360 environmental

Lake Mackay Sulphate of Potash Project

Waterbird Survey at Lake Mackay

Prepared for:
Agrimin Ltd

July 2017

people • planet • professional

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2188AC	C CLIENT FINAL	RF			1 Electronic (email)	09/08/17

Executive Summary

Agrimin Limited (Agrimin) requires a number of baseline biological assessments to be carried out at its Lake Mackay Sulphate of Potash (SOP) project. The SOP project comprises nine tenements (all in Western Australia) covering the majority of Lake Mackay over a total area of 2,560 km^2. The SOP project has indicated mineral resources of 4.3 million tonnes and inferred mineral resources of 18.9 million tonnes of SOP (based on specific yield) at a potassium concentration of 3,603 mg/L of brine. The mineral resources are estimated on the basis of drainable brine volume from surface to an average depth of only 24.7 m.

Lake Mackay is the 4th largest lake in Australia dominated by an episodically inundated shallow lake bed as well as surrounding freshwater claypans. It is located on the Western Australia (WA) – Northern Territory (NT) border. Following a major rainfall event during summer-autumn 2001, an aerial survey found that the lake was of national and international significance for waterbird populations (26 waterbirds species, >40,000 individual birds). It was also shown to be a significant site for breeding of Banded Stilt *Cladorhynchus leucocephalus*, an Australian-endemic shorebird, with more than 4,400 juvenile birds observed at two sites. In December 2016, a major rainfall event (426 mm) and subsequent inundation created an opportunity to assess the status, abundance and significance of waterbirds in the SOP project area. Arid-zone wetlands such as Lake Mackay are always drying or flooding which stimulates movements of waterbirds in response to resource abundance and depletion.

Waterbirds and other birds were surveyed at a total of 62 georeferenced sites during 14-17 April 2017, 114-117 days after the rain event. This included 17 ground survey sites, 10 on Lake Mackay and seven at claypans. Total ground survey effort was 20 hrs and 47 mins, including 11 hrs and 59 mins at the 10 Lake Mackay sites and 8 hrs and 48 mins at the seven claypan sites. At each ground site, waterbirds were observed with binoculars and a spotting scope and counted or numbers estimated. The presence and absence of waterbirds on Lake Mackay was recorded at georeferenced sites during all general and targeted helicopter flights over Lake Mackay and associated claypan wetlands (approximately 600 km of flights in total).

A total of 52 bird species were recorded including 26 waterbird species (12 shorebirds and 14 other waterbirds) and 26 landbird species. On Lake Mackay, waterbird diversity was very low (7 species) and at very low abundance. Only 682 individual waterbirds were recorded including 540 shorebirds, comprised of 252 Red-necked Stints *Calidris ruficollis*, 235 Banded Stilts (including one flock of 190 birds), 47 Red-capped Plovers *Charadrius ruficapillus* and six Sharp-tailed Sandpipers *Calidris acuminata*. All shorebirds were observed actively foraging at the shoreline, or mostly well offshore (>1 km) in typically very shallow water (around 3-15 cm). There was a striking difference in the productivity and relative density of waterbirds on Lake Mackay compared to nearby claypans. Claypans hosted a species-rich and high density of shorebird and other

waterbird communities, with 2,591 individual waterbirds from 26 species (in 66.8 ha). The density of waterbirds on claypans compared to Lake Mackay was approximately 680 times greater (3,878.7 versus 5.7 birds/km^2). For example, one 21 ha claypan site (C7) hosted at least 888 individual waterbirds. No major breeding colonies of Banded Stilt or other shorebirds were recorded on Lake Mackay or associated islands. Several shorebirds and waterbirds had bred successfully at claypans with tens of individual juvenile Black-winged Stilt, Whiskered Tern *Chlidonias hybrida* and Australian Gull-billed Tern *Gelochelidon macrotarsa* observed. A few juvenile plumaged Banded Stilt were seen foraging on Lake Mackay and may have bred locally. Including secondary data, a total of at least 40 waterbird species have been recorded at Lake Mackay including 16 shorebird species and 24 other waterbirds.

There were major differences in the abundance of waterbirds between observations in September–October 2001 and the present survey. This is best explained by the quantum, spread and timing of rain and associated patterns of evaporation and also electrical conductivity. In 2001 there was a higher total rainfall (808 mm) spread out over 3 months in late summer, whereas in December 2016 the rainfall was a singular event (425 mm) in early summer. Inundation in 2001 was presumably much greater with reduced surface water evaporation because water depth was higher in September 2001 compared to April 2017 (40 cm versus c.10-15 cm), with electrical conductivity 1.6 to 3 times greater in 2017 compared to 2001. Shorebirds such as the Banded Stilt have been found to move away from wetlands when electrical conductivity reaches 127,000 μS/cm (micro Siemens per cm). In April 2017, electrical conductivity in Lake Mackay was 140,000 to 262,000 μS/cm (about 3-5 times greater than seawater).

An anticipated boom in primary productivity which would attract and maintain large numbers of waterbirds on Lake Mackay had largely busted at 114-117 days after a major rainfall event. Lake Mackay was found to support low numbers of relatively few waterbird species and no major breeding colonies were recorded. Flocks of 10,000s of waterbirds may have been present on Lake Mackay up until around February-March 2017, but had moved during summer as water levels and food availability plummeted and electrical conductivity increased. Many waterbird species obviously use both saline habitats on Lake Mackay as well as claypans, but specialized species such as Banded Stilt depend on saline lakes for breeding. This study highlights claypans as habitat supporting waterbird communities of high conservation significance. Despite their small areal extent these held a diverse range and large numbers of waterbird including Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) listed species such as the Australian Painted Snipe, *Rostratula australis* (Australia's rarest waterbird), and supported breeding by several waterbird species. Only seven claypans were surveyed but imagery shows that 1,000s of claypans occur around Lake Mackay including at least 30 greater than 8 ha.

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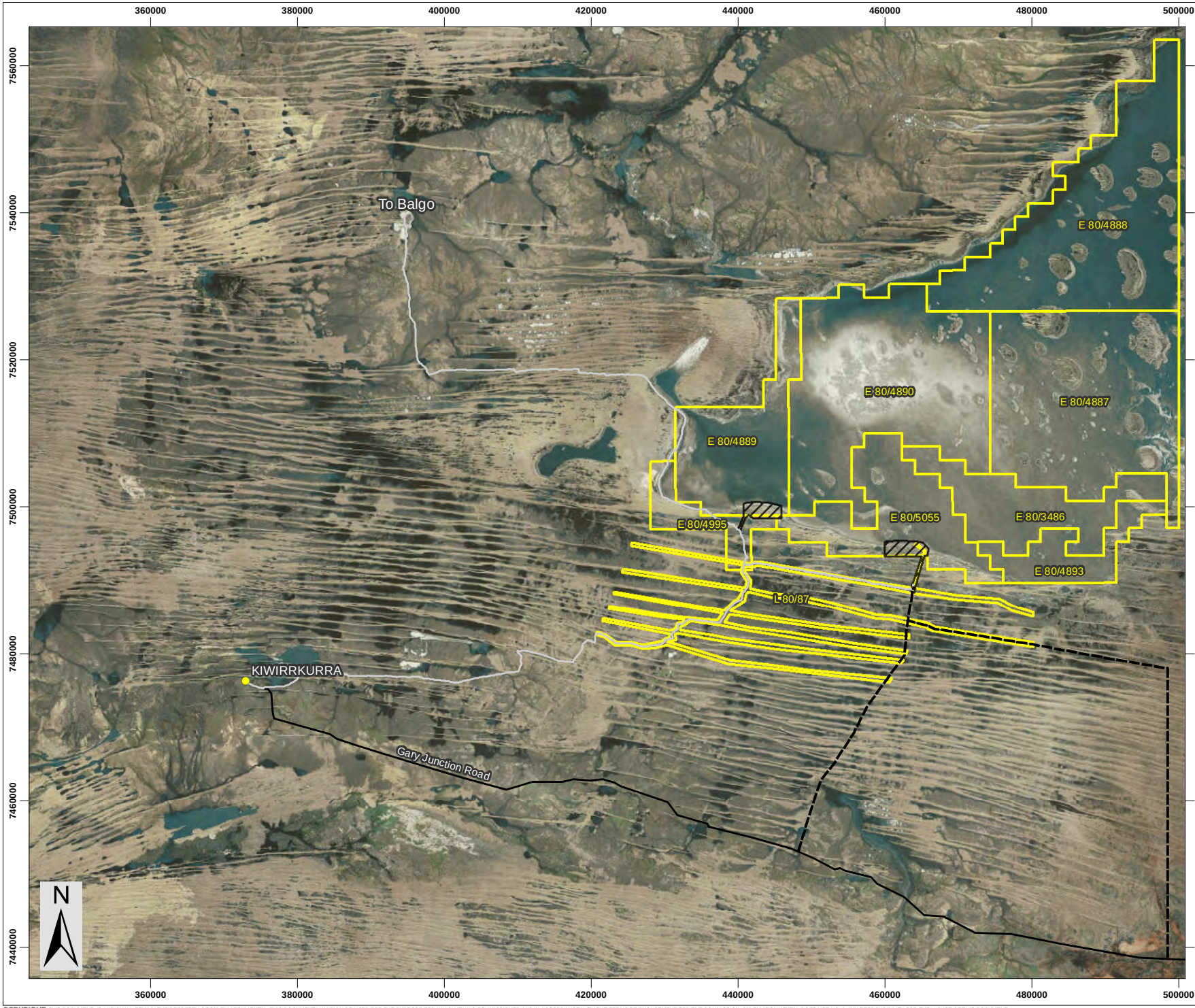
Agrimin Limited (Agrimin) requires a number of baseline biological assessments to be carried out at its Lake Mackay Sulphate of Potash (SOP) project. The SOP project comprises nine tenements (all in Western Australia) covering the majority of Lake Mackay over a total area of 2,560 km^2. Lake Mackay is a seasonally inundated salt lake located on the Western Australia (WA) – Northern Territory (NT) border, with most of the lake located within WA. The project is situated entirely within WA but is accessed from Alice Springs in the NT, approximately 540 km to the south-east (Figure 1).

A first-phase level 2 flora and vegetation survey and level 1 terrestrial fauna survey for the project was undertaken in spring 2016. Agrimin has sought to expand on the existing environmental studies.

In December 2016, a significant rainfall event caused a flooding and inundation event at Lake Mackay. Flooding of inland salt lakes provides episodic and ephemeral habitat for continental-scale populations of waterbirds (i.e. more than 10-20% of the total Australian population of some individual waterbird species including shorebirds and ducks at individual wetlands). Major breeding events of some shorebirds, such as the Banded Stilt *Cladorhynchus leucocephalus*, are largely caused by the extraordinary abundance of aquatic invertebrates such as brine shrimps (*Paratemia spp.*).

1.2 Survey Objectives

The objective of the April 2017 survey at Lake Mackay was to undertake ground and aerial surveys of waterbirds recording bird species, estimation of abundance of individual bird species and identification of bird nesting, roosting and foraging areas.



Legend

- Tenements
- Proposed Infrastructure Boundaries
- Existing Track
- Existing Road
- Proposed Track

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2006
- TENEMENTS SOURCED FROM AGRIMIN 2017
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2007 AND ADDITIONAL LANGATE COMPOSITE AERIALS

SLIP ENABLER

360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

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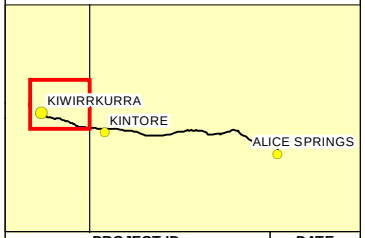
LOCALITY MAP



PROJECT ID	DATE
2188	1/08/2017

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 52

CREATED	CHECKED	APPROVED	REVISION
JA	CT	NW	0

Agrimin
Sulphate of Potash Project
Lake Mackay, WA

Waterbirds and Aquatic Fauna Survey

Figure 1
Site location

K:\Projects\1.0 EBS\2188 Eco Surveys Lake Mackay\Figures\2188 Figure 1 Site Location.mxd

2 Environment

2.1 Lake Mackay

At 4,737 km^2, Lake Mackay is the 4th largest lake in Australia. It is a salt lake, classified broadly as a 'Saline open water basin' and, more specifically, as a 'Highly Saline Lake (Salt lake)' by Duguid *et al.* (2005). Saline lakes are created by permanent and long-term discharge directly below the lake bed which results in areas of permanently saturated hyper-saline soils or brine (Duguid *et al.* 2005). The lake is not vegetated, except on islands, and has a surface salt crust when dry. There is little information on the hydrology of the lake, but no major stream channels appear to reach the lake. Often there is inflow from springs into salt lakes in general, or by elevated water tables after major rain events (Duguid *et al.* 2005). Lake Mackay is shallow, but depth is poorly documented; the Northern Territory portion was thought to be the deepest part of the lake, with inundation lasting 6 months or more (Duguid 2005, Duguid *et al.* 2005). The lake is characterized by 100s, perhaps 1000s of small islands from the leptoscale (<100 m by 100 m) up to macroscale (> 1000 by 1000 m) with about 10 islands of more than 10 km^2 and the largest of around 30 km^2.

2.2 Claypans south of Lake Mackay

Claypans are open freshwater basins and can be categorized as 'Large open freshwater basins' if more than 8 ha, and 'Small open freshwater basins' if less than 8 ha (Duguid *et al.* 2005). Some of the vegetated claypans around Lake Mackay could also be categorized as types of wooded or shrubby swamps. There is little documentation of claypans in the Lake Mackay region, but Google Earth imagery shows at least 30 claypans greater than 8 ha and perhaps 100-1,000s of claypans less than 8 ha. Aerial assessments by Duguid *et al.* (2005) and Duguid (2005) also surveyed waterbirds on claypans, though these make no specific summary of results for this habitat. None of the claypans is greater than 100 ha, but, during inundation, claypans might join together forming larger wetlands. A majority are less than 10 km from the shoreline of Lake Mackay. The small, unvegetated claypans can be categorized as playa lakes. Claypans typically have high surface or sub-surface clay (Duguid *et al*. 2005). Claypans around Lake Mackay often occur between sand dune swales. Some of the claypans are very shallow and unvegetated while others are deeper and well-vegetated. Hydrology is variable with some only filling directly from rainfall, or from localized run-off. In general, water in claypans can last for months to as long as one year or so. Aggregations of claypans may be important waterbird habitat (Duguid *et al.* 2005).

