

Appendix 4*

Pambalong Nature Reserve Monitoring Plan 2012

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Pambalong Nature Reserve Monitoring Plan 2012

Abel Underground Coal Mine, Beresfield NSW
Prepared for Gloucester Coal Ltd

April 2012



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Pambalong Nature Reserve Monitoring Plan 2012

Final Report

Abel Underground Coal Mine, Beresfield NSW | Prepared for Gloucester Coal Ltd

Approved By

Approved By

Position

Position

Date

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Document Control

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Executive Summary

Donaldson Coal Pty Ltd (now owned by Gloucester Coal Ltd) commenced operations at Abel Underground Coalmine at Beresfield in the lower Hunter Valley, New South Wales, during 2008. To comply with part of the conditions of consent a Flora and Fauna Management Plan was prepared in late 2007 by **ecobiological**.

This plan identified the need to establish a monitoring plan for Pambalong Nature Reserve (a 34 ha freshwater wetland located between the eastern extent of the Abel coal mine lease and the F3 freeway). The reserve provides critical habitat for wader and water bird species and is part of a chain of protected wetlands including those within Hunter Wetlands National Park. This national park includes the previous Kooragang and Hexham Swamp Nature Reserves, and incorporates Stockton Sandspit and part of Ash Island. The wetland 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 could compromise the ecological integrity of the wetland (ecobiological 2007).

It is estimated that it will be approximately 13 years before there could be any potential for subsidence impacts on Pambalong Nature Reserve. Specific potential detrimental impacts on the wetland could be brought about by increased rates of sedimentation and a decline in the quantity and quality of water, producing a decline in wetland area and an overall loss of aquatic and terrestrial floral and faunal biodiversity. Negative impacts could also result from weeds and/or feral animals, and population increases of exotic species could occur as a result of the reserve ecosystem being weakened by external factors (ecobiological 2007).

This is the fourth annual report to establish baseline conditions at Pambalong Nature Reserve against which any changes over time can be measured and evaluated. It is important that data is collected over approximately the next 13 years to determine what constitutes normal variation so that any impacts resulting from subsidence can be properly identified and addressed with suitable management actions.



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1. Introduction

Gloucester Coal Ltd commenced mining during 2008 at a new underground mine (known as Abel Underground Coal Mine), located approximately 23 km north-west of Newcastle. 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 is often associated with adverse environmental impacts because of subsidence (Bell *et al.* 2000, Sidle *et al.* 2000). Subsidence can cause 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 (Sidle *et al.* 2000). Of these, one of the major environmental concerns 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, thus 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.

Associated with development approval for the Abel coal mine were a number of conditions of consent. These conditions included a requirement for the preparation of a Flora and Fauna Management Plan (F & FMP) which was prepared by **ecobiological** in 2007. The F & FMP, which forms part of a comprehensive Environmental Management System for the Abel mine, sets out a strategy to monitor the effectiveness of the conservation measures proposed in the Environmental Assessment (EA) Statement of Commitments for the overall operation of the mine. Part of this strategy was to establish a Surface Ecological Monitoring Plan (SEMP) to monitor the effectiveness of the conservation measures proposed in the EA to mitigate against subsidence impacts on three distinct 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.

The SEMP outlines a monitoring plan for each of these areas by which baseline and subsequent monitoring data are to be gathered to inform future management. This report forms the baseline report for Pambalong Nature Reserve which forms part of the overall SEMP.



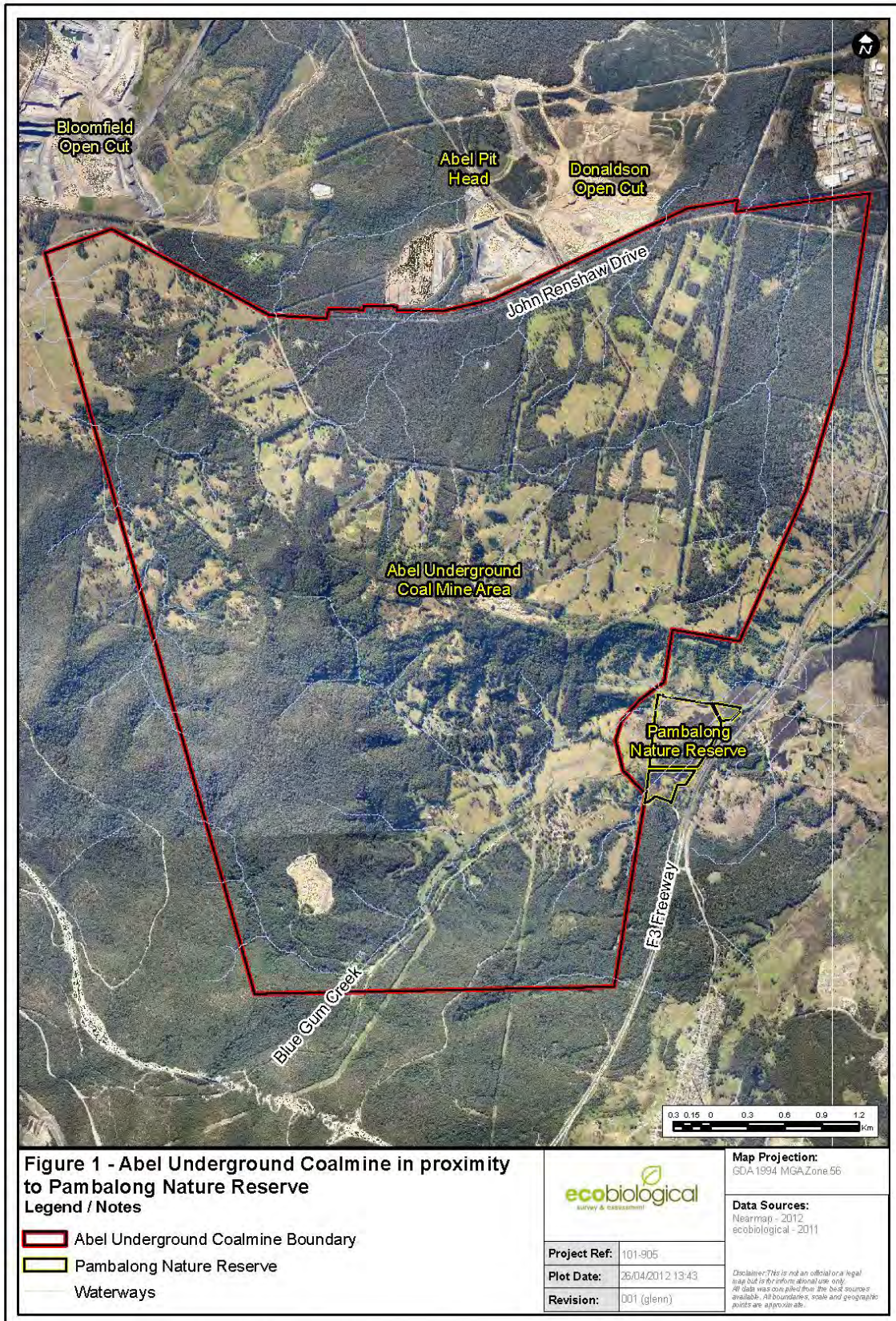
2. Location

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 Beresfield, with transfer of coal to the existing Bloomfield Coal Handling and Preparation Plant (CHPP) immediately to the north for coal washing and rail transport to the Port of Newcastle (Figure 1).

The Abel underground mine area is approximately 2750 ha and consists of low undulating forested hills with patches of cleared land for 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 F3 Freeway; 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 F3 Freeway, 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 Freeway (DFC 2006).





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3. Methods

3.1 Floral Diversity and Vegetation Mapping

Flora and vegetation mapping has been undertaken in accordance with the requirements of the F&FMP (section 5.2.3.2). The location of flora survey activities is shown in **Figure 3**.

A base vegetation map of the wetland was prepared in the 2008 monitoring report using a combination of aerial photograph interpretation and ground-truthing to delineate community boundaries. Communities were classified based on the type of habitat provided as well as on the floristic content and structure. Vegetation community boundaries will be mapped and monitored yearly to identify any variations from year to year.

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 included total floristic content and the cover abundance score for each species in the plots using the Braun-Blanquet scale which will be applied consistently over time.

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

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

Floristic identification and nomenclature was based on Harden (1992, 1993, 2000, 2002) with subsequent revisions as published on PlantNet (<http://plantnet.rbgsvd.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.

3.2 Faunal Diversity

All observation points and transects were established and documented in such a way as to ensure that data collected for each year is from the same location. Faunal diversity monitoring was 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 the total trap night count. **Table 2** provides details of survey effort undertaken to record faunal diversity across the subject site. The location of fauna survey activities is shown in **Figure 3**.

