013	Autumn 2013	Spring 2013	Autumn 2013	Spring 2014	Autumn 2014
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>Aviceda subcristata</i>	Pacific Baza									+										
Accipitridae	<i>Circus approximans</i>	Swamp Harrier				+															
Accipitridae	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle									+										+
Accipitridae	<i>Haliaeetus sphenurus</i>	Whistling Kite									+										
Acrocephalidae	<i>Acrocephalus australis</i>	Australian Reed-Warbler																			+
Alcedinidae	<i>Alcedo azurea</i>	Azure Kingfisher																			
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>	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																			+
Ardeidae	<i>Ardea alba</i>	Great Egret																			
Ardeidae	<i>Ardea ibis</i>	Cattle Egret																			+
Ardeidae	<i>Ardea pacifica</i>	White-necked Heron																			+
Ardeidae	<i>Egretta garzetta</i>	Little Egret																			+
Ardeidae	<i>Egretta novaehollandiae</i>	White-faced Heron																			+
Ardeidae	<i>Mesophoyx intermedia</i>	Intermediate Egret																			+



Family	Scientific Name	Common Name	Spring 2008	Autumn 2008	Spring 2009	Autumn 2009	Spring 2010	Autumn 2010	Summer 2010	Autumn 2011	Spring 2011	Autumn 2012	Spring 2012	Autumn 2013	Spring 2013	Autumn 2014
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	+	+	+	+	+	+	+	+						
Cisticolidae	<i>Cisticola exilis</i>	Golden-headed Cisticola	+	+	+	+	+	+	+	+			+			
Columbidae	<i>Leucosarcia picata</i>	Wonga 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 varifolius</i>	Brush Cuckoo	+		+	+			+					+	+	+
Cuculidae	<i>Centropus phasianus</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>Sythrops novaehollandiae</i>	Channel-billed Cuckoo													+	
Estrildidae	<i>Neochmia temporalis</i>	Red-browed Finch		+												
Eupetidae	<i>Psophodes olivaceus</i>	Eastern Whipbird	+	+					+	+		+	+	+	+	+
Halcyonidae	<i>Dacelo novaeguineae</i>	Laughing Kookaburra	+	+	+	+					+					



Family	Scientific Name	Common Name	Spring 2008	Autumn 2008	Spring 2009	Autumn 2009	Spring 2009	Autumn 2009	Spring 2010	Autumn 2010	Summer 2010	Autumn 2010	Spring 2011	Autumn 2011	Spring 2011	Autumn 2011	Spring 2012	Autumn 2012	Spring 2012	Autumn 2012	Spring 2013	Autumn 2013	Spring 2013	Autumn 2013	Spring 2014	Autumn 2014
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>	Variagated 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>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>Philemon corniculatus</i>	Noisy Friarbird	+																							
Meliphagidae	<i>Plectrohyncha lanceolata</i>	Striped Honeyeater	+		+		+		+		+		+		+		+		+		+		+		+	
Meropidae	<i>Merops ornatus</i>	Rainbow Bee-eater	+																							
Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-lark	+		+		+		+		+		+		+		+		+		+		+		+	
Monarchidae	<i>Myiagra rubecula</i>	Leadend Flycatcher	+																							
Nectariniidae	<i>Dicaeum hirundinaceum</i>	Mistletoebird											+		+											
Neositidae	<i>Daphoenositta chrysoptera</i>	Varied Sittella																								
Oriolidae	<i>Oriolus sagittatus</i>	Olive-backed Oriole			+						+															
Oriolidae	<i>Sphetheotes vieloti</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	+		+		+		+		+		+		+		+		+		+		+		+	
Pardalidae	<i>Pardalotus punctatus</i>	Spotted Pardalote	+									+														



Family	Scientific Name	Common Name	Spring 2008	Autumn 2008	Spring 2009	Autumn 2009	Spring 2010	Autumn 2010	Summer 2010	Autumn 2011	Spring 2011	Autumn 2011	Spring 2012	Autumn 2012	Spring 2013	Autumn 2013	Spring 2014	Autumn 2014
Pelecanidae	<i>Pelecanus conspicillatus</i>	Australian Pelican											+					
Petroicidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin			+									+				
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant								+				+				
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant			+									+				
Phalacrocoracidae	<i>Phalacrocorax melanoleucos</i>	Little Pied 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					+			+				+				
Rallidae	<i>Fulica atra</i>	Eurasian Coot					+											
Rallidae	<i>Gallinula tenebrosa</i>	Dusky Moorhen	+		+		+		+					+				+
Rallidae	<i>Porphyrho porphyrio</i>	Purple Swamphen	+		+		+		+					+				+
Rhipiduridae	<i>Rhipidura albiscapa</i>	Grey Fantail	+		+		+							+				+
Rhipiduridae	<i>Rhipidura leucophrys</i>	Willie Wagtail	+		+		+		+					+				+
Scolopacidae	<i>Gallinago hardwickii</i>	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			46	31	47	29	29	36	29	32	30	48	34	43	30			