2.3 Boom and Bust ecology of waterbirds in inland Australian wetlands

Waterbird populations of inland Australia exhibit boom-and-bust cycles associated with rainfall and flooding. Rivers, floodplains, lakebeds, channels and waterholes fill with water and provide the basis for productive food webs (Morton *et al*. 2011). Australian waterbirds respond to rapid changes in resource availability, with rapid movement at spatial and temporal scales equal to the dynamics of the resource (Kingsford-Smith *et al.* 2010). Large numbers of waterbirds congregate: they breed opportunistically, increasing population size, and then disperse or die (Morton *et al*. 2011). In north-western Australia following major rain events and inundation, three major inland wetlands (Fortescue Marsh, Mandora Marsh and Lake Gregory) are known to support up to 1 million individual waterbirds (Halse *et al.* 2005), or about 22% of the entire estimated Australian waterbird population of around 4.6 million birds (Kingsford *et al.* 2012). These sites are therefore described as being capable of supporting continental-scale populations of waterbirds. There are major differences in feeding opportunities for waterbirds depending on whether the wetland is saline or freshwater related to the greater abundance of food at salt lakes (Kingsford-Smith *et al*. 2010). Individual lakes also vary in their suitability as habitat over time with, for example, the abundance and diversity of waterbirds falling quickly with increasing salinity in hypersaline lakes (Kingsford-Smith *et al.* 2010). Arid-zone wetlands are always drying or flooding which stimulates movements of waterbirds in response to resource abundance and depletion (Kingsford-Smith *et al.* 2010).

2.4 Previous waterbird-bird surveys at Lake Mackay

There has only been one substantial targeted survey of waterbirds on Lake Mackay following a very large rainfall event. This rainfall event occurred from January to March 2001. During 5-6 September 2001 (166 days after the rain event), ground surveys and fixed-wing aerial surveys recorded a total of 42,473 individuals from 26 waterbird species on the Northern Territory (500 km^2) and Western Australian parts of Lake Mackay (Duguid *et al.* 2005, Duguid 2005). This total included 40,334 individuals of 21 waterbird species counted during the 2-hour aerial survey (Duguid *et al.* 2005, Duguid 2005). It was also shown to be a significant site for the breeding of Banded Stilt, with more than 4,400 juvenile birds observed at two sites in the northern part of the Western Australian portion (Duguid *et al.* 2005, Duguid 2005). Banded Stilt only breed on islands in inundated salt lakes and the salt lakes fill episodically. Because breeding is unpredictable and spasmodic, this increases the need for effective conservation management of the few known breeding sites (Duguid *et al.* 2005). The total count of 12,070 Banded Stilt was approximately 5% of the Australian and global population of the species which meets more than one of the criteria identifying Ramsar wetlands of international significance

(Duguid *et al.* 2005). Other large counts included Black-winged Stilt *Himantopus lecuocephalus* (3,263 individuals), Grey Teal *Anas gracilis* (4,653 individuals) and White-winged/Whiskered Terns (4,602 individuals). The authors determined that the wetland site was of national and international significance because more than 10,000 individual waterbirds were recorded.

Table 1. Waterbird species recorded previously in the Lake Mackay region

According to major databases and recent primary field surveys. Shorebirds are highlighted in bold font, including Little Buttonquail which, surprisingly, is also embedded within the shorebirds (*Charadriiformes*) according to molecular studies.

Common Name	Duguid (2005)	Atlas of Living Australia	NatureMap	DPAW Threatened and Priority Fauna Search	EPBC Protected Matters Search	NT DLRM Species Atlas	Bird Data	Outback Ecology (2012)	Kiwirrkurra IPA	Hawkins- (BushBlitz) (2017)	Ecologia (2017)
Little Buttonquail		x				x	x		x		x
Eurasian Coot	x								x		
Australasian Grebe									x		
Australian Gull-billed Tern	x	x				x					
Tern, Gull-billed or Caspian	x										
Tern, Whiskered or White-winged	x										
Silver Gull	x	x				x					
Masked Lapwing		x					x			x	
Banded Lapwing		x	x				x		x		
Oriental Plover		x		x	x	x	x		x		
Inland Dotterel		x				x					
Black-winged Stilt	x	x				x	x				

Banded Stilt	x	x				x					
Red-necked Avocet	x	x				x					
Common Greenshank	x										
Red-necked Stint											
Sharp-tailed Sandpiper											
Unidentified shorebirds smaller than Sharp-tailed Sandpiper	x										
Oriental Pratincole		x			x						
Brolga		x									x
Little Pied Cormorant	x										
Unidentified cormorant	x										
Australian White Ibis	x										
Straw-necked Ibis	x									x	
Glossy Ibis	x										
Cattle Egret					x						
Great Egret	x	x			x						
Little Egret							x				
Unidentified Egrets	x										
White-faced Heron	x	x				x	x				
White-necked Heron	x	x				x	x		x		
Black Swan	x	x				x					
Plumed Whistling Duck	x										
Pacific Black Duck	x	x				x					

Grey Teal	x	x				x	x				x
Pink-eared Duck	x	x									
Hardhead	x	x				x					
Unidentified ducks	x										
Total	26	20	1	1	4	14	9	0	6	2	3

A total of 33 waterbird species are confirmed from the Lake Mackay region, but an additional seven waterbird taxa were also reported by Duguid (2005) and these require specific verification (Table 1). This includes 12 confirmed shorebird species and at least 21 other waterbird species. Field surveys during 2012-2016 have each recorded 0-6 waterbird species, but this was during dry periods without major rainfall events in the preceding period and without specific targeted waterbird surveys (Table 1).

2.5 The December 2016 rainfall event and climate

During December 2016, there was an extreme rainfall event in the Great Sandy Desert area, with 425.4 mm (624% greater than the December average of 68.1 mm) falling at Kintore (Walunguru airport, the nearest climate station to Lake Mackay, around 100 km to the southeast). This included 231.6 mm on 26 December 2016 and a total of 392.8 mm during 24-29 December 2016. An exceptional total of 61.4 mm fell in 1 hour on 26 December which was described as a 1 in 50 year event (Vanovac 2016). Kintore has a mean annual rainfall of 306.1 mm (Bureau of Meteorology 2017).

After the rain event, and before the present survey, the mean maximum daily temperature at Kintore from December 2016 to March 2017 was 37.2°C, with a maximum temperature of 42.6°C (Bureau of Meteorology 2017). There is no evaporation data available for Kintore, but at nearby Rabbit Flat (about 230 km to the northeast) the historical total during December to March (1996-2014) was 1,092 mm, or an average of 273 mm of evaporation per month (Bureau of Meteorology 2017).

Conditions during the 14-17 April survey were overcast with thick cloud and occasional light rain, with maximum temperatures 2.9°C cooler than the long-term April average. These conditions would have had no impact on the waterbird surveys.

3 Methods

3.1 Secondary sources of waterbird data from Lake Mackay

The purpose of the desktop review was to gather secondary data on waterbird records from the Lake Mackay area and surrounds. Definitions of conservation codes for fauna of conservation significance are given in Appendix A.

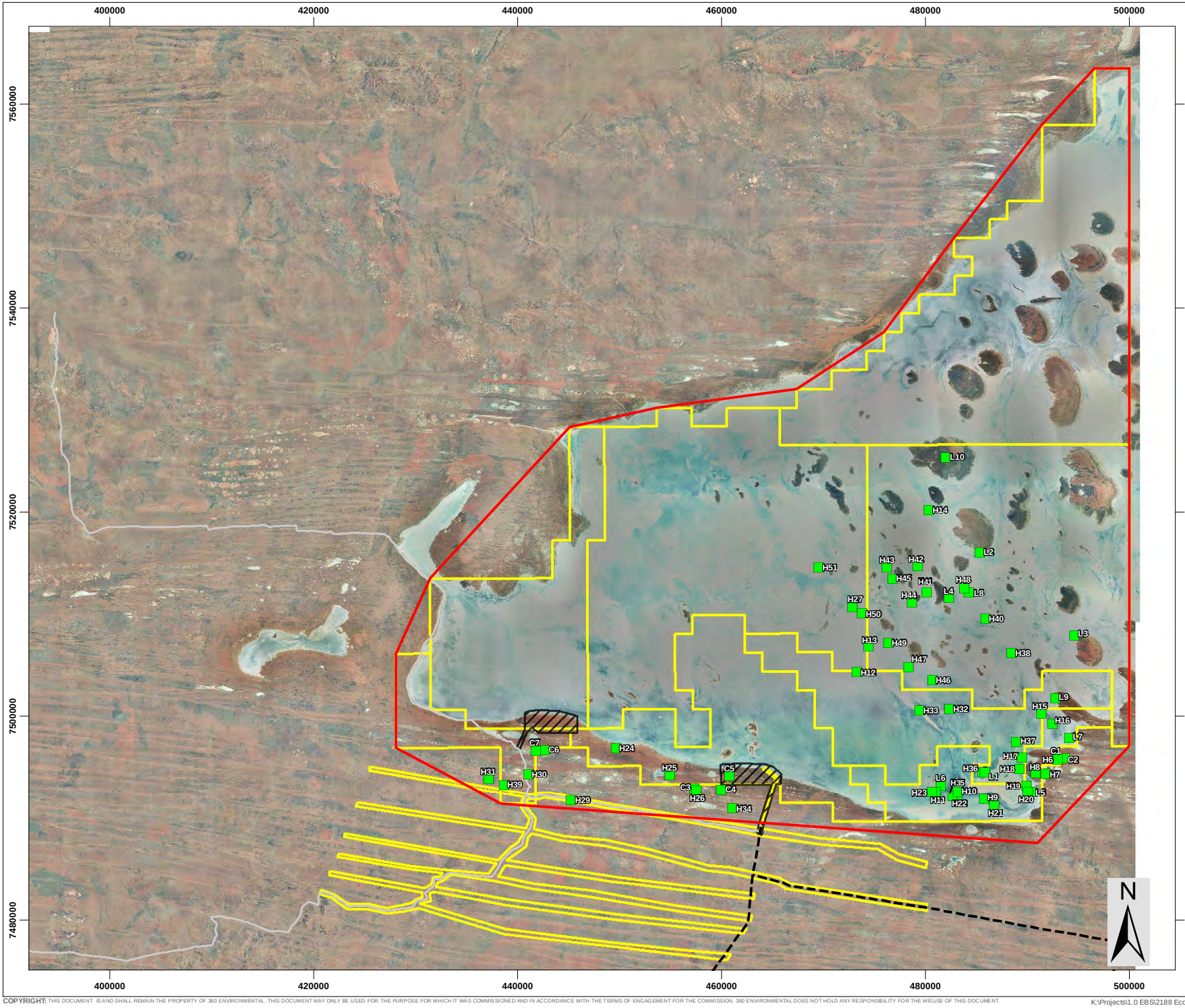
- Atlas of Living Australia (2017) is an e-infrastructure and collaborative partnership to capture, aggregate and manage biological data;
- Western Australian Museum (WAM) and Department of Parks and Wildlife combined biological database NatureMap, https://naturemap.dpaw.wa.gov.au/;
- DPaW Threatened and Priority Fauna database (DPaW, 2017);
- Duguid (2015) and Duguid *et al*. (2005) waterbird counts from aerial surveys of Lake Mackay;
- Northern Territory Fauna Atlas records, downloaded from Atlas of Living Australia (2017);
- Birdata - Birds listed by BirdLife Australia (Birdata, 2017);
- Previous fauna surveys/reports i.e. Desert Wildlife Services (2010, 2012), Outback Ecology (2012), Ecologia (2017); and
- Brian Hawkins, Bush Bioblitz (Kiwirrkurra Indigenous Protected Area), personal communications, 2017.

3.2 Survey period, access and sites

The survey was undertaken over 4 days from 14-17 April 2017. A helicopter based at the Kiwirrkurra (about 60 km south-west of Lake Mackay) community was used to access the Lake Mackay Survey Area and individual sites each morning just after dawn – arriving back each night on sunset.

Waterbirds and other birds were surveyed at a total of 62 georeferenced sites (Figure 2). This included 17 ground survey sites (Table 2), 10 on Lake Mackay (one was a terrestrial site on an island) and seven at claypans. On Lake Mackay, efforts were made to sample aquatic invertebrates, macroinvertebrates using sweep-netting and determine water characteristics at nine sites, but at four sites sampling was curtailed by the lack of water deep enough for sampling, or because deep, muddy shorelines prohibited safe access to water.

A brief summary of results of the aquatic survey relevant to the waterbird survey is presented here, with detailed information provided in a separate report to Agrimin.