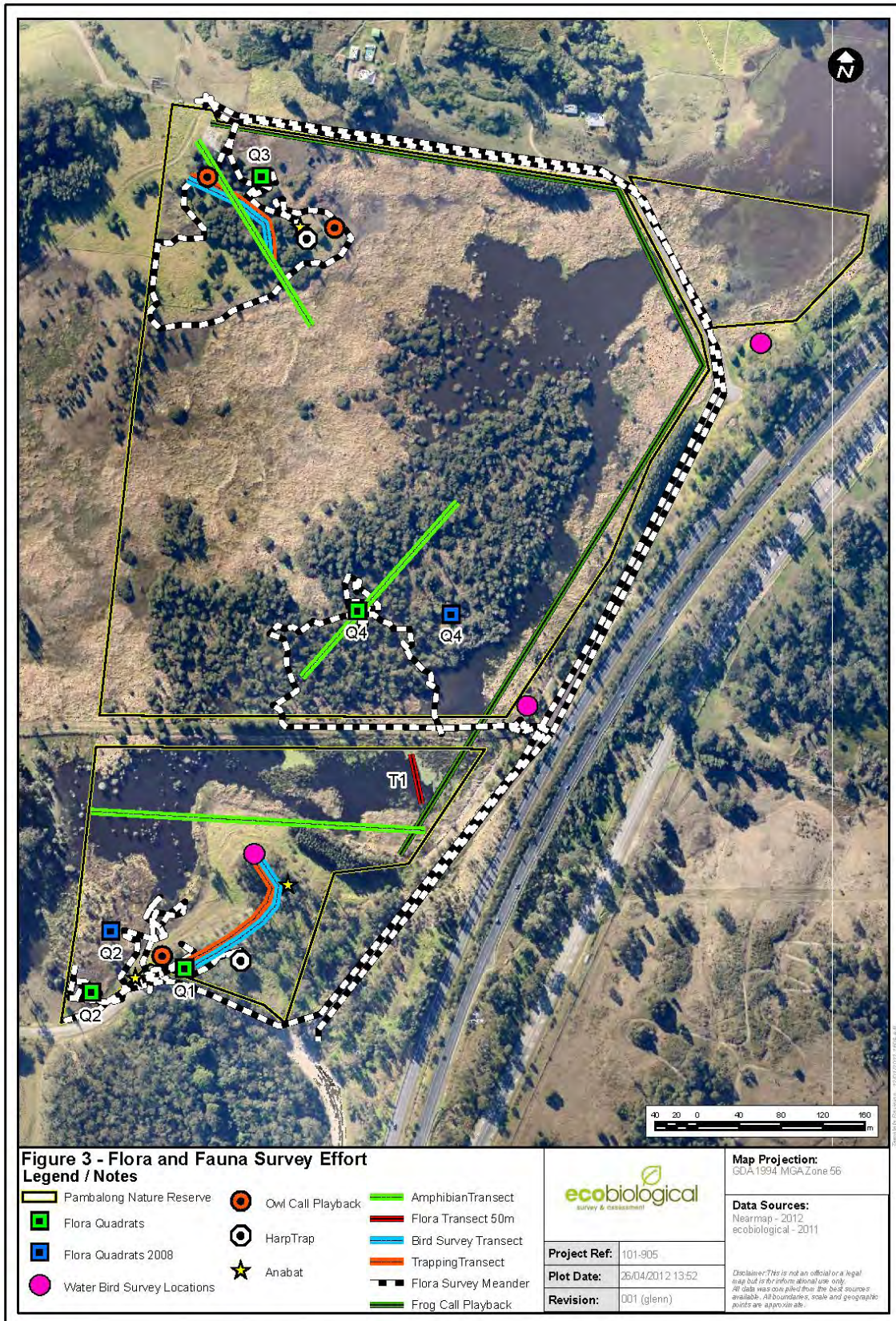


Table 1: Trapping statistics for the subject site.

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	3	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





3.2.1 Arboreal Mammals

Three Elliott B traps and eight hair tubes were placed in trees at heights of 3 m or above, along two transects and baited with a mixture of rolled oats, honey, peanut butter and treacle. The trunks of trees containing the traps were sprayed with a mixture of honey and water. These traps were checked daily for arboreal species and wafers from the hair tubes were collected after a 4-night period and checked for the presence of hair samples. Hair identification methods followed those of Brunner *et al.* (2002). If any hair sample was from a vulnerable or endangered species, the sample was sent to Barbara Triggs, an expert in the field of hair identification for a second opinion.

Spotlighting was undertaken along each transect from dusk over two nights to identify the presence of any arboreal mammals. Trees were inspected during daylight hours for the presence of habitat hollows and if present these were watched at dusk to see if any nocturnal birds or mammals emerged.

3.2.2 Terrestrial Mammals

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

Spotlighting was undertaken along each transect from dusk over two nights to identify the presence of any terrestrial mammals. Careful daytime searches were conducted to detect the presence of fauna activity such as diggings, droppings or scratch marks.

3.2.3 Bats

A harp trap was erected along each transect in bat 'flyways' such as across a track at the South Swamp and in a natural forest opening in the Main Swamp to maximise the likelihood of captures. The harp traps were set in position for four consecutive nights and checked each morning. Bats captured were identified in the field and placed in specially designed 'soft release' boxes tethered to nearby trees which enable the bats to shelter during the day and exit the boxes on nightfall from narrow openings at the base of the box.

Anabat II bat-call recorders (Titley Electronics, Ballina) were used to record the calls of any Microchiropteran bats feeding in the area. The units were set up at dusk and recording occurred for a total of four hours at four locations over two nights. Spotlighting searches of blossoming trees were also undertaken to identify any Megachiropteran bat species.

3.2.4 Birds

A bird survey of vegetation fringing the Main Swamp and South Swamp was undertaken by walking the lengths of each trapping transect for 20 minutes on 18 October 2011 and 25 October 2011 (Figure 3).

Four surveys (two dusk and two dawn) of each water body (North, Main and South) were undertaken approximately 1-week apart in Spring (October 2011) and replicated in Autumn (March 2012). A permanent monitoring location was established during the baseline survey



at each site and marked with a star picket to allow replication in future years. One observer undertook all surveys which involved a 20-minute survey of all birds seen and heard within the radius of each monitoring location (focusing on open water bodies). Birds were identified by sight, with the aid of binoculars or a spotting scope, or by their calls.

Bird surveys were conducted in the morning or late afternoon when bird activity is maximised (Bibby *et al.* 2000). Opportunistic sightings were also recorded and listed separately to actual survey results. Transect surveys were intended to record species diversity, not density whereas water body surveys were designed to assess water bird density, therefore counts, wherever possible, or density estimates were made to facilitate statistical comparison in future years.

At the completion of one of the dusk surveys in October 2011 and one of the dusk surveys in March 2012, an abundance estimate of birds roosting in the Melaleuca Swamp Forest within the Main Swamp was undertaken. This method is replicated at approximately the same time (on nightfall) each year to facilitate statistical comparison of changes in roosting bird density and/or diversity.

After dark the calls of threatened owl species (Powerful Owl, Masked Owl, Sooty Owl, Barking Owl and Grass Owl) were broadcast over a megaphone in an attempt to encourage a call back response. The subject site was also searched to locate any regurgitated owl pellets. The size, shape and content of any pellets found were analysed to determine the species of owl from which the pellet originated as well as the prey species the owl had been feeding on. Analysis methods followed those of Brunner *et al.* (2002) and Triggs (1996).

3.2.5 Amphibians

Standardised survey techniques for amphibians were carried out at each of the three main water bodies in the reserve across four days and nights. Survey techniques included diurnal habitat searches, nocturnal spotlight surveys, call playback and dip netting for tadpoles. During diurnal surveys, dip netting and visual searches were carried out to locate any tadpoles present in any water bodies. During nocturnal surveys, spotlight searches were carried out by walking lengths of suitable habitat and using head torches to search for frogs by eye shine or by physical sightings. Call playback for the endangered Green and Golden Bell Frog was carried out due to the species' historical occurrence at the site and suitable habitat being present.

Adult frogs encountered were identified by visual confirmation or by their distinct advertisement calls. Tadpoles were 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).

3.2.6 Feral Fauna

Several species of feral fauna such as Black Rats, rabbits, foxes, Common Myna, Spotted Dove, House Sparrow, Red-whiskered Bulbul and Common Starling have previously been recorded within the reserve (HBOC 1990 - 2008; Straw 2000; White 2000). The biodiversity of the reserve can be negatively impacted by increases in these species. Observations of any



introduced species were recorded during field surveys of the subject site. Liaison with the NSW Office of the Environment & Heritage (OEH) staff throughout the monitoring process is undertaken to address any evidence of increasing numbers of feral fauna within the Reserve.



4. Results and Discussion

4.1 Weather Conditions and Survey Activities

The prevailing weather conditions throughout the trapping survey period (24 - 28 October 2011) at the subject site were warm to hot, humid days and mild nights with partly cloudy skies and light winds. The mean minimum temperature was 13.5 °C, and the mean maximum temperature was 26.6° C. A full list of survey activities and weather conditions during the survey period are provided in Table 3.

Table 3: Schedule of activities and weather conditions during the survey period.

Activity	Day	Date	Weather Conditions
Flora			
Transect and plot surveys and vegetation community mapping	Mon	05/12/2011	Warm, no rain, light cloud and calm to light breeze
Threatened species search and weed surveys	Mon	05/12/2011	Warm, no rain, light cloud and calm to light breeze
Fauna			
Trapping	Mon - Fri	24-28/10/11	Warm to hot, humid days and mild nights with partly cloudy skies and light winds
Nocturnal field work (Spotlighting, owl call playback, Anabat recording)	Tues	20/12/11	Warm humid evening, no rain, light cloud, calm
	Weds	21/12/11	Warm humid evening, no rain, overcast, calm
Bird survey - Transects and morning water body surveys	Tues	18/10/11	Partly cloudy, mild, calm to light breeze
Bird survey - Dusk water body surveys	Wed	19/10/11	Calm, clear skies, warm, dry
Bird survey - Transects and morning water body surveys	Tues	25/10/11	Partly cloudy, mild, calm to light breeze
Bird survey - Dusk water body surveys	Wed	26/10/11	Overcast, mild, passing light showers, calm
Bird survey - Morning water body surveys	Fri	16/3/12	Clear skies, mild, calm, humid
Bird survey - Dusk water body surveys	Tues	13/03/12	Clear skies, warm, calm
Bird survey - Morning water body surveys	Mon	26/03/12	Overcast, calm, humid
Bird survey - Dusk water body surveys	Tues	20/03/12	Overcast, warm, calm
Amphibian survey	Thurs	27/10/11	Overcast, mild, calm, light rain
Amphibian survey	Mon	19/12/11	Warm humid evening, no rain, overcast, calm
Amphibian survey	Tues	20/12/11	Warm humid evening, no rain, light cloud, calm
Amphibian survey	Wed	21/12/11	Warm humid evening, no rain, overcast, calm



4.2 General Environmental Monitoring

Changes in the wetland and surrounds could be caused by a variety of events not associated with mining such as rainfall levels, bushfire events and large-scale farming activities (ecobiological 2007). No significant bushfire events occurred within proximity of Pambalong Nature Reserve during 2011 and ecobiological is not aware of any large-scale farming activities such as clearing, road construction or dam building in the surrounding area that would have impacted on water flow or quality.

Presently, there is no rainfall monitoring station at Pambalong Nature Reserve or within immediate proximity that can provide reliable long-term rainfall data. Instead, historical rainfall data has been sourced from the East Maitland Bowling Club weather station (Source: Rainman Streamflow v4) as it is relatively close by (~10 km to the north of Pambalong and a similar distance inland) and provides rainfall data over a 108-year period (1903 - 2011). Historical mean monthly rainfall (mm) from 1903 - 2011 and monthly rainfall (mm) from 2008, 2009, 2010 and 2011 is presented for comparison in Table 4. The monthly historical mean and the monthly actual rainfall results for 2011 is displayed in Figure 4.