Table 10 Roosting bird count results from the Main Swamp 2008 to 2014

Family	Scientific Name	Common Name	15/1/08 7:15 pm	05/03/09 7:40 pm	18/11/09 7:50 pm	23/03/10 7:20 pm	23/12/10 8:40 pm	23/03/11 8:00 pm	19/10/11 7:20 pm	20/03/12 7:20 pm	02/11/12 7:50 pm	05/03/13 7:15 pm	04/12/13 7:00 pm	12/12/13* 8:00 pm	10/03/14 7:30 pm
Anhinga	<i>Anhinga melanogaster</i>	Darter													1
Ardeidae	<i>Ardea ibis</i>	Cattle Egret	57	170	67		26		188	80		120		80	
Ardeidae	<i>Ardea pacifica</i>	White-necked Heron	1												
Ardeidae	<i>Egretta novaehollandiae</i>	White-faced Heron								4		20			
Monarchidae	<i>Grallina cyanoleuca</i>	Magpie-lark													1
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant					2			15		2		3	7
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	17	10	5		14		1	5	15			8	2
Phalacrocoracidae	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant			8	3						6	1	10	
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			
Threskiornithidae	<i>Threskiornis spinicollis</i>	Straw-necked Ibis	125	40	8	3						400			
Total No. of individuals			209	270	125	50	42	2	190	104	15	563	3	101	11

**12/12/2013: Many birds were observed flying in to roost south of the visible roost in Main Swamp.

21/03/2014: roost was empty





APPENDIX 3. WATER BODY PHOTOGRAPHS



Plate 11 Stitched photograph of South Swamp taken in November 2011.

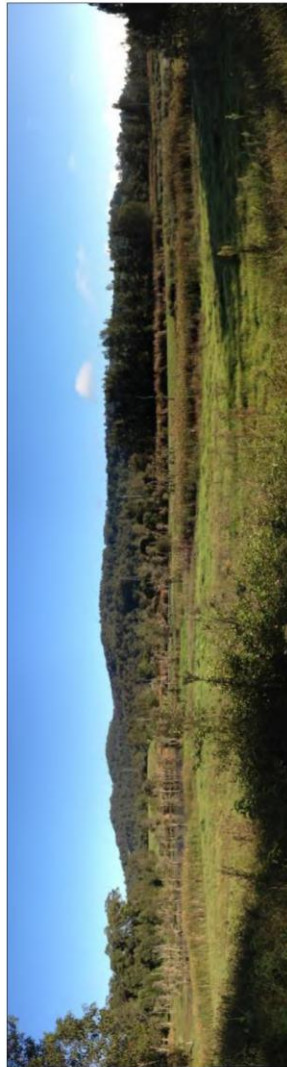


Plate 12 Stitched photograph of South Swamp taken in March 2012.

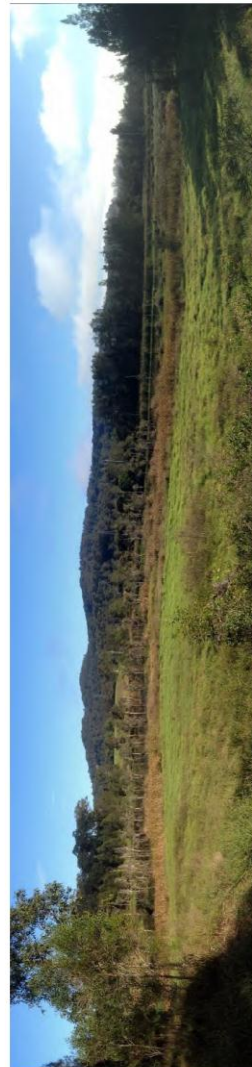


Plate 13 Stitched photograph of South Swamp taken in March 2014.

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Page 60
Appendix 3

25 July 2014





Plate 14 Stitched photograph of Main Swamp taken in November 2011.



Plate 15 Stitched photograph of Main Swamp taken in March 2012.



Plate 16 Stitched photograph of Main Swamp taken in March 2014.

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Page 61
Appendix 3

25 July 2014



25 July 2014



Plate 17 Stitched photograph of North Swamp taken in November 2011.



Plate 18 Stitched photograph of North Swamp taken in March 2012.



Plate 19 Stitched photograph of North Swamp taken in March 2014.

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Page 62
Appendix 3



APPENDIX 4. STAFF CONTRIBUTIONS

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

Name	Qualification	Title/Experience	Contribution
Daniel O'Brien	BScEnv & Mgt (Hons)	Ecologist (Zoologist/Herpetologist)	Fauna survey
Gayle Joyce	BSc (Forestry) (Hons)	GIS Specialist	Spatial data and figures
Gilbert Whyte	PhD	Senior Ecologist (Botanist)/Entomologist	Flora survey and report writing
Shawn Capararo	BNatRes (Hons)	Senior Ecologist/GIS Specialist	Fauna survey
Thomas Garnham	BEnvSc&Mgt	Ecologist	Fauna survey
David Russell	B.Sc	Senior Ecologist	Report writing

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APPENDIX 5. LICENSING

Kleinfelder employees involved in the current study are licensed or approved under the *National Parks and Wildlife Act 1974* (License Number: SL100730, Expiry: 31st March 2014) 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.

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