Legend

- Aerial Survey Area
- Tenements
- Proposed Infrastructure Boundaries
- Existing Tracks
- Proposed Track
- Waterbird Survey Sites

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2006
- TENEMENTS SOURCED FROM AGRIMIN 2017
- RARE AND PRIORITY FLORA SOURCED DPAW 2017
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2007 AND ADDITIONAL LANGATE COMPOSITE AERIALS (© Western Australian Land Information Authority 2015)

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360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

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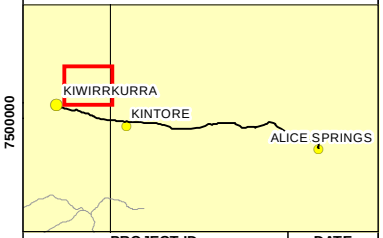
LOCALITY MAP



PROJECT ID	DATE
2188	10/08/2017

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 52

CREATED	CHECKED	APPROVED	REVISION
MH	CT	NW	0

Agrimin
Sulphate of Potash Project
Lake Mackay, WA

Waterbirds and Aquatic Fauna Survey

Figure 2
Waterbird Survey Sites

K:\Projects\1.0 EBS\2188 Eco Surveys Lake Mackay\Figures\2188 Birds Figure 2 Waterbird Survey Sites.mxd

3.3 Ground and Aerial Waterbird Surveys

Waterbirds were recorded at each ground site for 25 mins to 2 hrs and 45 mins, with differences in effort resulting from either success or failure to sample water characteristics, size of claypan sites and/or logistical considerations such as the availability of the helicopter for pick-up and drop-off at sites (Table 2). Total ground survey effort was 20 hrs and 47 mins, including 11 hrs and 59 mins at the 10 Lake Mackay sites and 8 hrs and 48 mins at the seven claypan sites (Table 2). At each site, waterbirds were observed with binoculars and a spotting scope, with visual or aural identification of bird species. At each ground site, the start and finish time was written into a notebook, together with a list of bird species and a count or estimate of the number of individuals of each bird species.

The presence and absence of waterbirds was routinely recorded during all helicopter flights over Lake Mackay and associated claypan wetlands, including 45 georeferenced site records (about 600 km of flights in total; see Figure 2, Appendix B & C). The helicopter routinely flew at between 40-80 knots (74-148 km/h) and around 50-100 m elevation above the lake, allowing high detectability of all waterbird species. A very high proportion of birds on Lake Mackay are thought to have been counted, and no groups of waterbirds larger than 50-100 individuals would have been overlooked. Several specific 20-30 km flights were made over the main body of the lake as well as targeting significant water channels (5-10 km long by 0.3-3 km wide), especially in the northwest.

Water on the lake occurred in major channels, and was present elsewhere, particularly as a result of wind, but the main section of the lake where the water ponded was in the extreme southeast corner, covering approximately 120 km^2. However, almost all birds observed on Lake Mackay were in a small section of deeper water (estimated at 5-15 cm) in the extreme southeast corner over about 20 km^2. In addition to presence and count records, visual waterbird searches from the helicopter which failed to detect birds were also noted as site absence records (Appendix B).

Table 2. Summary characteristics of the 17 ground survey sites on Lake Mackay and nearby claypans.

Including location, survey effort, and area of claypans and estimated water depth. See also Appendix B for the 45 helicopter survey sites.

Site code	Complete site name	Habitat	Zone	Easting	Northing	Date	Start Time	Effort (mins)	Area (ha)	Water Depth (cm)
L6	Lake Mackay6	Saline lake	52K	481524	7493182	14/4/17	9:40AM	70	-	1
L5	Lake Mackay5	Saline lake	52K	490391	7492584	14/4/17	12:05PM	125	-	10
L7	Lake Mackay7	Saline lake	52K	494075	7497843	14/4/17	14:30PM	25	-	10
L1	Lake Mackay1	Saline lake	52K	485598	7494480	14/4/17	15:30PM	60	-	<15
L2	Lake Mackay2	Saline lake	52K	485329	7516039	15/4/17	8:00AM	130	-	<15
L3	Lake Mackay3	Saline lake	52K	494604	7507954	15/4/17	10:30AM	95	-	<10
L10	Lake Mackay10	Island	52K	481988	7525407	15/4/17	16:20PM	35	-	<10
L9	Lake Mackay9	Saline lake	52K	492758	7501797	16/4/17	8:36AM	69	-	<10
L8	Lake Mackay8	Saline lake	52K	484254	7512142	16/4/17	12:00PM	55	-	2
L4	Lake Mackay4	Saline lake	52K	482252	7511603	16/4/17	13:05PM	55	-	<15
C1	Lake Mackay Claypan1	Claypan	52K	493005	7495890	15/4/17	12:40PM	20	12.8	>30
C2	Lake Mackay Claypan2	Claypan	52K	493551	7495818	15/4/17	13:30PM	95	13.3	>20

C3	Lake Mackay Claypan3	Claypan	52K	457329	7492905	16/4/17	15:00PM	105	5.8	>20
C4	Lake Mackay Claypan4	Claypan	52K	459903	7492753	17/4/17	8:15AM	48	4	>20
C5	Lake Mackay Claypan5	Claypan	52K	460774	7494177	17/4/17	10:40Am	35	0.1	<20
C6	Lake Mackay Claypan6	Claypan	52K	442632	7496681	17/4/17	12:25PM	60	9.8	>50
C7	Lake Mackay Claypan7	Claypan	52K	441755	7496647	17/4/17	11:25AM	165	21	>50

4 Results

4.1 Broad site and water characteristics

There were major differences in water characteristics between Lake Mackay's salt lake and the nearby freshwater claypans. Electrical conductivity was more than 100 times higher in the salt lake compared to the claypans, and was four times higher than seawater (Table 3). The lake was shallow to very shallow, averaging less than 13 cm at six sites, and often 5-10 cm deep compared to the claypans which were substantially deeper (Table 3). No macroinvertebrates were recorded on Lake Mackay but they were abundant at the nearby claypans.

Table 3. Summary characteristics of the 17 ground survey sites on Lake Mackay and nearby claypans.

Including location, survey effort, and area of claypans and estimated water depth. Values are means.

WATER CHARACTERISTICS	LAKE MACKAY SITES (N=6)	CLAYPAN SITES (N=3)
Conductivity (μS/cm)	209,543	1,994
Water depth (cm)	<12.8	>29
Macroinvertebrates (presence/absence)	Absent	Present

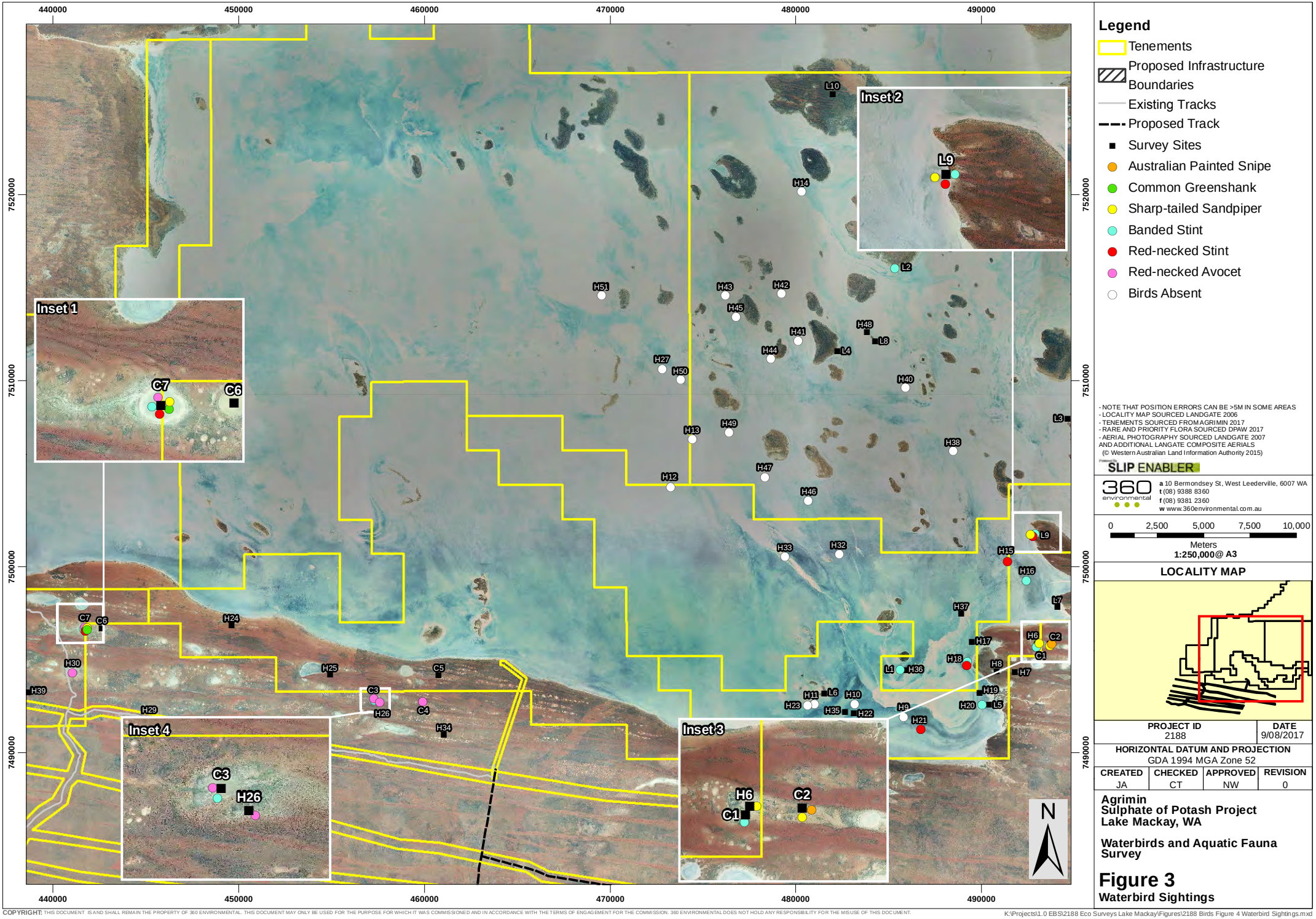
4.2 Overall bird and waterbird patterns

A total of 52 bird species were recorded, including 26 waterbird species (12 shorebirds and 14 other waterbirds) and 26 landbird species. Birds were recorded at 40 of the 62 sites, with a total of 3,884 individual birds observed and 191 individual bird by site records collected (Figure 3, Appendix D). There were striking differences in the relative density of waterbirds on Lake Mackay compared to the claypans. The density of waterbirds on claypans compared to Lake Mackay was approximately 680 times greater (3,878.7 versus 5.7 birds/km^2). One 21 ha claypan site (C7) hosted at least 963 individual birds, or about 25% of all birds recorded. There were also more bird species recorded on claypans (n= 46) compared to Lake Mackay (n= 20).

A total of seven waterbirds recorded during this survey represent the first record for Lake Mackay and surrounds: Black-tailed Native-hen *Tribonyx ventralis*, Hoary-headed Grebe *Poliocephalus poliocephalus*, Red-kneed Dotterel *Erythrogonys cinctus*, Red-capped Plover *Charadrius ruficapillus*, Black-fronted Dotterel *Elseyornis melanops*, Australian Painted Snipe *Rostratula australis* and Freckled Duck *Stictonetta naevosa*.

The Silver Gull *Chroicocephalus novaehollandiae* was the most frequently recorded species with 20 site records, but most bird species were recorded once (n= 18), twice (n= 6) or three times (n= 10). There were 14 observations of birds in groups of more than 100 individuals, but most records (130 of 191) were of 1-10 individual birds. Overall, the most abundant waterbirds were Grey Teal *Anas gracilis* (701 individuals; Plate 2), Red-necked Stint *Calidris ruficollis* (502 individuals), Red-necked Avocet *Recurvirostra novaehollandiae* (363 individuals; Plate 1) and Banded Stilt (257 individuals). The most regularly recorded and most abundant landbird species were Zebra Finch *Taeniopygia guttata* (211 individuals) and Budgerigar *Melopsittacus undulatus* (172 individuals) (Plate 3).

Birds were not recorded at 22 sites (Figure 3) mainly in the north and west of the Survey Area where water levels were very low (1-6 cm deep). Waterbirds were absent from tens of square kilometres of the lake bed (Plate 5).



Legend

- Tenements
- Proposed Infrastructure Boundaries
- Existing Tracks
- Proposed Track
- Survey Sites
- Australian Painted Snipe
- Common Greenshank
- Sharp-tailed Sandpiper
- Banded Stint
- Red-necked Stint
- Red-necked Avocet
- Birds Absent

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS
- LOCALITY MAP SOURCED LANDGATE 2006
- TENEMENTS SOURCED FROM AGRIMIN 2017
- RARE AND PRIORITY FLORA SOURCED DPAW 2017
- AERIAL PHOTOGRAPHY SOURCED LANDGATE 2007 AND ADDITIONAL LANGATE COMPOSITE AERIALS (© Western Australian Land Information Authority 2015)

SLIP ENABLER

360 environmental
a 10 Bermondsey St, West Leederville, 6007 WA
t (08) 9388 8360
f (08) 9381 2360
w www.360environmental.com.au

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LOCALITY MAP

PROJECT ID	DATE
2188	9/08/2017

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 52

CREATED	CHECKED	APPROVED	REVISION
JA	CT	NW	0

Agrimin
Sulphate of Potash Project
Lake Mackay, WA

Waterbirds and Aquatic Fauna Survey

Figure 3

Waterbird Sightings

K:\Projects\1.0 EBS\2188 Eco Surveys Lake Mackay\Figures\2188 Birds Figure 4 Waterbird Sightings.mxd

4.3 Shorebirds and waterbirds of Lake Mackay

Only seven waterbird species (682 individuals) were recorded on Lake Mackay including four shorebird species and three other waterbirds. Shorebirds were sparse with a total of only 540 individual birds observed, dominated by 252 Red-necked Stint, 235 Banded Stilt (mostly in one flock of 190 birds), 47 Red-capped Plovers and 6 Sharp-tailed Sandpipers. All shorebirds were observed actively foraging at the shoreline, or mostly well offshore (>1 km) in typically very shallow water (about 3-15 cm). The single flock of Banded Stilt was observed twice, once actively feeding on the lake, and a couple of hours later at roost near the shoreline (Plate 1). Few other waterbirds were observed on the lake, but Silver Gull *Chroicocephalus novaehollandiae* was regularly seen (123 individuals) with small numbers of Australian Gull-billed Tern *Gelochelidon macrotarsa* and Whiskered Tern *Chlidonias hybrida*. Locations of key shorebird species including Banded Stilt were mapped (Figure 3).