Table 4: Monthly rainfall (mm) recorded in 2008, 2009, 2010 and 2011 compared with mean monthly rainfall (mm) from 1903 - 2011.

Yearly actuals and the historical mean	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	56.5	75	104	141	67	1042.5
1903-2011	84	97	96	83	70	84	55	49	55	61	65	82	882

Above average rainfall was recorded throughout most months of 2011 as compared with the historical yearly average (with the exception of December, January, February and March). During ecobiological's field surveys each of the three water bodies had high water levels with no muddy margins present (refer to photographs in Appendix 3). Figure 5 presents a rainfall anomaly chart showing the difference between each season's actual rainfall (mm) and the average seasonal rainfall recorded between 1903 - 2011. The bars above 0 mm show those seasons when the actual seasonal rainfall exceeded the historical average, the bars below 0 mm lines show those seasons when the actual seasonal rainfall was less than the historical average. Above average rainfall was recorded in three out of four Spring survey seasons (2008, 2010 and 2011). Rainfall during the Autumn survey season has been similar to the historical average.

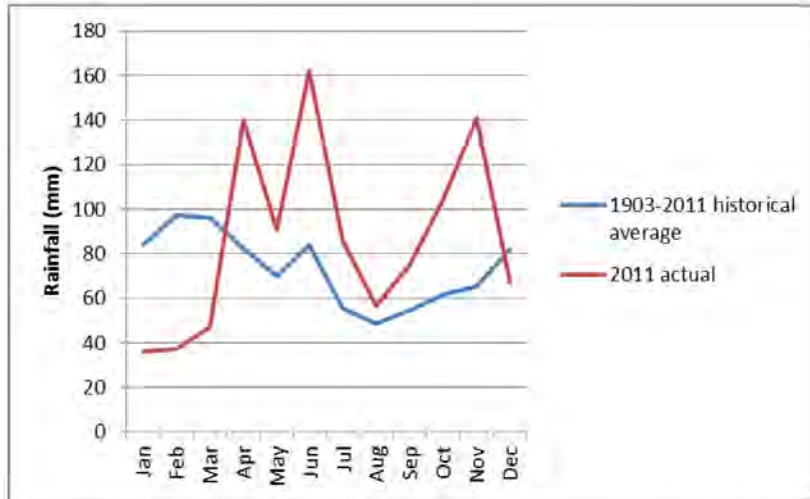


Figure 4: Monthly rainfall (mm) in 2011 compared with mean monthly rainfall (mm) from 1900 - 2011

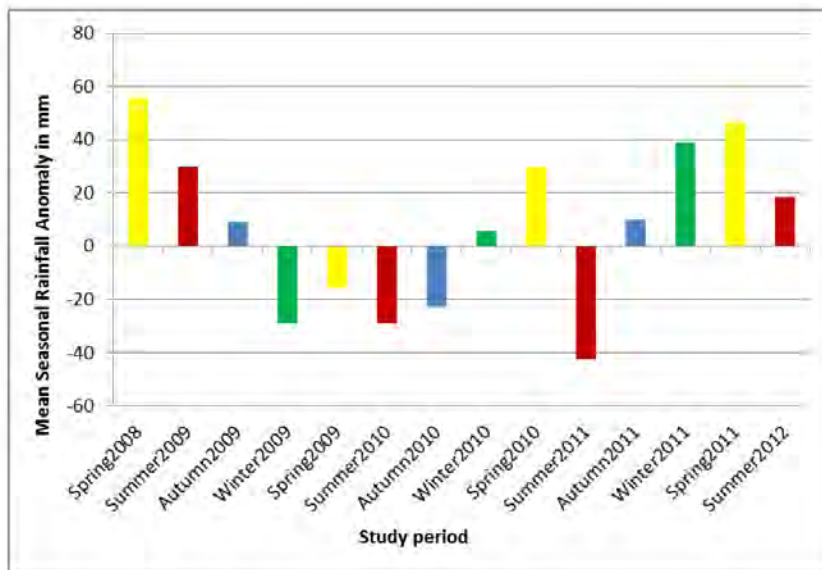


Figure 5: Mean seasonal rainfall (mm) anomaly during the study period compared with mean monthly rainfall (mm) from 1900 - 2011



The F&FMP (ecobiological 2007) recommends that sufficient weather stations are to 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. A weather station has been installed at Donaldson Coal mine, Beresfield approximately 5.5 km to the north which will provide more localised rainfall data in future.

The installation of permanent water depth indicators in the Main and South Swamps would also be useful to provide a quantitative level during each survey event. Permission for installation should be sought from OEH.



4.3 Flora

Flora surveys for this report were conducted during December 2011. A total of 177 flora species have been identified on the site since surveying commenced in 2008 within four survey quadrats, a single 50 m transect and a meandering survey (Appendix 1).

The Coastal Foothills Spotted Gum - Ironbark Forest (Q1) has previously been found to contain the highest species diversity of the flora plots surveyed in the Reserve (Plate 1). A total of 50, 47, 64 and 63 species were recorded during 2008, 2009, 2010 and 2011 surveys, respectively. The 2011 survey recorded one new species, *Oxalis perennans*, not previously recorded in the Reserve. The most significant weed recorded in this plot is *Lantana* (*Lantana camara*).



Plate 1: Flora quadrat 1 located in Coastal Foothills Spotted Gum - Ironbark Forest. Photograph taken in 2011.

Ten species were recorded in the Freshwater Wetland Complex (Q2) in 2008 (Plate 2). This quadrat was relocated as per an OEH request in 2009 and recorded 18 species in 2009 and 20 species in 2010. Species richness has decreased slightly in this quadrat since the previous survey, with 19 species recorded during the 2011 survey. The exotic species, *Aster subulatus* (Wild Aster) was not recorded in 2011.



Plate 2: Flora quadrat 2 located in Freshwater Wetland Complex dominated by Typha. Photograph taken in 2011.

The number of species recorded in Q3 located in the Paperbark Swamp Forest has steadily increased over the survey periods (Plate 3). A total of 15, 19 and 22 species were recorded during 2008, 2009 and 2010 surveys, respectively. *Alternanthera denticulata* (Lesser Joyweed), *Aster subulatus* (Wild Aster) and *Sonchus oleraceus* (Common Sowthistle) were not recorded in 2011.



Plate 3: Flora quadrat 3 located in Paperbark Swamp Forest. Photograph taken in 2011.



A total of 12 species were recorded in Q4 in 2008 (Plate 4). This quadrat was relocated as per a request from the OEH and recorded 18 species in 2009 and 17 species in 2010. One native species, *Triglochin procera* was not recorded in 2011.

The noxious weed, *Alternanthera philoxeroides* (Alligator Weed) was identified in 2011. Although only a few small plants were identified, this species is known to have the potential to cause severe impacts and should therefore continue to be closely monitored. The most significant weed located in this plot is Water Hyacinth (*Eichhornia crassipes*), which continues to persist at this location in low to moderate densities.



Plate 4: Flora quadrat 4 located in Paperbark Swamp Forest. Photograph taken in 2011.

The species richness of the flora transects has remained relatively static over the monitoring period. A total of 13 species were recorded during 2008, 2009 and 2010 survey events (Plate 5). The recent 2011 surveys recorded one less plant species, *Cynodon dactylon* during this survey event.



Plate 5: Flora transect located in Freshwater Wetland Complex. Photograph taken in 2011.

No threatened flora species were recorded during 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.

4.4 Weeds

The Reserve had significant weed infestations across both disturbed areas and within the natural vegetation (Figure 6). The primary weeds at the time of survey were:

Water Hyacinth (*Eichhornia crassipes*) – 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 would 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 species was found dominating 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 has been extracted from the open water and a grate installed to prevent this weed blocking the under road culvert (Plate 7). The 2011 monitoring event found that the coverage of this species has increased from the previous year, resulting in less open water present in the North Swamp (Plates 8 and 9).

Water Hyacinth is a declared Class 4 Noxious Weed in Newcastle, Cessnock and Maitland 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.



Plate 6: Water Hyacinth at the Northern Swamp inlet in 2008.



Plate 7: Water Hyacinth at the Northern Swamp inlet in 2009 (shows grate construction).



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.



- **Kikuyu (*Pennisetum clandestinum*)** is forming dense, monoculture grassy thickets at the disturbed areas of the subject site. The thickets are preventing any other growth at the wetland edges which is in turn preventing natural vegetation recruitment.

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.

- **Blackberry (*Rubus fruticosus aggregate*)** is found in areas of previous disturbance, and forms a dense thicket to 1 m high, preventing natural regeneration. Blackberry thickets have capabilities to 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 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 and 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. Outbreaks of this species were treated in 2008; however regrowth and regeneration of this species were recorded during the 2010 monitoring event. Follow up treatment is required to eradicate/suppress re-establishment of this species.

- **Lantana (*Lantana camara*)** is a primary weed of the dry sclerophyll woodland at the southern portion of the subject site. This species is dominating the shrub and mid stratum, effectively out-competing natural vegetation regeneration in areas. The thickets of Lantana reduce the natural plant biodiversity and also offer refuge for feral wildlife.

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, although at this stage there is no specific control program for this species in the reserve.

- **Crofton Weed (*Ageratina adenophora*)** 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, although at



this stage there is no specific control program for this species in the reserve.
There were no significant outbreaks of this species recorded in the 2011 surveys.

Crofton Weed is a declared Class 4 Noxious Weed in Newcastle, Cessnock and Maitland 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.