4.4 Shorebirds and waterbirds of Lake Mackay claypans

Claypans hosted species-rich and abundant shorebird and other waterbird communities. All 26 waterbird species recorded during the survey were recorded on claypans (a total of 2,591 individuals). In an overall Survey Area covering approximately 1,265 km^2, most birds (n= 2,227/57%) were recorded in seven claypans covering 66.8 ha. The most common shorebirds recorded on claypans were: Red-necked Avocet (363 individuals), Red-necked Stint (250 individuals) and Black-winged Stilt (131 individuals). A single EPBC listed Australian Painted Snipe *Rostratula australis* was recorded on one claypan. Three migrant shorebirds were recorded (Sharp-tailed Sandpiper, Common Greenshank *Tringa nebularia* and Red-necked Stint). Common waterbirds included Grey Teal (701 individuals), Silver Gull (362 individuals) and Hoary-headed Grebe (335 individuals).

4.5 Conservation and migration status of waterbirds at Lake Mackay

Of the 26 waterbird species recorded at Lake Mackay, one is globally and nationally endangered (Australian Painted Snipe); one is globally near threatened (Red-necked Stint); five Palearctic migrant species, which travel along the East Asian-Australasian Flyway, are listed under various state, national and bilateral agreements on migratory species. Two egrets are listed under bilateral agreements (Table 4). The taxonomy of world bird species has rapidly changed over the last decade or so with increasing recognition that former wide-ranging species actually comprise two or more distinct species. This includes the Australian Painted Snipe which was previously listed in Australia as the Greater Painted Snipe *Rostratula benghalensis*, which occurs widely in Asia and Africa. Similarly, the Australian Gull-billed Tern is a relatively recent split from

the Gull-billed Tern *Gelochelidon nilotica*, though confusingly Asian Gull-billed Tern migrates to Australia, and some Australian Gull-billed Terns visit Asia. Both egrets listed previously under bilateral agreements on migratory species are now both considered as resident Australian-endemic (non-migratory) bird species.

Table 4. Counts of all waterbirds recorded in 2001 (source: Duguid 2005) and in 2017 and their conservation and migratory status.

According to state, national and international lists, bilateral agreements and international conventions on migratory species. "?" denotes species whose taxonomic status has changed recently, and which probably should no longer be listed under specific agreements/conventions. See Appendix A for definition of conservation codes listed below. For other sources see Table 1.

Common Name	This survey	Duguid (2005)	Other sources	EPBC Act	WC Act	DPaW	IUCN	JAMBA	CAMBA	ROKAMBA	BONN
Little Buttonquail (*Turnix velox)*	6										
Black-tailed Native-hen (*Tribonyx ventralis)*	18										
Eurasian Coot (*Fulica atra)*	30	131									
Hoary-headed Grebe (*Poliocephalus poliocephalus)*	335										
Australian Gull-billed Tern (*Gelochelidon macrotarsa)*	39	14									?
Whiskered Tern (*Chlidonias hybrid)*	108										
Silver Gull (*Chroicocephalus novaehollandiae)*	485	129									
Tern, Gull-billed or Caspian		339									
Tern Whiskered or White-winged		4602									
Red-kneed Dotterel (*Erythrogonys cinctus)*	34										
Masked Lapwing (*Vanellus miles)*			x								
Banded Lapwing (*Vanellus tricolor)*	2										
Oriental Plover (*Charadrius veredus)*			x	IA	S5	IA					

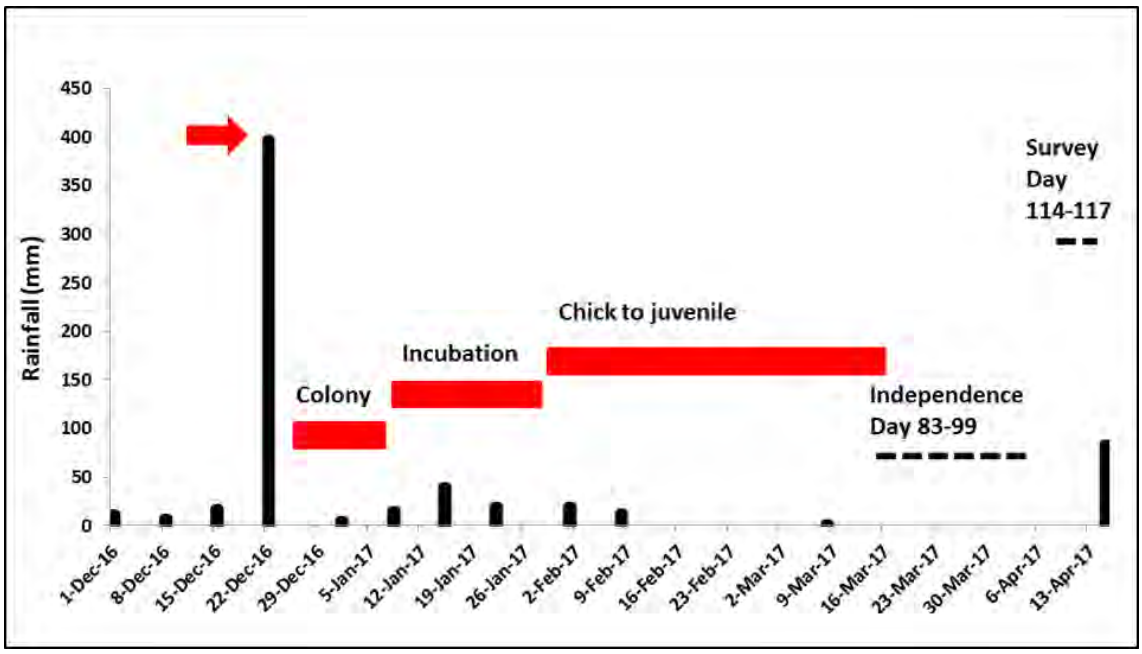
Red-capped Plover (*Charadrius ruficapillus)*	71										
Black-fronted Dotterel (*Elseyornis melanops)*	1										
Inland Dotterel (*Charadrius australis)*			x								
Black-winged Stilt (*Himantopus leucocephalus)*	131	3172									?
Banded Stilt (*Cladorhynchus leucocephalus)*	257	12070									
Red-necked Avocet (*Recurvirostra novaehollandiae)*	363	1295									
Common Greenshank (*Tringa nebularia)*	3	1		IA	S5			x	x	x	
Red-necked Stint (*Calidris ruficollis)*	502			IA	S5		NT	x	x	x	
Sharp-tailed Sandpiper (*Calidris acuminata)*	37			IA	S5			x	x	x	
Shorebird smaller than Sharp-tailed Sandpiper		1934									
Australian Painted Snipe (*Rostratula australis)*	1						EN		?		
Oriental Pratincole (*Glareola maldivarum)*			x	M	S3						
Brolga (*Antigone rubicunda)*			x								
Glossy Ibis (*Plegadis falcinellus)*		110									
Australian White Ibis (*Threskiornis Molucca)*		5									
Straw-necked Ibis (*Threskiornis spinicollis)*		71									
Little Pied Cormorant (*Microcarbo melanoleucos)*		22									
Unidentified Cormorant		1									
Cattle Egret (*Bubulcus ibis)*			x	IA	S5			?	?		
Great Egret (*Ardea alba)*		7		IA	S5			?	?		

Little Egret (*Egretta garzetta)*			x								
White-faced Heron (*Egretta novaehollandiae)*	4	19									
White-necked Heron (*Ardea pacifica)*		14									
Unidentified egrets		16									
Black Swan (*Cygnus atratus)*	3	106									
Plumed Whistling-Duck (*Dendrocygna eytoni)*	28	720									
Pacific Black Duck (*Anas superciliosa)*	6	604									
Grey Teal (*Anas gracilis)*	701	4343									
Pink-eared Duck (*Malacorhynchus membranaceus)*	41	300									
Freckled Duck (*Stictonetta naevosa)*	56										
Hardhead (*Aythya australis)*	10	1636									
Unidentified ducks		8410									

4.6 Evidence of waterbird breeding on Lake Mackay

There was little evidence of breeding by shorebirds and other waterbirds at Lake Mackay and associated claypans. Small numbers (<10 individuals) of juvenile Banded Stilt were observed from a helicopter feeding on Lake Mackay. These were photographed and showed clean white chest and flanks without chestnut belly bands so were not birds in non-breeding adult plumage (Plate 4). These probably had bred at island colonies on Lake Mackay, becoming independent in March 2017 (Figure 4). Small numbers of Black-winged Stilt had bred at the claypans visited (Plate 4). The ecology of Banded Stilt differs greatly from Black-winged Stilt and Red-necked Avocet by synchronously nesting in very large colonies shortly after major rain events, particularly on islands in salt lakes. During the survey, a few individual juvenile Red-necked Avocet showing duller rufous-brown heads were seen and photographed at claypans (Plate 4). Juvenile Red-kneed Dotterels, Silver Gull, Australian Gull-billed Tern and Whiskered Tern were also observed at claypans, showing that limited regional breeding of these birds had occurred at the claypans. It is likely that flocks of juvenile and adult birds had already dispersed away from Lake Mackay as environmental conditions, especially food availability, declined.

Figure 4. Breeding phenology of hypothetical colonies of Banded Stilt at Lake Mackay following the December 2016 rain event. Breeding data taken from Marchant and Higgins (1993).



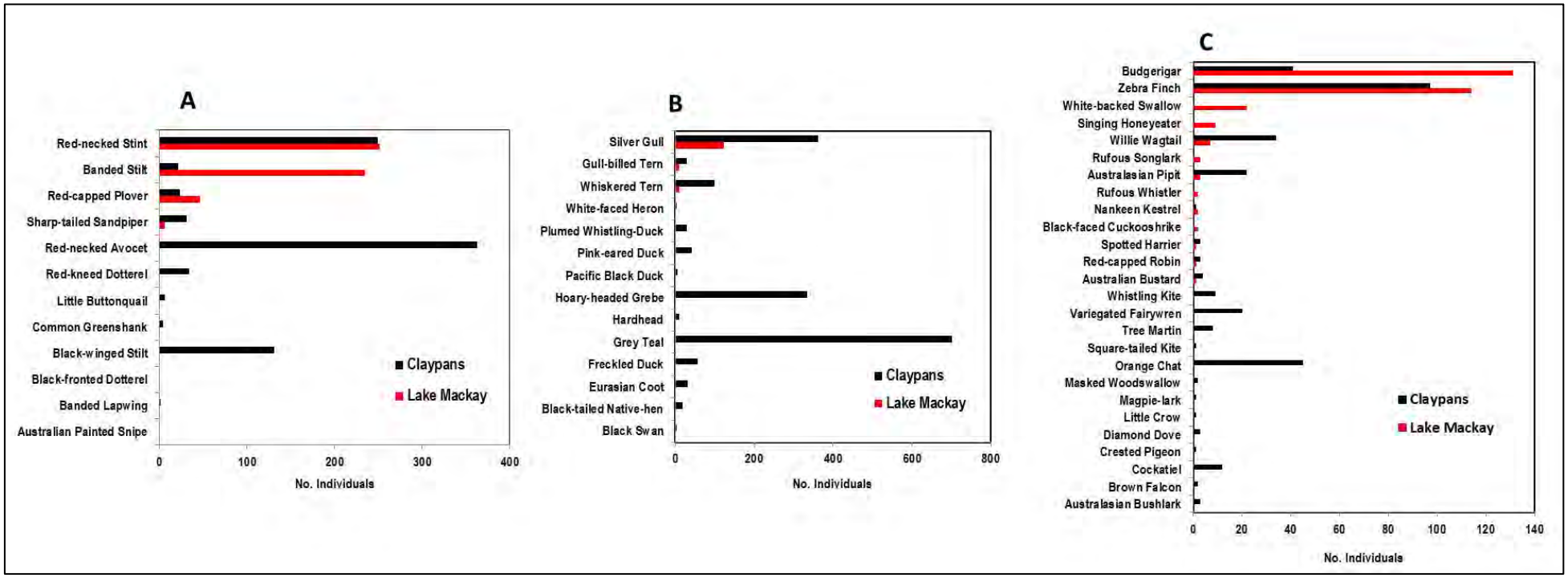
5 Discussion

5.1 The boom that went bust – waterbird abundance in 2017

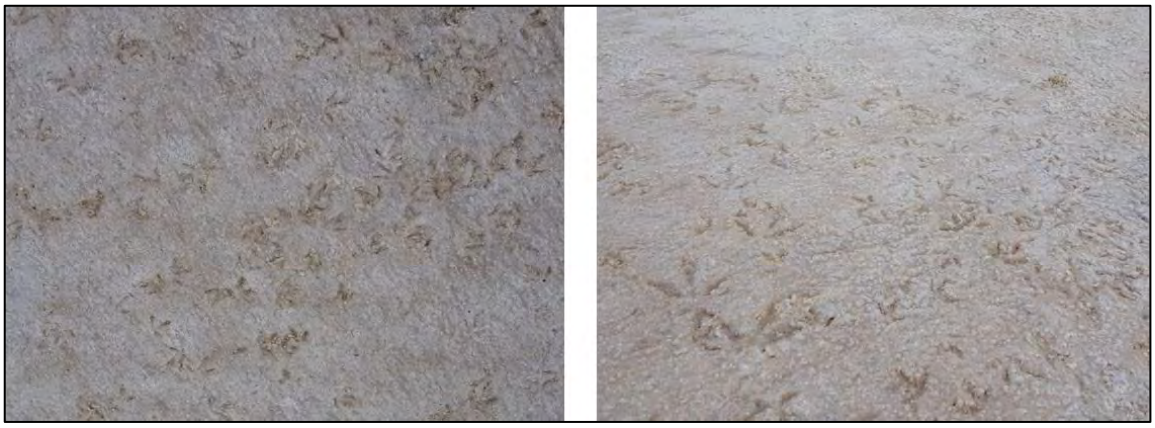
This waterbird survey of Lake Mackay added a wealth of new information on the diversity, composition and abundance of waterbird species on the saline lake and nearby freshwater claypans. The diversity and abundance of waterbirds on Lake Mackay at 114-117 days after an extreme rainfall event was low. However, waterbirds at nearby claypans had high diversity (26 species) and were abundant with evidence of breeding for several species (Figure 5). Five Palearctic shorebird migrants were recorded including more than 200 Red-necked Stints feeding in shallow water on Lake Mackay. One EPBC Act listed species, the Australian Painted Snipe, was observed briefly in flight at a small (13.3 ha) claypan, testament to the capacity of small wetlands to provide habitat for birds of high conservation significance. A total of seven waterbirds were recorded for the first time at Lake Mackay and surrounds during this survey: Black-tailed Native-hen, Hoary-headed Grebe, Red-kneed Dotterel, Red-capped Plover, Black-fronted Dotterel, Australian Painted Snipe and Freckled Duck. The Australian Painted Snipe record is notable as it is Australia's rarest waterbird with a population estimated at only 600-1,700 mature individuals (BirdLife International 2017). It is important to note that there was only one record of the Australian Painted Snipe and it was approximately 25 km to the east of one of the proposed infrastructure areas. It was recorded at a claypan and satellite imagery shows that 1,000s of claypans occur around Lake Mackay. Observations of Freckled Duck were also noteworthy distributional records, with at least 56 birds in total observed at three claypan sites.