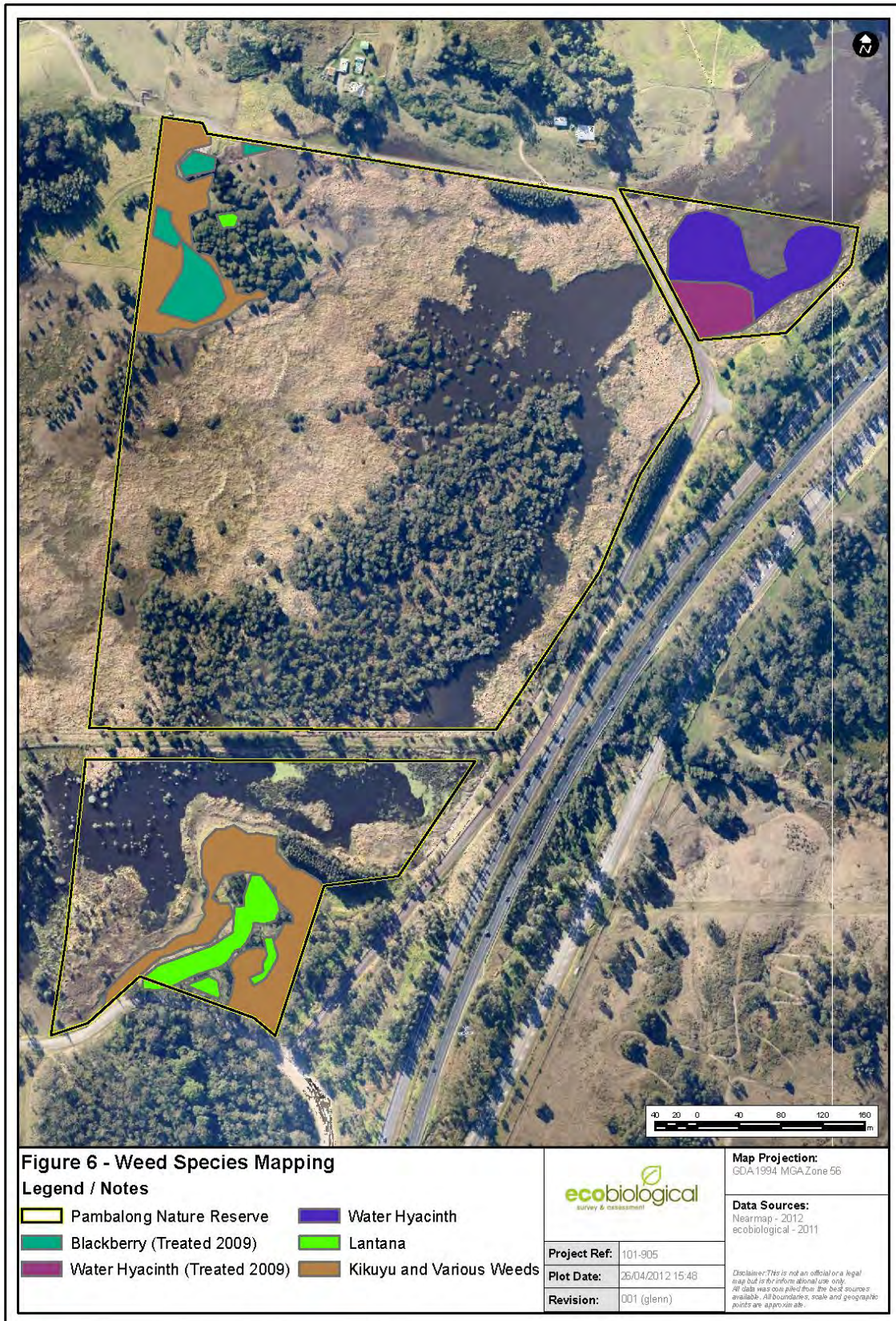
- **Alligator Weed (*Alternanthera philoxeroides*)** – although only a few small plants were identified, this species is known to have the potential to cause severe impacts and should continue to be closely monitored. Alligator Weed has the potential to infest waterways and invade adjoining land. Alligator 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 were general weeds of disturbed areas (e.g. former rail line, roadsides etc.) and pastures. These weeds are confined to the fringes of the reserve, roadsides and the former rail line. Generally these species are located outside the natural vegetation areas.

Other significant weeds not identified during field surveys but which have the potential to occur were:

- **Noogoora Burr (*Xanthium occidentale*)** – 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.

Legislation requires that noxious weeds be controlled. Alligator Weed, Blackberry, Crofton Weed, Water Hyacinth and Lantana are considered noxious in the Newcastle, Maitland and Cessnock City Council LGA's.

Some naturally occurring species may also present a problem if they become too abundant. Typha (*Typha orientalis*) and Phragmites (*Phragmites australis*) have the potential to spread into areas of open water, restricting the habitat of species preferring or utilising open water, such as pelicans, ducks and swans. If these native plant species threaten the habitat value of the reserve, they may require control.



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4.5 Vegetation Communities

Three natural vegetation communities and associated variations, and two altered vegetation types were mapped on the subject site in 2008 (Figure 7). The community extent did not change in the 2011 surveys.



4.5.1 Coastal Foothills Spotted Gum - Ironbark Forest (Dry Sclerophyll Forest)

Occurs as 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. 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.

4.5.2 Paperbark Swamp Forest (Swamp Sclerophyll Forest)

The Paperbark communities on the subject site are restricted to more elevated ground and areas bordering the freshwater wetland complex. The Paperbark community at the centre of the Reserve is the most mature, and has 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, 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*.

Q4 has similar paperbark species to Q3; however, with the more permanent inundation several other species are present, namely *Emydra fluctuans*, *Juncus pallidus*, *Ludwigia peploides* subsp. *montevicensis*; *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*.



4.5.3 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 consisted 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.

4.5.3.1 Typha Reedland

The Typha Reedland dominates deeper permanently inundated areas and relates directly to the depth within Open Water freshwater lagoons. The Typha Reedland generally borders the lagoon areas as the water is generally too deep within these open water lagoons. The extent of Typha relates to the seasons and water levels. During the warmer months, growth in the Typha Reedland areas will expand and is likely to reduce in the cooler months or when water levels rise. The plot Q2 is located in this community variant, with dominant species being *Typha orientalis* (Broadleaf Cumbungi), *Schoenoplectus validus*, *Paspalum distichum* (Water Couch) *Eleocharis equisetina* and *Bolboschoenus caldwellii*.

4.5.3.2 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 composition 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* are also common throughout.

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 2011 surveys were not significantly different to the 2009 or 2010 surveys and the water depths are similar.

4.5.3.3 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 and the composition and structure are indicative of type of



disturbance. This community is dominated by dense *Paspalum distichum* with *Triglochin* sp. and *Persicaria* sp. also common. The Swamp Meadow is fringed on the deeper inundations by Typha Reedland.

4.5.4 Altered Vegetation - Swamp Oak Forest (planted)

Two isolated sections of the subject site had monospecific *Casuarina glauca* stands that have been physically planted (i.e. still having plastic bags around stems). These communities are not natural and composition does not adequately represent a natural community. However, the *Casuarina glauca* is found naturally throughout the Paperbark Swamp Forest.

4.5.5 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. These Kikuyu areas have significant Blackberry clumps which have been recently treated.

The rail line between the South Swamp and Main Swamp is infested by weeds; however, this is relatively contained to the elevated area and is not impacting upon the swamp areas.

4.5.6 Endangered Ecological Communities

The vegetation mapping encompasses two natural vegetation communities listed as EEC's; *Freshwater Wetlands on Coastal Floodplains* EEC; and, *Swamp Sclerophyll Forest on Coastal Floodplains* EEC. The EEC areas are delineated in Figure 7. These EEC's cover the majority of the reserve.

4.5.6.1 Freshwater Wetlands

Description

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 (DEC 2005).

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.

Distribution

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



4.5.6.2 Swamp Sclerophyll Forests

Description

The Paperbark Swamp Forest is recognised as a Swamp Sclerophyll Forest EEC. The community composition of mainly *Melaleuca linariifolia*, *M. ericifolia* and *M. styphelioides* (paperbarks) and scattered *Casuarina glauca* 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 indicative of the EEC and is composed of abundant sedges, ferns, forbs, and grasses.

Distribution

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).

4.6 Faunal diversity

Fauna trapping and surveys were conducted in October, November and December 2011 with bird surveys repeated in March 2012. A total of 104 fauna species were recorded by ecobiological on the subject site in 2011/2 compared with 97 fauna species in 2010, 99 fauna species in 2009 and 107 fauna species in 2008 (Appendix 2).

Species recorded in 2011/12 comprised one fish, five frog, two terrestrial mammal, three reptile, 12 bat and 81 bird species. Of these, three species are listed as significant (Vulnerable) under the NSW TSC Act (Table 5). However, it should be noted that the call identification of Eastern False Pipistrelle and Eastern Cave Bat was classified as 'possible'. This means that while the call characteristics (i.e. pulse shape and characteristic frequency) suggest the presence of these species, there were very few calls of marginal quality from which to make an identification.

Latham's Snipe (*Gallinago hardwickii*) which was recorded by ecobiological in 2009 was not recorded during surveys in 2011/12. The annual Latham's Snipe count undertaken in the Reserve each December by the HBOC was cancelled again in 2011 at the request of OEH due to the presence of weed outbreaks in the swamp.

Table 5:Threatened fauna species recorded on the subject site.

Scientific Name	Common Name	Legal status	Survey Method
<i>Miniopterus australis</i>	Little Bentwing-bat	V - TSC Act	Anabat recording (confident)
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V - TSC Act	Anabat recording (possible)
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V - TSC Act	Anabat recording (possible)

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



Figure 8 provides a graph comparing total faunal diversity (excluding birds) and diversity per class (Fish, Amphibians, Reptiles, Mammals) in each survey year. The graph shows that both total diversity and diversity within classes across the years has remained relatively stable, with the exception of 2009 where total diversity was considerably lower (no reptile and fewer mammal species recorded).

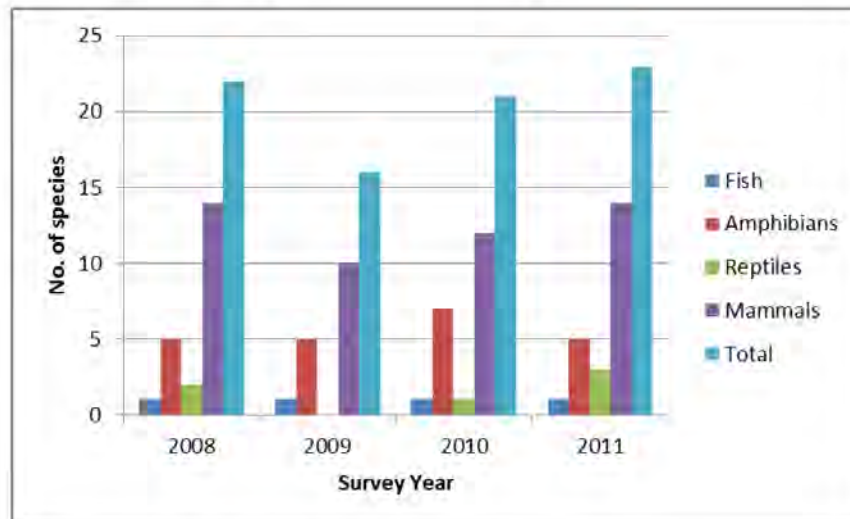


Figure 8: Faunal diversity (excluding birds) per survey year

The native Brown Antechinus (*Antechinus stuartii*) was trapped by ecobiological in 2011 but neither the native Bush Rat (*Rattus fuscipes*) nor the introduced Black Rat (*Rattus rattus*) or House Mouse (*Mus domesticus*) were captured. The Sugar Glider (*Petaurus breviceps*) previously recorded by White (2000) has not been recorded on site by ecobiological in any survey to date. Introduced competitors such as the House Mouse and Black Rat and predators such as the Red Fox, Feral Cat and Dog have the potential to reduce or wipe out native mammal populations at the site. Of these, only the Red Fox was recorded during the 2011 surveys. Future surveys will assist in confirming the ongoing presence or absence and abundance of these native species at the site.

The White-striped Mastiff-bat (*Tadarida australis*) was recorded by ecobiological for the first time since White's survey in 2000 using Anabat detection. Two additional bat species, the threatened Eastern Cave Bat (*Vespadelus troughtoni*) and the Eastern Horseshoe-bat (*Rhinolopus megaphyllus*) were recorded during surveys and have not previously been noted to occur in the nature reserve. This brings the total number of bat species recorded in the nature reserve to 16 which is considered a high diversity for the local area.

Figure 9 shows changes in bird diversity at each of the five survey locations across the four year survey period. A total of 81 bird species were recorded on site in 2011/12, compared with 75 species in 2010/11, 83 species in 2009/10 and 84 species in 2008/09.



Two new species not previously recorded by ecobiological (Azure Kingfisher and Black-faced Monarch) were recorded during the 2011 surveys.

The Hunter Bird Observers Club was approached for their records in 2011. One Latham's Snipe was recorded on 20/1/11 and eight White-breasted Woodswallows were recorded on 28/1/11. Both of these species have previously been recorded in the reserve.

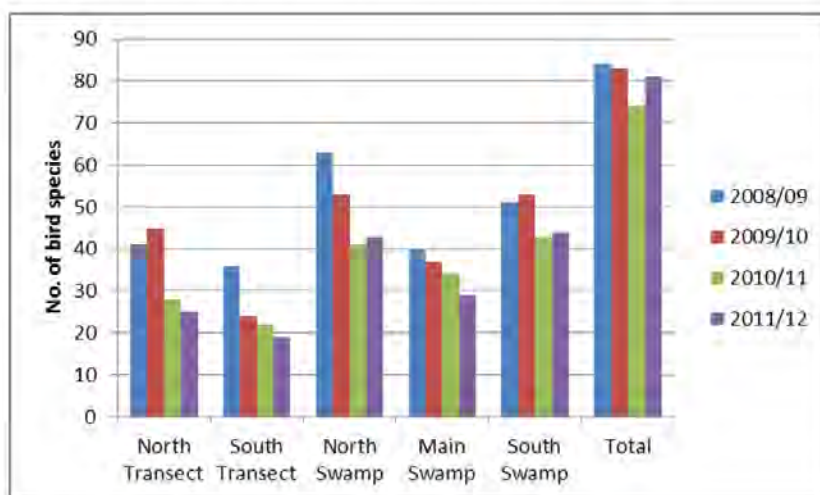


Figure 9: Bird diversity at survey sites per survey year

While total bird diversity has remained relatively constant, a decline in diversity at the North and South Transect and Main Swamp is apparent. Diversity at the North Swamp and South Swamp has not returned to the levels recorded in 2008/09 and 2009/10 but has increased slightly from the last survey event in 2010/11.

Reduced diversity at the North and South Transects and Main Swamp relates mainly to a reduction in recording of large, common species such as the Grey Butcherbird, Pied Currawong, Galah, Sulphur-crested Cockatoo, Australian Raven, Magpie-lark, Eastern Rosella and Australian King-parrot. Several migratory species such as the Channel-billed Cuckoo, Eastern Koel, Brush Cuckoo, Horsefield's Bronze-Cuckoo, Leaden Flycatcher and Rainbow Bee-eater have also not been recorded at these locations since 2008 or 2009.

While total bird species diversity was similar between survey events, species composition was found to be quite variable between seasons and year-to-year. Between 26 - 36 species out of a total bird species list of 110 (recorded to date by ecobiological) were not recorded in any given survey event.

Waterbird counts were down significantly on previous years. However, due to heavy and widespread rainfall in inland lake and wetland systems in late 2009 / early 2010



and continued above average rainfall in 2011 it is likely that many waterbirds moved inland to breed and take advantage of rich foraging opportunities (Reid, 2010). Likewise, counts of roosting waterbirds at the Main Swamp were low (approximately 40% of the peak count in March 2009). An analysis of waterbird abundance data will be undertaken in 2012 / 13 (5 year monitoring mark).

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 (e.g. some species have a large home range and may be absent from the study area during surveys or have cryptic traits which make them more difficult to detect).

Photographs of each water body surveyed for birds and amphibians are provided in Appendix 3. Photographs from both the October 2011 and March 2012 survey period are provided to enable a visual comparison of water levels, areas of open water and aquatic vegetation occurring at each of the three water bodies.

Four introduced fauna species were recorded during field surveys in 2011/12. The European Red Fox (*Vulpes vulpes*) was observed in long grass fringing the South Swamp, the Plague Minnow (*Gambusia holbrooki*) was detected during dipnetting surveys for tadpoles, and the following bird species were recorded as individuals or in low numbers (<5 individuals): Common Myna (*Sturnus tristis*) and Spotted Dove (*Streptopelia chinensis*).

4.7 Natural variations during surveys

It is acknowledged that water levels within Pambalong Nature Reserve fluctuate in response to local weather conditions. Local environmental conditions are also likely to affect the distribution and abundance of flora and fauna (predominantly amphibians and waterbirds) species within the swamp.

It is also acknowledged that collection of bird species presence and abundance in only two seasons does not fully account for the total diversity likely to occur within the wetland. To address this, ecobiological incorporate any available records from the Birds Australia Atlas, Hunter Bird Observers Club and any other reputable sightings in addition to its own in each annual report.



5. Conclusions and Recommendations

Monitoring of Pambalong Nature Reserve has been undertaken in 2011/12 in accordance with the Flora and Fauna Management Plan for Abel Underground Coalmine (ecobiological 2007). This fourth annual monitoring report continues the data collection that will build a picture of what constitutes normal variation so that any impacts from subsidence can be identified and appropriate management actions taken.

In all there were 63 flora (within the flora survey quadrats and transect) and 104 fauna species comprising one fish, five frog, two terrestrial mammal, three reptile, 12 bat and 81 bird species recorded by ecobiological within Pambalong Nature Reserve during the survey period. The following threatened species were recorded during field surveys:

- ☞ Little Bentwing-bat (*Miniopterus australis*);
- ☞ Eastern False Pipistrelle (*Falstirellus tasmaniensis*);
- ☞ Eastern Cave Bat (*Vespadelus troughtoni*).

The 2011 survey recorded one new flora species, *Oxalis perennans*, not previously recorded in the Reserve. 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 2011 surveys.

Weed management has been conducted by OEH in the 2011/12 financial year aimed predominantly at restricting the spread of Water Hyacinth and Alligator Weed. Hot and humid weather during the period has seen a huge increase in the amount of Water Hyacinth in the reserve. As is usually experienced with heavy rainfall and associated floods in the swamp, germination events are experienced. Although considerable OEH funding and resources have been spent on targeting this particular weed, it appears that the impact has been minimal. OEH have applied for a number of funding grants and strategies have been developed to target the issue in coming years. On a more positive note, the chemical treatment of Alligator Weed in the Main Swamp has been very successful with very limited regrowth from spraying. This also might be a factor of the high water levels. Splatter gun work on the site with Lantana and Moth Vine has also been successful. Kikuyu grass continues to cover significant areas and any treatment over these areas would require follow up regeneration and rehabilitation of the preferred community type and species. All other significant weed species identified in Pambalong Nature Reserve should continue to be monitored and managed if necessary.

The following recommendations are made to improve the reliability and robustness of future survey data (i.e. build a more reliable picture of what constitutes normal variation in the system) and to mitigate negative impacts on native flora and fauna:

- The installation of permanent water depth indicators in the Main and South Swamps would be useful to provide a quantitative water level during each survey event. Permission for installation should be sought from OEH and coordinated between involved parties.



- Ongoing control of noxious weeds is required (OEH responsibility).

Ongoing annual monitoring will be undertaken over the same time period each year describing the results of the current year's investigation and placing them in the context of the cumulative data. Additional data collected over the period of initial monitoring will be recorded for ongoing analytical purposes. At an appropriate time, statistical analysis will be applied to investigate whether any significant trends are developing. The future implications of any evident trends should be used to inform best practice measures to be incorporated into the Subsidence Management Plan (SMP).