There was secondary evidence of the relatively recent presence of 100-1,000s of waterbirds at each site visited on the lake, but where only a few individual waterbirds were actually present in April 2017. The rapid drying of Lake Mackay over hot summer days with high evaporation presumably leads to the rapid decline of the abundance and diversity of waterbirds as food availability declines and salinity increases (Kingsford-Smith *et al.* 2010). Most waterbirds probably departed Lake Mackay 1-2 months before the April surveys were carried out.

Figure 5. Comparing abundance of shorebirds, other waterbirds and landbirds on Lake Mackay and nearby claypan wetlands: (A) shorebirds, (B) other waterbirds and (C) landbirds. Birds are ordered from most abundant species on Lake Mackay to least abundant or absent.



Numerous prints of shorebirds and waterbirds were seen on the salt crust at all sites on Lake Mackay, with large flocks probably departing the area in February or March prior to the survey. At these sites, waterbirds were in very low numbers (<10 individuals) or completely absent in April 2017 (see photos below).



5.2 The total number of waterbird species at Lake Mackay

At least 40 waterbird species have been recorded at Lake Mackay, including 16 shorebird species and 24 other waterbirds (Table 4). In addition, the aerial survey by Duguid (2005) reported on an additional seven taxa whose identity was unverified. This might include several additional species, but several unidentified birds were probably recorded definitively in the current survey. For example, the 'unidentified shorebirds smaller than Sharp-tailed Sandpiper' probably refers to Red-necked Stint which was observed several times during the present survey both on the lake and adjacent claypans.

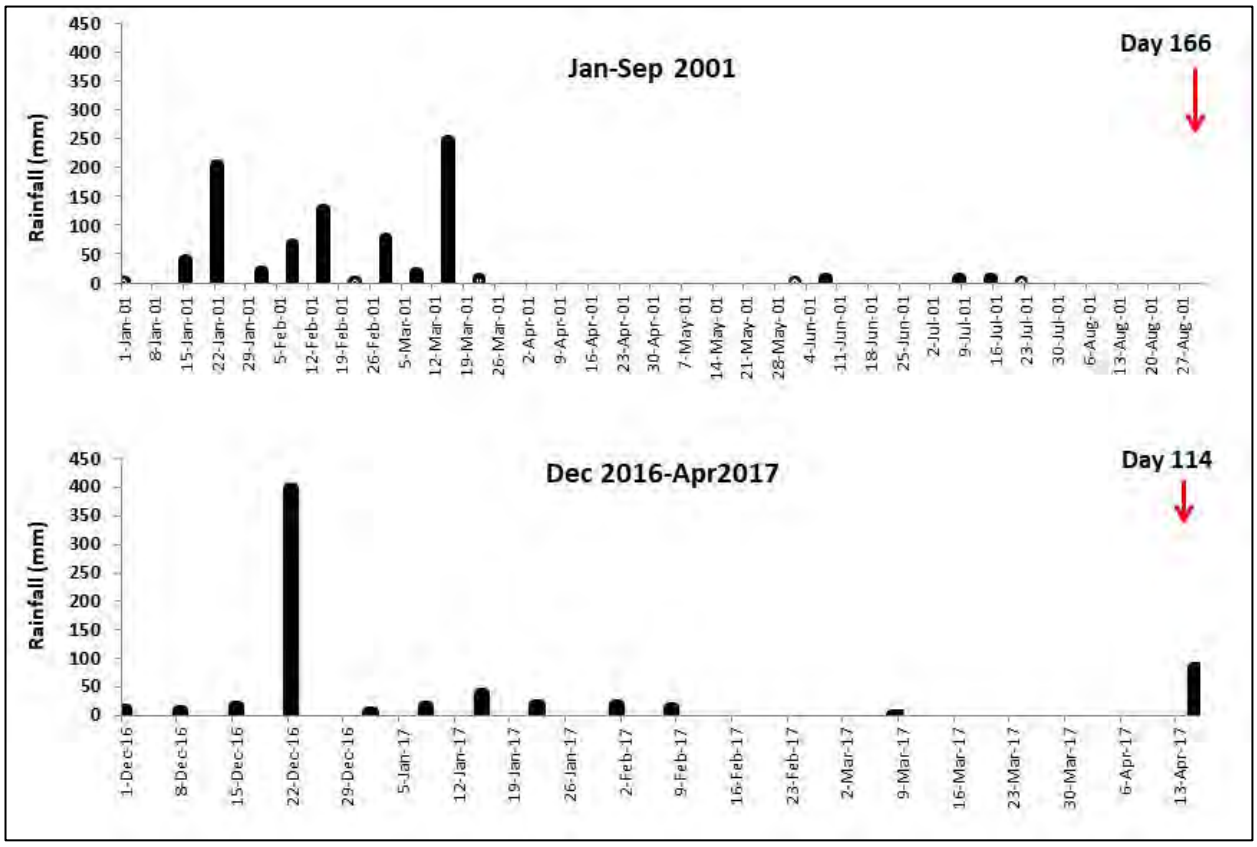
5.3 Boom-bust, rain, flood and evaporation: comparison to the NT government waterbird survey of 2001

Surveys by the Northern Territory Government included a fixed wing aerial survey on 6 September 2001 and ground surveys during 3-10 October 2001 (Duguid *et al.* 2005). A total of 26 waterbird species were recorded (here excluding Australian Bustard as a waterbird) including 20 species identified to species-level and six waterbird taxa where it was impossible to accurately identify to species-level. Of the 20 waterbirds identified, four were unrecorded in the present survey including three species of ibis and Great Egret (Table 4). According to coordinates given by Duguid *et al.* (2005) for individual waterbird records, all these were recorded on dryland or claypan habitats, rather than on the saline habitats of Lake Mackay. The present survey was able to confirm the presence

of Whiskered Tern on Lake Mackay, which were observed foraging on saline and claypan wetlands and breeding in the latter. The migratory White-winged Tern would be expected to occur at Lake Mackay as an annual migrant in the region especially during September to March depending on the presence of water. Discriminating Whiskered Tern from the similarly plumaged White-winged Tern from aerial surveys would be impossible.

There were major differences in the abundance of waterbirds between the two visits. The 2001 aerial survey recorded more than 40,000 waterbirds, whereas in 2017 only 2,591 waterbirds were recorded. Obviously, the type of survey was different, but the major difference was the extraordinary rainfall during the summer of 2001 where 808.2 mm was recorded between January to March with three individual weeks receiving more than 100 mm of rain. The December 2016 extreme rainfall event was restricted to a single week with a smaller total of 551.4 mm recorded from December 2016 up to the present survey (Figure 6).

Figure 6. Weekly rainfall patterns prior to waterbird surveys on Lake Mackay – the September 2001 and April 2017 survey.



The total amount of rain, the spread and the timing are undoubtedly crucial in causing the initial flooding, the level (depth) of flooding and in differing rates of evaporation. Early summer rains such as those in December 2016 allows greater evaporation of any resulting surface water because there were several months of 35°C plus days. In 2001, the quantity of rain was greater and occurred over a longer period, with much of it occurring late in summer, presumably with substantially lower rates of evaporation. These differences undoubtedly lead to dramatic differences in inundation to Lake Mackay and surrounding claypans. For example, water depth was measured at 40 cm in October 2001 and was estimated to have reached a maximum depth of 120 cm (Duguid *et al.* 2005) whereas in April 2017 maximum water depth was less than 20 cm, and mostly only around 1-10 cm. It seems that Lake Mackay is most able to support waterbird populations over extended periods (4-8 months) when there are a series of extreme rainfall events, especially towards the end of summer.

There is no data on evaporation available, but 188 days after the rainfall event (5 October 2001) electrical conductivity (EC) was measured by Duguid *et al.* (2005) at 80,000 μS/cm, while in April 2017 it was substantially higher at 140,000 to 262,000 μS/cm. Seawater has electrical conductivity of approximately 50,000 μS/cm. Electrical conductivity levels in salt lakes are a major determinant of food webs and the presence and abundance of waterbirds. For example, Pedler *et al.* (2014) studied a breeding colony of Banded Stilt on Lake Eyre when electrical conductivity was 66,000 μS/cm, however satellite tagged birds had left the colony 7 weeks later when electrical conductivity reached 127,000 μS/cm.

6 Conclusions

An anticipated boom in primary productivity which would attract and maintain large numbers of waterbirds on Lake Mackay had largely busted at 114-117 days after a major rainfall event. Lake Mackay was found to support low numbers of relatively few waterbird species and no major breeding colonies were recorded. Flocks of 10,000s of waterbirds may have been present on Lake Mackay up until around February-March 2017, but had moved during summer as water levels and food availability plummeted and electrical conductivity increased. Many waterbird species obviously use both saline habitats on Lake Mackay as well as claypans, but specialized species such as Banded Stilt depend on saline lakes for breeding. This study highlights claypans as habitat supporting waterbird communities of high conservation significance. Despite their small areal extent, these held a diverse range and large numbers of waterbirds including EPBC Act listed species such as the Australian Painted Snipe, *Rostratula australis* (Australia's rarest waterbird) and supported breeding by several waterbird species. Only seven claypans were surveyed but satellite imagery shows that 1,000s of claypans occur about Lake Mackay including at least 30 greater than 8 ha.

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PLATES

Plate 1. Examples of shorebirds recorded during the survey.

(A) Black-winged Stilt at site C1, (B) Red-necked Avocet at C6, (C) flock of c. 190 Banded Stilt in breeding plumage, roosting near shoreline at L1, (D) Red-capped Plover at C6, (E) Black-fronted Dotterel at C4, (F) Red-kneed Dotterel atC2, (G) Palearctic migrant Sharp-tailed Sandpiper at C7, and (H) Palearctic migrant Red-necked Stints, photographed from helicopter actively feeding on Lake Mackay at L9.

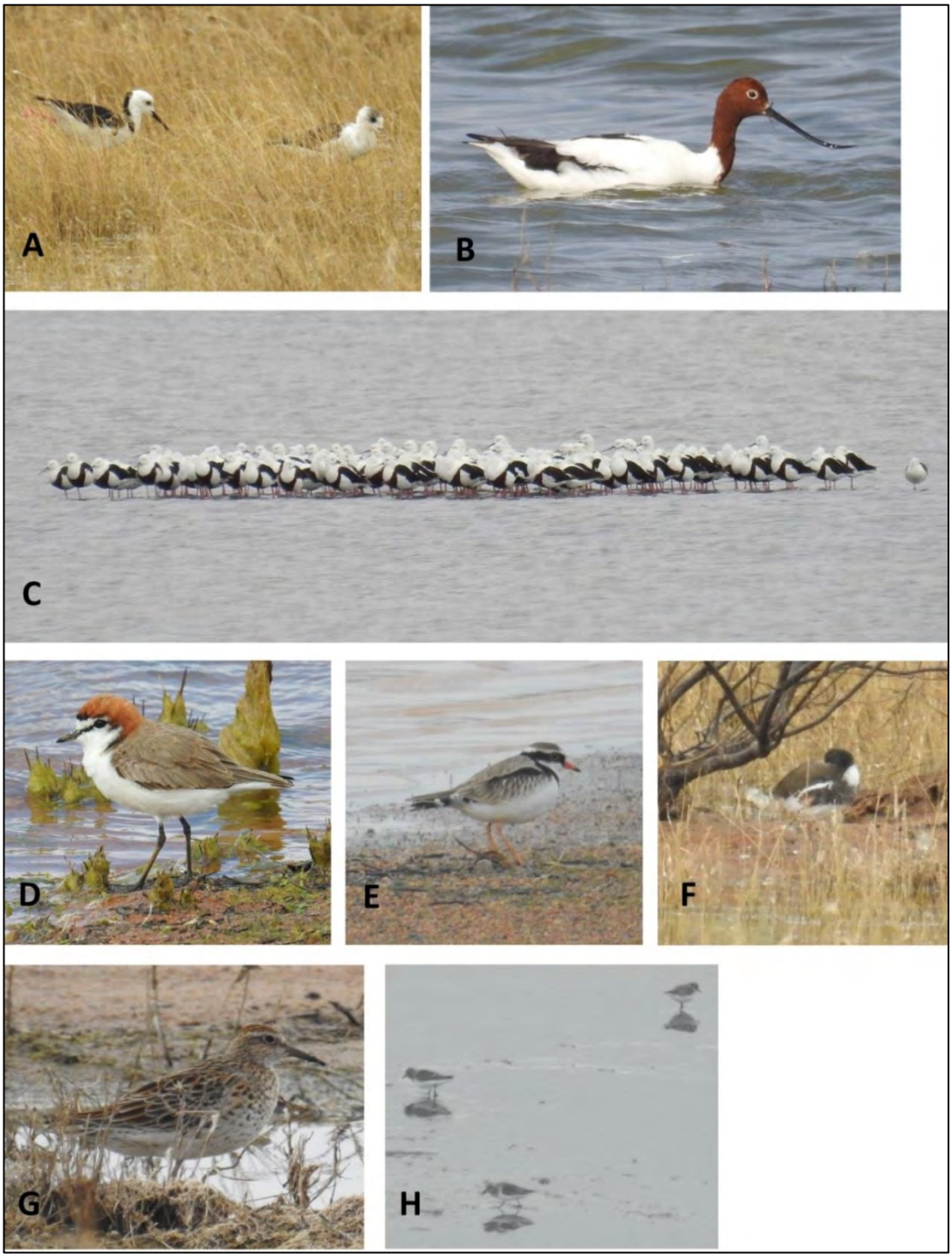

Plate 2. Examples of other waterbirds recorded during the survey.

(A) Freckled Duck at C7, (B) Grey Teal with Red-necked Avocet at C4, (C) Pink-eared Duck at C7, (D) Hardhead with Grey Teal at C7, (E) Hoary-headed Grebe at C6, (F) Black-tailed Native-hen at C2, (G) Silver Gull at H26, and (H) Australian Gull-billed Tern at L2.

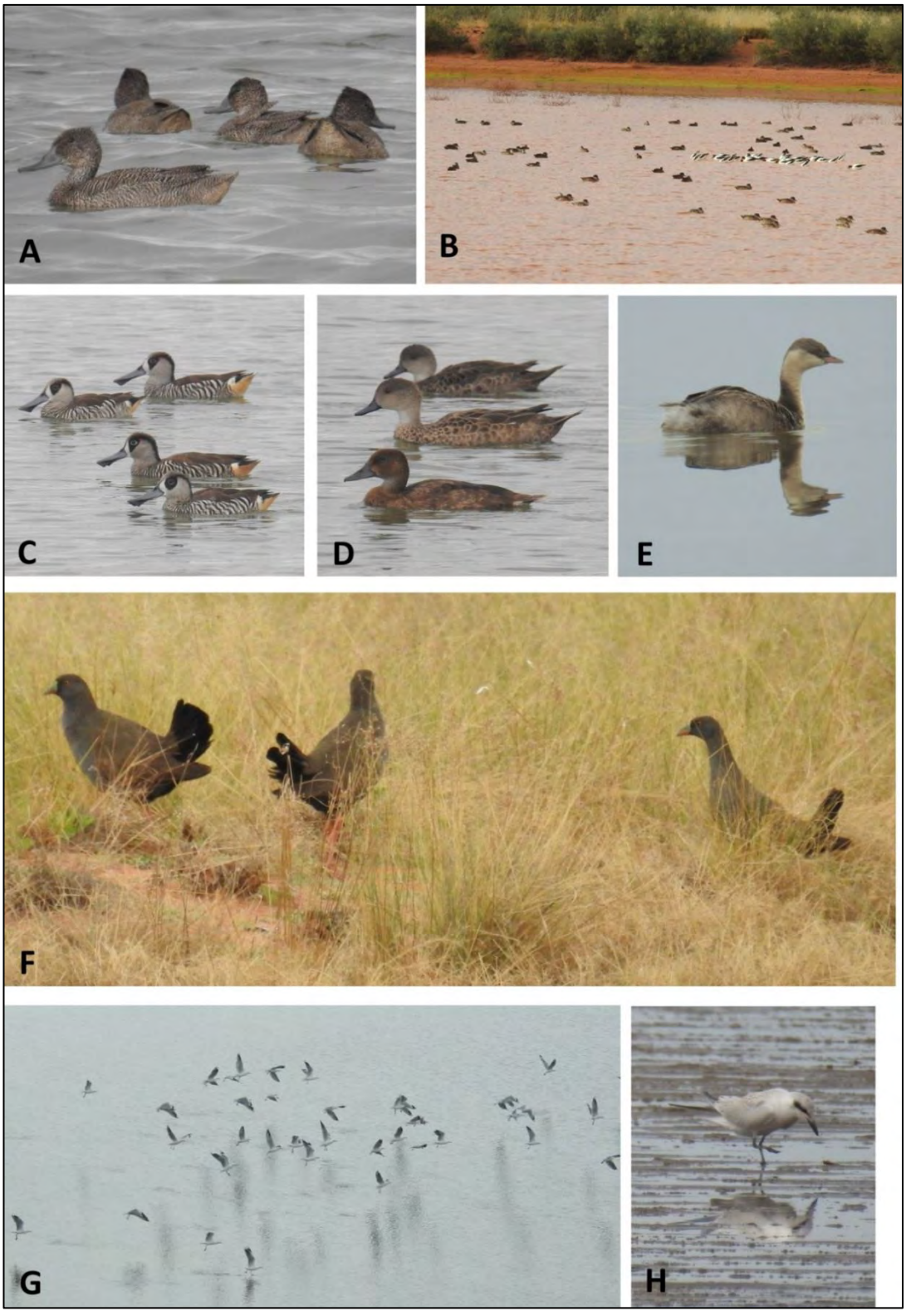

Plate 3. Examples of landbirds recorded during the survey:

(A) Spotted Harrier, (B) Australian Bustard, (C) Diamond Dove, (D) Brown Falcon, (E) male Orange Chat, (F) female Orange Chat, (G) Masked Wood Swallow (H) female Rufous Whistler, (I) Willy Wagtail, (J) female Red-capped Robin, (K) White-backed Swallow, (L) Australasian Pipit, and (M) Zebra Finch.

Plate 4. Evidence of recent breeding success in the Lake Mackay area:

(A & B) Juvenile-plumaged Black-winged Stilt at C7, (C) juvenile plumaged Red-necked Avocet at C7, (D) juvenile Banded Stilt on Lake Mackay at H7, (E) juvenile plumaged Red-kneed Dotterel at C2, (F) juvenile plumaged Silver Gull at C6, (G) adult Australian Gull-billed Tern followed by food-begging juvenile bird at left at C6, (H) two juvenile Whiskered Tern and adult bird at right, at C1, (I) c. 35 mm long eggshell, probably of Whiskered Tern at C2, (J) recently used nest at rapidly drying claypan, probably Whiskered Tern at C2.

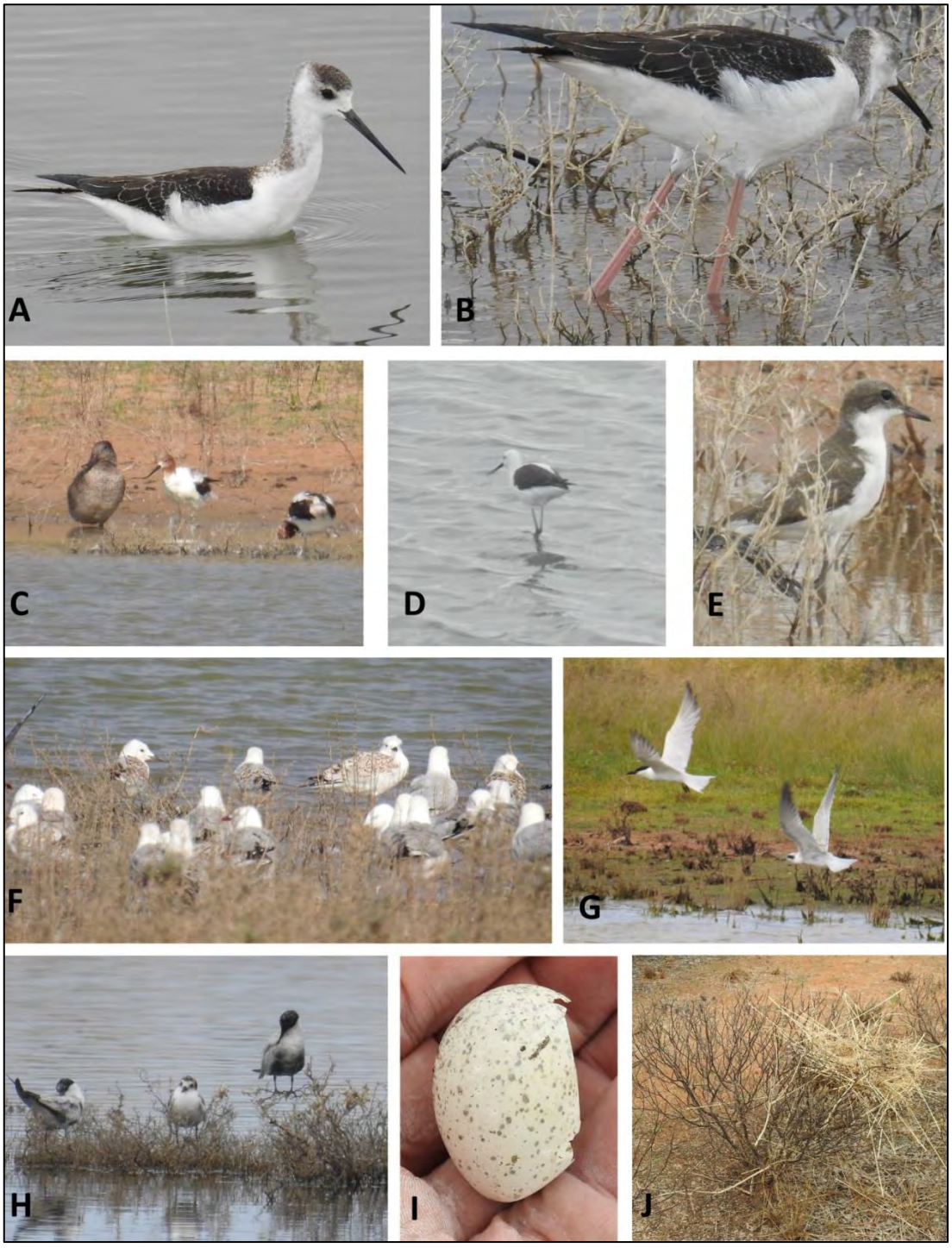

Plate 5. Aerial view of islands, water channels, large expanses of water and shoreline of Lake Mackay.

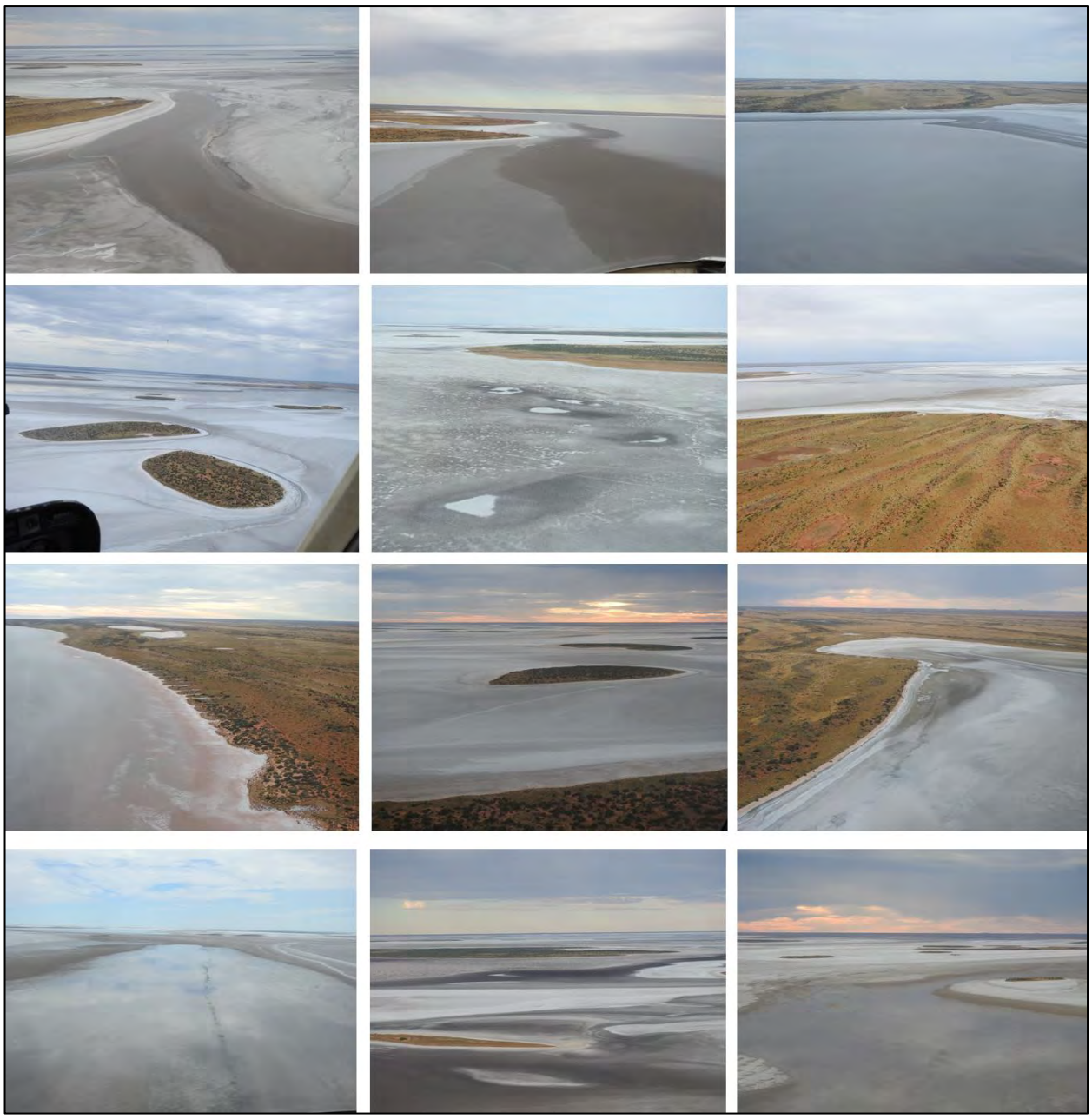

Plate 6. Examples of the diversity of bare and well-vegetated claypan wetlands near Lake Mackay.