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Appendix 1: Flora survey results

Key to symbols/abbreviations	
Q1 = Dry Sclerophyll Forest Plot	Cover abundance (CA) 1 = <5% cover, few individuals or sparse occurrence 2 = <5% cover, many individuals 3 = 5 - <25% cover 4 = 25 - <50% cover 5 = 50 - <75% cover 6 = 75 - 100% cover
Q2 = Freshwater Wetland Plot	
Q3 = Swamp Sclerophyll Paperbark Swamp Plot 1	
Q4 = Swamp Sclerophyll Paperbark Swamp Plot 2	
T1 = Freshwater Wetland 50 m Transect	
* Introduced species	
+ Indicates presence in transect survey	

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	T1
Acanthaceae	<i>Brunoniella australis</i>	Blue Trumpet	1				
Adiantaceae	<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>	Mulga Fern	1				
Alismataceae	<i>Alisma plantago-aquatica</i>	Water Plantain					
Amaranthaceae	<i>Alternanthera denticulata</i>	Lesser Joyweed		1			
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>Amujia sericifera</i>	Moth Vine					
Apocynaceae	* <i>Gomphocarpus fruticosus</i>	Wild Cotton					
Apocynaceae	<i>Parsonsia straminea</i>	Monkey Rope			2		
Asparagaceae	* <i>Protasparagus aethiopicus</i>	Fern Asparagus					
Asteraceae	* <i>Ageratina adenophora</i>	Crofton Weed					
Asteraceae	* <i>Ambrosia tenuifolia</i>	Lacy Ragweed					
Asteraceae	* <i>Aster subulatus</i>	Wild Aster					
Asteraceae	* <i>Bidens pilosa</i>	Cobblers peg	2				
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				
Asteraceae	* <i>Senecio madagascariensis</i>	Fireweed	1				
Asteraceae	* <i>Sonchus oleraceus</i>	Milk Thistle		1			
Asteraceae	* <i>Tugetes minuta</i>	Stinking Roger					
Asteraceae	<i>Brachycome multifida</i> var. <i>dilatata</i>	Cut-leaf daisy	2				
Asteraceae	<i>Cotula coronopifolia</i>	Water Buttons					
Asteraceae	<i>Enydra fluctuans</i>					2	
Asteraceae	<i>Euchiton involucreatus</i>	Star Cudweed					
Asteraceae	<i>Hypochaeris radicata</i>	Catsear					
Asteraceae	<i>Ozothamnus diosmifolius</i>	White dogwood					
Asteraceae	<i>Senecio pterophorus</i>						
Asteraceae	<i>Vernonia cinerea</i> var. <i>cinerea</i>		2				
Asteraceae	<i>Vittadinia cuneata</i> var. <i>cuneata</i>	Fuzzweed	2				
Azollaceae	<i>Azolla filiculoides</i>	Pacific Azolla				6	1
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	

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Family	Scientific Name	Common Name	Q 1	Q 2	Q 3	Q 4	T 1
Celastraceae	<i>Maytenus silvestris</i>	Orange Bark	1				
Ceratophyllaceae	<i>Ceratophyllum demersum</i>	Hornwort					1
Chenopodiaceae	<i>Einadia hastata</i>	Berry Saltbush			2		
Commelinaceae	* <i>Tradescantia albiflora</i>	Wandering Jew					
Commelinaceae	<i>Commelina cyanea</i>	Scurvy Weed	2		2		
Convolvulaceae	* <i>Ipomoea purpurea</i>	Common Morning Glory					
Convolvulaceae	<i>Dichondra repens</i>	Kidney weed	2				
Cyperaceae	* <i>Cyperus difformis</i>						
Cyperaceae	<i>Bolboschoenus caldwellii</i>			3	2	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 splucelata</i>	Tall Spike-rush					1
Cyperaceae	<i>Fimbristylis dichotoma</i>	Common Fringe- sedge					
Cyperaceae	<i>Schoenoplectus subulatus</i>						
Cyperaceae	<i>Schoenoplectus validus</i>			3			1
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	1				
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>		2				
Fabaceae - Faboideae	<i>Hardenbergia violacea</i>	Purple Twining Pea	1				
Fabaceae - Faboideae	<i>Kennedia rubicunda</i>	Red Kennedy Pea					
Fabaceae - Faboideae	<i>Kennedia rubicunda</i>	Red Kennedy Pea					
Fabaceae - Mimosoideae	<i>Acacia fulcata</i>	Sickle Wattle					
Fabaceae - Mimosoideae	<i>Acacia fimbriata</i>						



Family	Scientific Name	Common Name	Q 1	Q 2	Q 3	Q 4	T 1
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
Juncaceae	<i>Juncus continuus</i>		1		1	1	
Juncaceae	<i>Juncus pallidus</i>	Pale Rush				1	
Juncaceae	<i>Juncus usitatus</i>	Common Juncus	1	1	1		
Juncaginaceae	<i>Triglochin procerum</i>						
Juncaginaceae	<i>Triglochin striata</i>	Streaked Arrowgrass		1			
Lamiaceae	<i>Plectranthus parviflorus</i>	Cockspur Flower	1				
Lemnaceae	<i>Sparganium punctatum</i>	Duck Weed				4	1
Lobeliaceae	<i>Pratia purpurascens</i>	White root	2				
Lomandraceae	<i>Lomandra multiflora</i> subsp. <i>multiflora</i>	Iron Grass	2				
Loranthaceae	<i>Dendrophthoe vitellina</i>	Mistletoe					
Luzuriagaceae	<i>Eustrephus latifolius</i>	Wombat Berry	1				
Luzuriagaceae	<i>Geitonoplesium cymosum</i>	Scrambling Lily	1				
Malvaceae	* <i>Sida rhombifolia</i>	Paddy's Lucerne	2				
Menispermaceae	<i>Stephania japonica</i> var. <i>discolor</i>	Snake Vine	1				
Moraceae	<i>Ficus macrophylla</i>	Moreton Bay Fig			1		
Myoporaceae	<i>Eremophila debilis</i>	Winter Apple	1				
Myrsinaceae	<i>Myrsine variabilis</i>		2				
Myrtaceae	<i>Corymbia maculata</i>	Spotted Gum	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					
Onagraceae	* <i>Oenothera stricta</i>	Evening Primrose					
Onagraceae	<i>Epilobium billardierianum</i> subsp. <i>billardierianum</i>						
Onagraceae	<i>Ludwigia peploides</i> subsp. <i>montevideensis</i>	Water Primrose		2		2	1
Orchidaceae	<i>Dendrobium linguiforme</i>	Tongue Orchid				1	
Orchidaceae	<i>Dendrobium teretifolium</i>	Rat's Tail Orchid				1	
Oxalidaceae	<i>Oxalis perennans</i>		1				
Passifloraceae	* <i>Passiflora edulis</i>	Common Passionfruit	1				
Phormiaceae	<i>Diinella cuerideae</i>	Blue Flax-lily	1				
Phormiaceae	<i>Dianella revoluta</i> var. <i>revoluta</i>	Blueberry Lily	1				
Phyllanthaceae	<i>Breynia oblongifolia</i>	Coffee Bush	1				
Phyllanthaceae	<i>Phyllanthus hirtellus</i>	Thyme Spurge	1				
Pittosporaceae	<i>Bursaria spinosa</i>	Box Thorn	2				
Plantaginaceae	* <i>Plantago lanceolata</i>	Lambs Tongue	2				
Poaceae	* <i>Andropogon virginicus</i>	Whisky Grass					
Poaceae	* <i>Axonopus fissifolius</i>	Narrow-leaved Carpet Grass					



Family	Scientific Name	Common Name	Q 1	Q 2	Q 3	Q 4	T 1
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>Ehrharta erecta</i>	Panic Veldtgrass	2				
Poaceae	* <i>Eragrostis curvula</i>	African Lovegrass					
Poaceae	* <i>Hyparrhenia hirta</i>	Coolatai Grass					
Poaceae	* <i>Lolium perenne</i>	Perennial Ryegrass					
Poaceae	* <i>Melinis repens</i>	Red Natal Grass					
Poaceae	* <i>Panicum maximum</i>	Guinea Grass					
Poaceae	* <i>Paspalum dilatatum</i>	Paspalum	1				
Poaceae	* <i>Paspalum urvillei</i>	Tall Paspalum					
Poaceae	* <i>Pennisetum clandestinum</i>	Kikuyu			1		
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	2				
Poaceae	<i>Aristida vagans</i>	Three-awned Spear Grass	1				
Poaceae	<i>Austrostipa</i> sp.		1				
Poaceae	<i>Capillipedium parviflorum</i>	Scented-top Grass					
Poaceae	<i>Cymbopogon refractus</i>	Barbed Wire Grass	1				
Poaceae	<i>Cynodon dactylon</i>	Couch		3	4		
Poaceae	<i>Dichelachne micrantha</i>	Shorthair Plumegrass	2				
Poaceae	<i>Digitaria ramularis</i>						
Poaceae	<i>Echinopogon caespitosus</i>	Tufted Hedgehog Grass	2				
Poaceae	<i>Entolasia stricta</i>	Wiry panic	4				
Poaceae	<i>Imperata cylindrica</i>	Bladey grass	2				
Poaceae	<i>Lachnagrostis filiformis</i>		1				
Poaceae	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass	1				
Poaceae	<i>Optismenus aemulus</i>	Basket Grass	1				
Poaceae	<i>Panicum simile</i>	Two Colour Panic	1				
Poaceae	<i>Paspalum distichum</i>	Water Couch		3	2	1	1
Poaceae	<i>Themeda australis</i>	Kangaroo grass	3				
Poaceae	<i>Austrodanthonia tenuior</i>	Wallaby Grass					
Polygonaceae	* <i>Polygonum arenastrum</i>	Wireweed		1	2		
Polygonaceae	* <i>Rumex conglomeratus</i>	Clustered Dock			1		
Polygonaceae	* <i>Rumex crispus</i>	Dock			2		
Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed			2	2	1
Polygonaceae	<i>Persicaria hydropiper</i>	Water Pepper					
Pontederiaceae	* <i>Eichhornia crassipes</i>	Water Hyacinth				1	
Ranunculaceae	* <i>Ranunculus repens</i>	Creeping Buttercup					
Ranunculaceae	<i>Clematis glycinoides</i>	Old Man's Beard					
Ranunculaceae	<i>Ranunculus inundatus</i>	River Buttercup		2			
Rhamnaceae	<i>Alphitonia excelsa</i>	Red Ash	1				
Rosaceae	* <i>Rubus fruticosus</i> aggregate	Blackberry					
Rubiaceae	<i>Opercularia diphylla</i>		1				
Scrophulariaceae	<i>Bacopa monnieri</i>	Bacopa		2			
Solanaceae	* <i>Solanum mauritianum</i>	Wild Tobacco					



Family	Scientific Name	Common Name	Q 1	Q 2	Q 3	Q 4	T 1
Solanaceae	<i>Solanum nigrum</i>	Blackberry Nightshade		1			
Solanaceae	<i>Solanum brownii</i>	Violet Nightshade					
Solanaceae	<i>Solanum prinophyllum</i>	Forest Nightshade					
Typhaceae	<i>Typha orientalis</i>	Broadleaf Cumbungi		5		4	1
Verbenaceae	<i>Lantana camara</i>	Lantana	3				
Verbenaceae	<i>Verbena bonariensis</i>	Purpletop		1			
Violaceae	<i>Viola hederaea</i>	Ivy-leaved Violet					
Vitaceae	<i>Cayratia clematidea</i>	Native Grape	1				



Appendix 2: Fauna species recorded on the subject site

Table 1: Fauna species (excluding birds) recorded from trapping and nocturnal survey activities by ecobiological in baseline study (October 2008), November 2009, November 2010, October 2011 and White (2000).

Scientific Name	Common Name	Method	2008	2009	2010	2011	White (2000)
Fish							
<i>Gambusia holbrooki</i>	Plague Minnow	Tadpole search	+	+	+	+	+
Amphibians							
<i>Crinia signifera</i>	Common Eastern Froglet	Nocturnal amphibian survey	+		+	+	
<i>Limnodynastes peronii</i>	Striped Marsh Frog	Nocturnal amphibian survey	+	+	+	+	
<i>Litoria fallax</i>	Eastern Dwarf Tree Frog	Nocturnal amphibian survey	+	+	+	+	
<i>Litoria freycineti</i>	Freyinet'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 verreauxi</i>	Verreaux's Tree Frog	Nocturnal amphibian survey		+			
<i>Uperoleia laevis</i>	Smooth Toadlet	Nocturnal amphibian survey			+		
Reptiles							
<i>Pseudonaja textilis</i>	Eastern Brown Snake (deceased)	Opportunistic sighting					+
<i>Chelodina longicollis</i>	Eastern Long-necked Turtle	Opportunistic sighting				+	+
<i>Eulamprus quoyi</i>	Eastern Water Skink	Diurnal reptile survey					+
<i>Amphibolurus muricatus</i>	Jacky Lizard	Diurnal reptile survey					+
<i>Ctenotus robustus</i>	Robust Ctenotus	Diurnal reptile survey					+
<i>Lampropholis delicata</i>	Garden Skink	Diurnal reptile survey					+
<i>Physignathus lesueuri lesueuri</i>	Eastern Water Dragon	Opportunistic sighting	+				
<i>Pseudochis porphyriacus</i>	Red-bellied Black Snake	Opportunistic sighting	+		+	+	+
Terrestrial / Scansorial Mammals							
<i>Antechinus stuartii</i>	Brown Antechinus	Trapping	+		+	+	+
<i>Mus domesticus</i>	*House Mouse	Trapping	+	+			
<i>Petaurus breviceps</i>	Sugar Glider	Spotlighting					+
<i>Rattus fuscipes</i>	Bush Rat	Trapping	+				+
<i>Rattus rattus</i>	*Black Rat	Trapping/spotlighting	+	+	+		+

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Scientific Name	Common Name	Method	2008	2009	2010	2011	White (2000)
<i>Vulpes vulpes</i>	*Red Fox	Opportunistic sighting				+	+
<i>Felis catus</i>	*House Cat	Spotlighting			+		
Bats							
<i>Pteropus poliocephalus</i>	# Grey-headed Flying-fox	Spotlighting (2008) / dead animal observed in 2009	+	+			+
<i>Tadarida australis</i>	White-striped Mastiff-bat	Anabat analysis				+	+
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat	Anabat analysis/trapping	+	+	+	+	+
<i>Chalinolobus mono</i>	Chocolate Wattled Bat	Anabat analysis/trapping			+	+	+
<i>Falsistrellus tasmaniensis</i>	# Eastern False Pipstrelle	Anabat analysis		+		+	
<i>Miniopterus australis</i>	# Little Bentwing-bat	Anabat analysis	+	+	+	+	
<i>Miniopterus eocanensis</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>Nyctophilus sp.</i>	Unidentified Long-eared Bat	Anabat analysis	+		+	+	
<i>Nyctophilus gouldii</i>	Gould's Long-eared Bat	Trapping					+
<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat	Anabat analysis				+	
<i>Saccolanmus flaviventris</i>	# Yellow-bellied Shear-tail-bat	Anabat analysis			+		
<i>Scotoneuz rupestris</i>	# Greater Broad-nosed Bat	Anabat analysis	+				
<i>Scotorepens orion</i>	Eastern Broad-nosed Bat	Anabat analysis			+	+	
<i>Vespadelus pumilus</i>	Eastern Forest Bat	Anabat analysis	+	+	+	+	
<i>Vespadelus troughtoni</i>	# Eastern Cave Bat	Anabat analysis				+	
<i>Vespadelus vulturnus</i>	Little Forest Bat	Trapping & Anabat analysis	+	+	+	+	+

* denotes an introduced species.
denotes a threatened species under the NSW TSC Act 1995
NR: Taxonomy for bats follows Clench (2008).

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Table 2. Bird species recorded along Transects by ecobiological during Spring 2008 compared with Spring 2009, Summer 2010, Spring 2011.

Family	Scientific Name	Common Name	Spring 2008				Spring 2009				Summer 2010				Spring 2011			
			T1-Nth	T2-Sth	T1-Nth	T2-Sth	T1-Nth	T2-Sth	T1-Nth	T2-Sth	T1-Nth	T2-Sth	T1-Nth	T2-Sth	T1-Nth	T2-Sth		
Acanthidae	<i>Geopelia striata</i>	Brown Gerygone	h		h		h		h		B		h		h			
Acanthidae	<i>Acanthya pusilla</i>	Brown Thornbill	h		h		A		A		A		A		A		A	
Acanthidae	<i>Stomoxys viridis</i>	White-browed Scrubwren	h		h		h		A		h		A		A		A	
Acanthidae	<i>Acanthya tana</i>	Yellow Thornbill	A				A		A		A		A		A		A	
Accipitridae	<i>Amelia suberulata</i>	Pacific Baza									1							
Accipitridae	<i>Accipiter</i>	Wedge-tailed Eagle	1															
Acrocephalidae	<i>Acrocephalus australis</i>	Australian Reed-Warbler	h	h			h	h	h	h	h		h				h	
Alcedidae	<i>Hirundinidae</i>	White-throated Noddy											A					
Alcedidae	<i>Alcedo</i>	Carlini Egret							B									
Alcedidae	<i>Egretta sacra</i>	White-faced Heron			1													
Artamidae	<i>Cracticus tibicen</i>	Australian Magpie	h	+	h	h	h	h	h		h		h	h	A		h	
Artamidae	<i>Cracticus torquatus</i>	Grey Butcherbird	h	h					h		h				h			
Artamidae	<i>Cracticus nigropictus</i>	Pied Butcherbird	h	h	h		h		h								A	
Artamidae	<i>Strepera graculina</i>	Pied Currawong	h															
Artamidae	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow		A														
Caculidae	<i>Callipepla</i>	Galah			h	h											A	
Caculidae	<i>Callipepla</i>	Lute Crinifera					h								h			
Caculidae	<i>Callipepla</i>	Sulphur-crested Cockatoo	h				h	h	h								A	
Campophagidae	<i>Corvus australis</i>	Black-faced Cuckoo-shrike	h	h		A	h	h	h		A	A	A	A			A	
Campophagidae	<i>Corvus tenuirostris</i>	Cuckabird									A							
Charadriidae	<i>Vanellus miles</i>	Masked Lapwing	h		h		h		2									
Cisticolidae	<i>Cisticola erythraea</i>	Golden-headed Cisticola	h	h	h	h	h	h	h									
Columbidae	<i>Columba lividus</i>	Bar-bouldered Dove					h	h										
Columbidae	<i>Columba lividus</i>	Crested Pigeon			h	h	h	h									h	
Columbidae	<i>Luscinia sibilatrix</i>	Wonga Pigeon															h	
Coraciidae	<i>Eurystomus orientalis</i>	Dolliebird									A		h					
Corvidae	<i>Corvus coronoides</i>	Australian Raven	h		h	A	h	h	h		h		A					
Cuculidae	<i>Cuculus cyaneus</i>	Brush Cuckoo	h	h	h				h							h	h	
Cuculidae	<i>Syzygius aculeatus</i>	Charm-billed Cuckoo							h									
Cuculidae	<i>Eudynamis orientalis</i>	Eastern Kestrel			h												h	
Cuculidae	<i>Cuculus cyaneus</i>	White-tailed Cuckoo	h	h		h										h	h	
Cuculidae	<i>Chalcides basalis</i>	Horsfield's Bronze-Cuckoo				h											h	
Cuculidae	<i>Centropus phasianinus</i>	Pheasant Cuckoo			h	h	h	h	h	h	h	h	A	h	A	h	h	
Cuculidae	<i>Chalcides lucidus</i>	Shining Bronze-Cuckoo	h				h	h								h		
Estrildidae	<i>Tamiasca bicolor</i>	Double-banded Finch				h												
Estrildidae	<i>Nesospiza temporalis</i>	Red-browed Finch	A		h			h	A		A		B		A			
Eupodidae	<i>Pezopoda olivacea</i>	Eastern Whipbird	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	
Falconidae	<i>Ducula araxagena</i>	Laughing Kookaburra	h	2		A	1		h				h		h			
Falconidae	<i>Turdus sordidus</i>	Sacred Kingfisher	A	A	h	h	A	h			h		h				h	
Falconidae	<i>Halcyon leucopygia</i>	Welcome Swallow	A	h	h	A	A											
Falconidae	<i>Malurus cyanus</i>	Superc Fairy-wren	h	h	h	h	B	h	h	h	h	h	A	h	h	h	h	
Falconidae	<i>Malurus lamberti</i>	Variagated Fairy-wren	h	h	h	h					A							
Falconidae	<i>Megascops grammurus</i>	Little Grassbird			h				h									
Falconidae	<i>Megascops grammurus</i>	Tawny Grassbird			h				h									
Meliphagidae	<i>Meliphaga melanopygia</i>	Red Miner	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	
Meliphagidae	<i>Meliphaga fasciata</i>	Brown-headed Honeyeater	h															
Meliphagidae	<i>Meliphaga lewinii</i>	Lewin's Honeyeater	h	h	h	h	h	h	h	h	h	h	h	h	h	h	h	
Meliphagidae	<i>Phylloscopus collybita</i>	Noisy Friarbird				A												
Meliphagidae	<i>Meliphaga melanopygia</i>	Noisy Miner	h	h	h	h	h	h	h	h	A	h		A		A		