APPENDIX A

Definitions of Threatened Fauna Species Categories

Western Australian Threatened Fauna Categories Wildlife Conservation Act 1950 (WA)

CATEGORY	CODE	DESCRIPTION
Schedule 1	S1	Rare or likely to become extinct as critically endangered fauna.
Schedule 2	S2	Fauna that is rare or is likely to become extinct as endangered fauna.
Schedule 3	S3	Fauna that is rare or is likely to become extinct as vulnerable fauna.
Schedule 4	S4	Fauna presumed to be extinct.
Schedule 5	S5	Migratory birds protected under an international agreement.
Schedule 6	S6	Fauna that is of special conservation need as conservation dependent fauna.
Schedule 7	S7	Other specially protected fauna.

Department of Parks and Wildlife Fauna Priority Codes

CATEGORY	CODE	DESCRIPTION
Priority 1	P1	Taxa with few, poorly known populations on threatened lands.
Priority 2	P2	Taxa with few, poorly known populations on conservation lands.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	P4	Taxa in need of monitoring: not currently threatened or in need of special protection, but could become so. Usually represented on conservation lands.
Priority 5	P5	Taxa in need of monitoring: not considered threatened, but the subject of a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Categories of Threatened Fauna Species under the EPBC Act

CONSERVATION CODE	DESCRIPTION
Ex	**Extinct** Taxa which at a particular time if, at the time, there is no reasonable doubt that the last member of the species has died.
Exec	**Extinct in the Wild** Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.

CE	**Critically Endangered** Taxa which at a particular time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	**Endangered** Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
V	**Vulnerable** Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.
MI	**Migratory** Taxa that migrate to Australia and its external territories, or pass through or over Australian waters during their annual migrations, that are included in an international agreement approved by the Minister for the Environment, Heritage and the Arts and that have been placed on the national List of Migratory Species under the provisions of the EPBC Act. At present there are four such agreements: • the Bonn Convention • the China-Australia Migratory Bird Agreement (CAMBA) • the Japan-Australia Migratory Bird Agreement (JAMBA) • the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
Ma	**Marine** Taxa protected in a Commonwealth Marine Protected Area by virtue of section 248 of the EPBC Act. These taxa include certain seals, crocodiles, turtles and birds, as well as various marine fish. Commonwealth marine areas are matters of national environmental significance under the EPBC Act. An action will require approval if the: • action is taken in a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment, or • action is taken outside a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment in a Commonwealth marine area1

	The Commonwealth marine area is any part of the sea, including the waters, seabed, and airspace, within Australia's exclusive economic zone and/or over the continental shelf of Australia, that is not State or Northern Territory waters. The Commonwealth marine area stretches from 3 to 200 nautical miles (approximately 5-370 km) from the coast. Marine protected areas are marine areas which are recognised to have high conservation value.

Source: *Environment Protection and Biodiversity Conservation Act 1999*

APPENDIX B

Summary characteristics of the 45 sites surveyed by helicopter on Lake Mackay and nearby claypans, including location, date, and whether birds were present at site or absent. Refer to ground survey sites in Table 1.

SITE CODE	SITE FULL NAME	ZONE	EASTING	NORTHING	DATE	TIME	BIRDS PRESENT	BIRDS ABSENT
H6	Lake Mackay, Heli6, claypan	52K	492953	7495775	14-Apr-17	15:10PM	x	
H7	Lake Mackay, Heli7, claypan	52K	491792	7494368	14-Apr-17	15:11PM	x	
H8	Lake Mackay, Heli8, claypan	52K	490807	7494395	14-Apr-17	14:20PM	x	
H24	Lake Mackay, Heli24, claypan	52K	449634	7496858	16-Apr-17	10:50AM	x	
H30	Lake Mackay, Heli30, claypan	52K	441053	7494299	15-Apr-17	17:26PM	x	
H26	Lake Mackay, Heli26, claypan	52K	457535	7492729	16-Apr-17	10:54AM	x	
H15	Lake Mackay, Heli15	52K	491368	7500281	16-Apr-17	9:53AM	x	
H16	Lake Mackay, Heli16	52K	492411	7499266	16-Apr-17	9:57AM	x	
H17	Lake Mackay, Heli17	52K	489465	7495961	16-Apr-17	10:04AM	x	
H18	Lake Mackay, Heli18	52K	489225	7494882	16-Apr-17	10:05AM	x	
H19	Lake Mackay, Heli19	52K	489897	7493222	16-Apr-17	10:07AM	x	
H20	Lake Mackay, Heli20	52K	490019	7492574	16-Apr-17	10:08AM	x	
H21	Lake Mackay, Heli21	52K	486718	7491260	16-Apr-17		x	
H22	Lake Mackay, Heli22	52K	483125	7492146	16-Apr-17		x	
H25	Lake Mackay, Heli25	52K	454942	7494200	16-Apr-17	10:53AM	x	
H29	Lake Mackay, Heli29	52K	445227	7491788	15-Apr-17	17:22PM	x	
H31	Lake Mackay, Heli31	52K	437130	7493845	15-Apr-17	17:27PM	x	
H34	Lake Mackay, Heli34	52K	461057	7490964	16-Apr-17	10:55AM	x	

H35	Lake Mackay, Heli35	52K	482660	7492208	16-Apr-17	11:15AM	x	
H36	Lake Mackay, Heli36	52K	485846	7494445	16-Apr-17		x	
H37	Lake Mackay, Heli37	52K	488913	7497488	16-Apr-17		x	
H39	Lake Mackay, Heli39	52K	438664	7493257	17-Apr-17	7:44AM	x	
H48	Heli48	52K	483838	7512597	16-Apr-17	11:28AM	x	
H9	Heli9	52K	485806	7491949	15-Apr-17			x
H10	Heli10	52K	483170	7492594	15-Apr-17			x
H11	Heli11	52K	480983	7492596	15-Apr-17			x
H12	Heli12	52K	473246	7504289	15-Apr-17			x
H13	Heli13	52K	474430	7506850	15-Apr-17			x
H14	Heli14	52K	480300	7520184	15-Apr-17			x
H23	Heli23	52K	480607	7492557	16-Apr-17			x
H27	Heli27	52K	472818	7510650	15-Apr-17	17:10PM		x
H32	Heli32	52K	482334	7500671	16-Apr-17			x
H33	Heli33	52K	479426	7500554	16-Apr-17			x
H38	Heli38	52K	488471	7506214	16-Apr-17			x
H40	Heli40	52K	485875	7509610	16-Apr-17			x
H41	Heli41	52K	480118	7512149	16-Apr-17			x
H42	Heli42	52K	479208	7514707	16-Apr-17			x
H43	Heli43	52K	476202	7514610	16-Apr-17			x
H44	Heli44	52K	478648	7511185	16-Apr-17			x
H45	Heli45	52K	476784	7513438	16-Apr-17			x
H46	Heli46	52K	480664	7503573	16-Apr-17			x

H47	Heli47	52K	478338	7504820	16-Apr-17			x
H49	Heli49	52K	476392	7507204	16-Apr-17			x
H50	Heli50	52K	473794	7510072	16-Apr-17			x
H51	Heli51	52K	469548	7514612	16-Apr-17			x

APPENDIX C

Photographic documentation of ground survey sites.
Refer to Table 1 for further site details

Lake Mackay 1 (L1) - aerial view on approach showing proximity of water to a small island and view of shoreline of Lake Mackay.

Lake Mackay 1 (L1) - view of shoreline of Lake Mackay.

Lake Mackay 2 (L2) - small island view over Lake Mackay shoreline.

Lake Mackay 2 (L2) - view of shoreline and shallow water channel between islands in lake.

Lake Mackay 5 (L5) - aerial view over well-watered extreme south-east corner of Lake Mackay.

Site: Lake Mackay 6 (L6).

Site: Lake Mackay 7 (L7) - deep mud at this south-east Lake Mackay site meant that aquatic sampling could not be done.

Site: Lake Mackay 8 (L8) - aerial view on landing, water sampled on left side of island at narrow channel.

Site: Claypan1 (C1) - view over well vegetated freshwater basin wetland.

Site: Claypan2 (C1) - view over well vegetated freshwater basin wetland.

Site: Claypan3 (C3) - view over well vegetated freshwater basin wetland.

Site: Claypan4 (C4) - view over sparsely vegetated and turbid freshwater basin wetland.

Site: Claypan5 (C5) - view over rapidly drying and small claypan, devoid of waterbirds.

Site: Claypan6 (C6) - large deep open water claypan with 100s of ducks and other waterbirds.

Site: Claypan7 (C7) - large deep, well-vegetated, open water claypan with 100s of ducks and other waterbirds.

Site: Claypan7 (C7) - large deep, well-vegetated, open water claypan with 100s of ducks and other waterbirds.

APPENDIX D

The 191 georeferenced bird by site records. Refer to Table 2 and Appendix B for further site details.

SITE CODE	DATE	TIME	COMMON NAME	SCIENTIFIC NAME	COUNT
C7	04-17-2017	11:25 AM	Australasian Bushlark	*Mirafra javanica*	3
C1	04-15-2017	12:40 PM	Australasian Pipit	*Anthus novaeseelandiae*	2
C2	04-15-2017	1:30 PM	Australasian Pipit	*Anthus novaeseelandiae*	14
C3	04-16-2017	3:00 PM	Australasian Pipit	*Anthus novaeseelandiae*	2
C6	04-17-2017	12:35 PM	Australasian Pipit	*Anthus novaeseelandiae*	2
C7	04-17-2017	11:25 AM	Australasian Pipit	*Anthus novaeseelandiae*	2
L3	04-15-2017	8:00 AM	Australasian Pipit	*Anthus novaeseelandiae*	3
H25	04-16-2017	10:53 AM	Australian Bustard	*Ardeotis australis*	1
H31	04-15-2017	5:27 PM	Australian Bustard	*Ardeotis australis*	1
H34	04-16-2017	10:55 AM	Australian Bustard	*Ardeotis australis*	1
H39	04-17-2017	7:44 AM	Australian Bustard	*Ardeotis australis*	1
L3	04-15-2017	8:00 AM	Australian Bustard	*Ardeotis australis*	1
C2	04-15-2017	1:30 PM	Australian Painted Snipe	*Rostratula australis*	1
C4	04-17-2017	8:15 AM	Banded Lapwing	*Vanellus tricolor*	2
C3	04-16-2017	3:00 PM	Banded Stilt	*Cladorhynchus leucocephalus*	1
C7	04-17-2017	11:25 AM	Banded Stilt	*Cladorhynchus leucocephalus*	1
H16	04-16-2017	9:57 AM	Banded Stilt	*Cladorhynchus leucocephalus*	3
H18	04-16-2017	10:05 AM	Banded Stilt	*Cladorhynchus leucocephalus*	1
H20	04-16-2017	10:08 AM	Banded Stilt	*Cladorhynchus leucocephalus*	1
H6	04-14-2017	3:10 PM	Banded Stilt	*Cladorhynchus leucocephalus*	20
L1	04-14-2017	12:05 PM	Banded Stilt	*Cladorhynchus leucocephalus*	190

L2	04-14-2017	3:30 PM	Banded Stilt	*Cladorhynchus leucocephalus*	35
L9	04-16-2017	8:36 AM	Banded Stilt	*Cladorhynchus leucocephalus*	5
H30	04-17-2017	5:22 PM	Black Swan	*Cygnus atratus*	1
H8	04-14-2017	2:20 PM	Black Swan	*Cygnus atratus*	2
L10	04-15-2017	4:20 PM	Black-faced Cuckoo shrike	*Coracina novaehollandiae*	2
C4	04-17-2017	8:15 AM	Black-fronted Dotterel	*Elseyornis melanops*	1
C2	04-15-2017	1:30 PM	Black-tailed Native-hen	*Tribonyx ventralis*	18
C1	04-15-2017	12:40 PM	Black-winged Stilt	*Himantopus leucocephalus*	8
C2	04-15-2017	1:30 PM	Black-winged Stilt	*Himantopus leucocephalus*	13
C3	04-16-2017	3:00 PM	Black-winged Stilt	*Himantopus leucocephalus*	10
C7	04-17-2017	11:25 AM	Black-winged Stilt	*Himantopus leucocephalus*	80
H24	04-16-2017	10:50 AM	Black-winged Stilt	*Himantopus leucocephalus*	20
C2	04-15-2017	1:30 PM	Brown Falcon	*Falco berigora*	1
C3	04-16-2017	3:00 PM	Brown Falcon	*Falco berigora*	1
C1	04-15-2017	12:40 PM	Budgerigar	*Melopsittacus undulatus*	10
C3	04-16-2017	3:00 PM	Budgerigar	*Melopsittacus undulatus*	1
C4	04-17-2017	8:15 AM	Budgerigar	*Melopsittacus undulatus*	20
C5	04-17-2017	10:40 AM	Budgerigar	*Melopsittacus undulatus*	10
L4	04-15-2017	10:30 AM	Budgerigar	*Melopsittacus undulatus*	121
L9	04-16-2017	8:36 AM	Budgerigar	*Melopsittacus undulatus*	10
C2	04-15-2017	1:30 PM	Cockatiel	*Nymphicus hollandicus*	12
C7	04-17-2017	11:25 AM	Common Greenshank	*Tringa nebularia*	4
C4	04-17-2017	8:15 AM	Crested Pigeon	*Ocyphaps lophotes*	1