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Family	Scientific Name	Common Name	Spring 2008				Spring 2009				Summer 2010				Spring 2011			
			T1-Nth	T2-Sth	T1-Nth	T2-Sth	T1-Nth	T2-Sth	T1-Nth	T2-Sth	T1-Nth	T2-Sth	T1-Nth	T2-Sth	T1-Nth	T2-Sth		
Meliphagidae	<i>Meliphaga melanopygia</i>	Scarlet Honeyeater	h	h	h	h				h					A		A	
Meliphagidae	<i>Ptilinopus loricatus</i>	Sussex Honeyeater	h		h	h												
Meliphagidae	<i>Troglodytes aedon</i>	Yellow-faced Honeyeater	h	h	h				A			h						
Micropodidae	<i>Micropus ornatus</i>	Rainbow Bee-eater	h															
Monarchidae	<i>Monarcha melanopygia</i>	Black-faced Monarch															h	
Monarchidae	<i>Gullinula cyaneus</i>	Magpie-lark	h	h			h	h	h					h				
Nectarinidae	<i>Dicaeum formicivorum</i>	Mudkicker						h	B				h					
Oryziolidae	<i>Sporophila viridis</i>	Australian Fighbird					h	h	h	h				B		h		
Oryziolidae	<i>Oryzopsis sagittata</i>	Olive-backed Oriole	h	2			A	1										
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler	h	h	h	h	h	h	h			h	h	h				
Pachycephalidae	<i>Collocalia harrisi</i>	Grey Shrike-thrush											h	h				
Pachycephalidae	<i>Pachycephala rufinervis</i>	Rufous Whistler	h	h	h	h	h	h	h	h	h	h	h	h	h	h	A	
Parulidae	<i>Parulotus juncatus</i>	Spotted Pardalote	h								h							
Petrochelidonidae	<i>Petrochelidon lunifrons</i>	Eastern Yellow Robin								h		h	A	A				
Ptilinopus	<i>Micropus ornatus</i>	Australian King-Parrot				h												
Ptilinopus	<i>Ptilinopus cyanus</i>	Eastern Rosella	h	h	A	A	A	h	A		A					A		
Ptilinopus	<i>Troglodytes aedon</i>	Rainbow Lorikeet	h	2					h	A				2 fo	A	A		
Rallidae	<i>Porphyrio porphyrio</i>	Purple Swamphen	h						h									
Rhipiduridae	<i>Rhipidura albicollis</i>	Grey Fantail	h	h	h	h	h	A	h	A	h	h	h	h	h	h	h	
Rhipiduridae	<i>Rhipidura leucopygia</i>	Willie Wagtail	h	h	h	A	h	h	h	h	A	h	h	h	h	h	h	
Sturnidae	<i>Sturnus tristis</i>	*Common Myna					A											
Sturnidae	<i>Sturnus vulgaris</i>	*Common Starling			2													
Thraupidae	<i>Thraupis spirozella</i>	Shaw-billed Thrush	2	1														
Troglodytidae	<i>Zosterops lateralis</i>	Silvereye	h	B		h		B	h	B	h	h	h	A				
	No. of Species		29	30	30	19	39	13	29	20	21	17	20	13	22	15	13	14

The list follows the taxonomy of Christidis & Jolin (2008).
h = heard only
+ = flying over
* = introduced species
Where numbers were counted, these are shown. In other cases the estimate of abundance is represented by the following approximations:
A=1-5 birds present; B=6-20 birds present; C=21-50 birds present; D=51-100 birds present; E=more than 100 birds present.

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Du = Dawn survey; Du = Dusk survey

Family	Scientific Name	Common Name	Spring 2008			Autumn 2009			Summer 2010			Autumn 2011			Spring 2011			Autumn 2012								
			Du	Du	Du	Du	Du	Du	Du	Du	Du	Du	Du	Du	Du	Du	Du	Du	Du	Du						
Moropidae	<i>Morop ornatus</i>	Rainbow Bee-eater	A	h																						
Monarchidae	<i>Altagira rubicula</i>	Leadren Flycatcher		h																						
Monarchidae	<i>Grallina cyanoleuca</i>	Maggpie-Lark	h	1	h	h	h	h	A		A		A		A	h	h	h								
Noctuidae	<i>Dicranes leucomerum</i>	Night-crowber																								
Oriolidae	<i>Sphocollis ocellati</i>	Australasian Figbird																								
Oriolidae	<i>Oriolus agittatus</i>	Olive-backed Oriole																								
Pachycephalidae	<i>Pachycephala pectoralis</i>	Golden Whistler	+	h																						
Pachycephalidae	<i>Pachycephala ruficeps</i>	Rufous Whistler		h																						
Pardalidae	<i>Pardalipicus punctatus</i>	Spotted Pardalote		h																						
Petrochelidonidae	<i>Eopsaltria australis</i>	Eastern Yellow Robin																h	h							
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant																	1							
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant																	1							
Phalacrocoracidae	<i>Phalacrocorax melanoleucus</i>	Little Pied Cormorant	1		1														1							
Phalacrocoracidae	<i>Phalacrocorax ururus</i>	Pied Cormorant																	1							
Podicipedidae	<i>Tachypetes novaezelandiae</i>	Australasian Grebe																	1							
Psittacidae	<i>Platycercus eremius</i>	Eastern Rosella	h	1	2	3	h	2		A	A	A	A	A	A	A	A	A	A							
Psittacidae	<i>Alisterus scapularis</i>	Australian King Parrot																	A							
Psittacidae	<i>Trichoglossus haemateros</i>	Rainbow Lorikeet				h													A							
Rallidae	<i>Gallinula trichotis</i>	Dusky Moorhen		2	11	3	4	5	1																	
Rallidae	<i>Fulica atra</i>	Eurasian Coot							1																	
Rallidae	<i>Porphyrula porphyrio</i>	Purple Swamphen	4	5	1	1	5	3	4	3	1	h	h	8	8	8	10	8	8							
Rhipiduridae	<i>Rhipidura olivacea</i>	Cree Fantail			h	h	h	h											h							
Rhipiduridae	<i>Rhipidura leucopygia</i>	Willie Wagtail	h	1	h	h	h	h	3	h	A	h	h	A	A	h	A	A	h							
Sturnidae	<i>Sturnus tristis</i>	*Common Myna																								
Sturnidae	<i>Sturnus vulgaris</i>	*Common Starling																								
Threskiornithidae	<i>Platya regia</i>	Royal Spoonbill																								
No. of Species			29	23	33	12	18	17	22	7	18	14	12	19	9	10	15	13	18	14	13	16	18	19	20	12

The list follows the taxonomy of Christie & Isles (2008).
h = heard only; + = adult ♀ brooding; ♂ = ♂ introduced species
Where numbers were counted, these are shown. In other cases the estimate of abundance is represented by the following approximations:
A=1-5 birds present; B=6-20 birds present; C=21-50 birds present; D=51-100 birds present; E=more than 100 birds present.

Table 6: Roosting bird count results from the Main Swamp during Spring 2008 / Autumn 2009 compared with Spring 2009 / Autumn 2010, Summer 2010 / Autumn 2011 and Spring 2011 / Autumn 2012.

Family	Scientific Name	Common Name	15/10/08 7-15pm	5/3/09 7-10am	18/11/09 7-5pm	23/3/10 7-20am	23/12/10 8-10am	23/03/11 8am	19/10/11 7-20am	20/3/12 7-20 pm
Ardeidae	<i>Anas thib</i>	Cattle Egret	57	170	67		26		188	80
Ardeidae	<i>Anas pacific</i>	White-necked Heron	1							
Ardeidae	<i>Egretta novaezelandiae</i>	White-faced Heron								4
Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant					2			15
Phalacrocoracidae	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant	17	10	8		14		1	5
Phalacrocoracidae	<i>Phalacrocorax melanoleucus</i>	Little Pied Cormorant			8	3				
Threskiornithidae	<i>Threskiornis molucca</i>	Australian White Ibis	9	50	37	44		2	1	
Threskiornithidae	<i>Threskiornis spinicollis</i>	Straw-necked Ibis	125	40	8	3				
No. of individuals			209	270	126	50	42	2	190	104

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Appendix 3 - Water body photographs



Plate 1: Stitched photograph of South Swamp taken in November 2011.



Plate 2: Stitched photograph of South Swamp taken in March 2012.

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Plate 3: Stitched photograph of Main Swamp taken in November 2011.



Plate 4: Stitched photograph of Main Swamp taken in March 2012.

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Plate 5: Stitched photograph of North Swamp taken in November 2011.

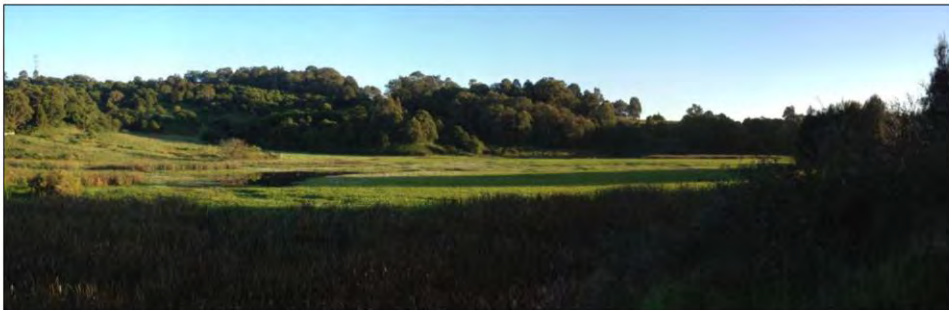


Plate 6: Photograph of North Swamp taken in March 2012.

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Appendix 4: Contributions and qualifications of ecobiological staff

Name	Qualification	Title	Contribution
Gilbert Whyte	B. Bio. Sc. (Hons)	Ecologist (Botanist / Entomologist)	Flora survey and report writing.
Shawn Capararo	B. Sc (Natural Resources) (Hons)	Ecologist	Bird survey.
Kristy Peters	B. ParkMgt (Hons)	Senior Ecologist (Ornithologist)	Bird survey, Anabat analysis and report writing.
Gayle Joyce	B. Sc (Forestry) (Hons)	GIS Officer	Map preparation.



Appendix 5: Licensing matters relating to the survey

ecobiological employees involved in the current study are licensed or approved under the *National Parks and Wildlife Act 1974* (License Number: S12398, Expiry: 30 November 2012) 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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