C2	04-15-2017	1:30 PM	Diamond Dove	*Geopelia cuneata*	1
C3	04-16-2017	3:00 PM	Diamond Dove	*Geopelia cuneata*	2
C7	04-17-2017	11:25 AM	Eurasian Coot	*Fulica atra*	30
C3	04-16-2017	3:00 PM	Freckled Duck	*Stictonetta naevosa*	6
C6	04-17-2017	12:35 PM	Freckled Duck	*Stictonetta naevosa*	44
C7	04-17-2017	11:25 AM	Freckled Duck	*Stictonetta naevosa*	6
C1	04-15-2017	12:40 PM	Grey Teal	*Anas gracilis*	42
C2	04-15-2017	1:30 PM	Grey Teal	*Anas gracilis*	4
C3	04-16-2017	3:00 PM	Grey Teal	*Anas gracilis*	70
C4	04-17-2017	8:15 AM	Grey Teal	*Anas gracilis*	77
C6	04-17-2017	12:35 PM	Grey Teal	*Anas gracilis*	128
C7	04-17-2017	11:25 AM	Grey Teal	*Anas gracilis*	120
H26	04-16-2017	10:54 AM	Grey Teal	*Anas gracilis*	120
H29	04-15-2017	5:22 PM	Grey Teal	*Anas gracilis*	40
H30	04-15-2017	5:26 PM	Grey Teal	*Anas gracilis*	100
C6	04-17-2017	12:35 PM	Australian Gull-billed Tern	*Gelochelidon macrotarsa*	11
C7	04-17-2017	11:25 AM	Australian Gull-billed Tern	*Gelochelidon macrotarsa*	18
L1	04-14-2017	12:05 PM	Australian Gull-billed Tern	*Gelochelidon macrotarsa*	3
L2	04-14-2017	3:30 PM	Australian Gull-billed Tern	*Gelochelidon macrotarsa*	1
L7	04-14-2017	2:30 PM	Australian Gull-billed Tern	*Gelochelidon macrotarsa*	1
L9	04-16-2017	8:36 AM	Australian Gull-billed Tern	*Gelochelidon macrotarsa*	5

C1	04-15-2017	12:40 PM	Hardhead	*Aythya australis*	4
C3	04-16-2017	3:00 PM	Hardhead	*Aythya australis*	4
C7	04-17-2017	11:25 AM	Hardhead	*Aythya australis*	2
C1	04-15-2017	12:40 PM	Hoary-headed Grebe	*Poliocephalus poliocephalus*	100
C2	04-15-2017	1:30 PM	Hoary-headed Grebe	*Poliocephalus poliocephalus*	40
C3	04-16-2017	3:00 PM	Hoary-headed Grebe	*Poliocephalus poliocephalus*	15
C6	04-17-2017	12:35 PM	Hoary-headed Grebe	*Poliocephalus poliocephalus*	20
C7	04-17-2017	11:25 AM	Hoary-headed Grebe	*Poliocephalus poliocephalus*	100
H26	04-16-2017	10:54 AM	Hoary-headed Grebe	*Poliocephalus poliocephalus*	40
H29	04-15-2017	5:22 PM	Hoary-headed Grebe	*Poliocephalus poliocephalus*	20
C1	04-15-2017	12:40 PM	Little Buttonquail	*Turnix velox*	1
C6	04-17-2017	12:35 PM	Little Buttonquail	*Turnix velox*	4
C7	04-17-2017	11:25 AM	Little Buttonquail	*Turnix velox*	1
C4	04-17-2017	8:15 AM	Little Crow	*Corvus bennetti*	1
C3	04-16-2017	3:00 PM	Magpie-lark	*Grallina cyanoleuca*	1
C5	04-17-2017	10:40 AM	Masked Wood swallow	*Artamus personatus*	2
C3	04-16-2017	3:00 PM	Nankeen Kestrel	*Falco cenchroides*	1
H39	04-16-2017	11:28 AM	Nankeen Kestrel	*Falco cenchroides*	1
L10	04-15-2017	4:20 PM	Nankeen Kestrel	*Falco cenchroides*	1
C4	04-17-2017	8:15 AM	Orange Chat	*Epthianura aurifrons*	1
C6	04-17-2017	12:35 PM	Orange Chat	*Epthianura aurifrons*	2
C7	04-17-2017	11:25 AM	Orange Chat	*Epthianura aurifrons*	42
C6	04-17-2017	12:35 PM	Pacific Black Duck	*Anas superciliosa*	6

C3	04-16-2017	3:00 PM	Pink-eared Duck	*Malacorhynchus membranaceus*	8
C4	04-17-2017	8:15 AM	Pink-eared Duck	*Malacorhynchus membranaceus*	2
C6	04-17-2017	12:35 PM	Pink-eared Duck	*Malacorhynchus membranaceus*	8
C7	04-17-2017	11:25 AM	Pink-eared Duck	*Malacorhynchus membranaceus*	23
C3	04-16-2017	3:00 PM	Plumed Whistling-Duck	*Dendrocygna eytoni*	11
C6	04-17-2017	12:35 PM	Plumed Whistling-Duck	*Dendrocygna eytoni*	17
C6	04-17-2017	12:35 PM	Red-capped Plover	*Charadrius ruficapillus*	1
C7	04-17-2017	11:25 AM	Red-capped Plover	*Charadrius ruficapillus*	23
L1	04-14-2017	12:05 PM	Red-capped Plover	*Charadrius ruficapillus*	2
L2	04-14-2017	3:30 PM	Red-capped Plover	*Charadrius ruficapillus*	3
L6	04-14-2017	9:40 AM	Red-capped Plover	*Charadrius ruficapillus*	20
L9	04-16-2017	8:36 AM	Red-capped Plover	*Charadrius ruficapillus*	22
C2	04-15-2017	1:30 PM	Red-capped Robin	*Petroica goodenovii*	2
C4	04-17-2017	8:15 AM	Red-capped Robin	*Petroica goodenovii*	1
L4	04-15-2017	10:30 AM	Red-capped Robin	*Petroica goodenovii*	1
C2	04-15-2017	1:30 PM	Red-kneed Dotterel	*Erythrogonys cinctus*	8
C3	04-16-2017	3:00 PM	Red-kneed Dotterel	*Erythrogonys cinctus*	3
C7	04-17-2017	11:25 AM	Red-kneed Dotterel	*Erythrogonys cinctus*	23
C3	04-16-2017	3:00 PM	Red-necked Avocet	*Recurvirostra novaehollandiae*	26
C4	04-17-2017	8:15 AM	Red-necked Avocet	*Recurvirostra novaehollandiae*	33
C7	04-17-2017	11:25 AM	Red-necked Avocet	*Recurvirostra novaehollandiae*	200
H26	04-16-2017	10:54 AM	Red-necked Avocet	*Recurvirostra novaehollandiae*	100
H30	04-17-2017	5:22 PM	Red-necked Avocet	*Recurvirostra novaehollandiae*	4

C7	04-17-2017	11:25 AM	Red-necked Stint	*Calidris ruficollis*	250
H15	04-16-2017	9:53 AM	Red-necked Stint	*Calidris ruficollis*	2
H18	04-16-2017	10:05 AM	Red-necked Stint	*Calidris ruficollis*	20
H21	04-16-2017	10:11 AM	Red-necked Stint	*Calidris ruficollis*	20
L2	04-14-2017	3:30 PM	Red-necked Stint	*Calidris ruficollis*	10
L9	04-16-2017	8:36 AM	Red-necked Stint	*Calidris ruficollis*	200
L3	04-15-2017	8:00 AM	Rufous Songlark	*Megalurus mathewsi*	3
L4	04-15-2017	10:30 AM	Rufous Whistler	*Pachycephala rufiventris*	2
C1	04-15-2017	12:40 PM	Sharp-tailed Sandpiper	*Calidris acuminata*	8
C2	04-15-2017	1:30 PM	Sharp-tailed Sandpiper	*Calidris acuminata*	20
C7	04-17-2017	11:25 AM	Sharp-tailed Sandpiper	*Calidris acuminata*	3
L9	04-16-2017	8:36 AM	Sharp-tailed Sandpiper	*Calidris acuminata*	6
C1	04-15-2017	12:40 PM	Silver Gull	*Chroicocephalus novaehollandiae*	19
C2	04-15-2017	1:30 PM	Silver Gull	*Chroicocephalus novaehollandiae*	4
C3	04-16-2017	3:00 PM	Silver Gull	*Chroicocephalus novaehollandiae*	151
C7	04-17-2017	11:25 AM	Silver Gull	*Chroicocephalus novaehollandiae*	2
H18	04-16-2017	10:05 AM	Silver Gull	*Chroicocephalus novaehollandiae*	3
H21	04-16-2017	10:11 AM	Silver Gull	*Chroicocephalus novaehollandiae*	25
H22	04-16-2017	10:12 AM	Silver Gull	*Chroicocephalus novaehollandiae*	2
H24	04-16-2017	10:50 AM	Silver Gull	*Chroicocephalus novaehollandiae*	4
H26	04-16-2017	10:54 AM	Silver Gull	*Chroicocephalus novaehollandiae*	120
H35	04-16-2017	11:15 AM	Silver Gull	*Chroicocephalus novaehollandiae*	4
H36	04-16-2017	11:20 AM	Silver Gull	*Chroicocephalus novaehollandiae*	4

H37	04-16-2017	11:22 AM	Silver Gull	*Chroicocephalus novaehollandiae*	3
H6	04-14-2017	3:10 PM	Silver Gull	*Chroicocephalus novaehollandiae*	2
H7	04-14-2017	3:11 PM	Silver Gull	*Chroicocephalus novaehollandiae*	60
L1	04-14-2017	12:05 PM	Silver Gull	*Chroicocephalus novaehollandiae*	4
L5	04-16-2017	1:05 PM	Silver Gull	*Chroicocephalus novaehollandiae*	1
L6	04-14-2017	9:40 AM	Silver Gull	*Chroicocephalus novaehollandiae*	5
L7	04-14-2017	2:30 PM	Silver Gull	*Chroicocephalus novaehollandiae*	64
L8	04-16-2017	12:00 PM	Silver Gull	*Chroicocephalus novaehollandiae*	1
L9	04-16-2017	8:36 AM	Silver Gull	*Chroicocephalus novaehollandiae*	7
L10	04-15-2017	4:20 PM	Singing Honeyeater	*Gavicalis virescens*	6
L9	04-16-2017	8:36 AM	Singing Honeyeater	*Gavicalis virescens*	3
C2	04-15-2017	1:30 PM	Spotted Harrier	*Circus assimilis*	1
C3	04-16-2017	3:00 PM	Spotted Harrier	*Circus assimilis*	1
C5	04-17-2017	10:40 AM	Spotted Harrier	*Circus assimilis*	1
L3	04-15-2017	8:00 AM	Spotted Harrier	*Circus assimilis*	1
C7	04-17-2017	11:25 AM	Square-tailed Kite	*Lophoictinia isura*	1
C2	04-15-2017	1:30 PM	Tree Martin	*Petrochelidon nigricans*	8
C2	04-15-2017	1:30 PM	Variegated Fairywren	*Malurus lamberti*	8
C6	04-17-2017	12:35 PM	Variegated Fairywren	*Malurus lamberti*	12
C1	04-15-2017	12:40 PM	Whiskered Tern	*Chlidonias hybrida*	74
C4	04-17-2017	8:15 AM	Whiskered Tern	*Chlidonias hybrida*	1
C7	04-17-2017	11:25 AM	Whiskered Tern	*Chlidonias hybrida*	4
H17	04-16-2017	10:04 AM	Whiskered Tern	*Chlidonias hybrida*	2

H19	04-16-2017	10:07 AM	Whiskered Tern	*Chlidonias hybrida*	5
H30	04-15-2017	5:26 PM	Whiskered Tern	*Chlidonias hybrida*	20
H36	04-16-2017	11:20 AM	Whiskered Tern	*Chlidonias hybrida*	1
L1	04-14-2017	12:05 PM	Whiskered Tern	*Chlidonias hybrida*	1
C1	04-15-2017	12:40 PM	Whistling Kite	*Haliastur sphenurus*	1
C2	04-15-2017	1:30 PM	Whistling Kite	*Haliastur sphenurus*	6
C7	04-17-2017	11:25 AM	Whistling Kite	*Haliastur sphenurus*	2
L3	04-15-2017	8:00 AM	White-backed Swallow	*Cheramoeca leucosterna*	7
L6	04-14-2017	9:40 AM	White-backed Swallow	*Cheramoeca leucosterna*	12
L8	04-16-2017	12:00 PM	White-backed Swallow	*Cheramoeca leucosterna*	3
C1	04-15-2017	12:40 PM	White-faced Heron	*Egretta novaehollandiae*	1
C6	04-17-2017	12:35 PM	White-faced Heron	*Egretta novaehollandiae*	2
C7	04-17-2017	11:25 AM	White-faced Heron	*Egretta novaehollandiae*	1
C1	04-15-2017	12:40 PM	Willie Wagtail	*Rhipidura leucophrys*	6
C2	04-15-2017	1:30 PM	Willie Wagtail	*Rhipidura leucophrys*	8
C3	04-16-2017	3:00 PM	Willie Wagtail	*Rhipidura leucophrys*	4
C4	04-17-2017	8:15 AM	Willie Wagtail	*Rhipidura leucophrys*	1
C5	04-17-2017	10:40 AM	Willie Wagtail	*Rhipidura leucophrys*	1
C6	04-17-2017	12:35 PM	Willie Wagtail	*Rhipidura leucophrys*	2
C7	04-17-2017	11:25 AM	Willie Wagtail	*Rhipidura leucophrys*	12
L10	04-15-2017	4:20 PM	Willie Wagtail	*Rhipidura leucophrys*	1
L3	04-15-2017	8:00 AM	Willie Wagtail	*Rhipidura leucophrys*	2
L4	04-15-2017	10:30 AM	Willie Wagtail	*Rhipidura leucophrys*	3

L9	04-16-2017	8:36 AM	Willie Wagtail	*Rhipidura leucophrys*	1
C1	04-15-2017	12:40 PM	Zebra Finch	*Taeniopygia guttata castanotis*	10
C2	04-15-2017	1:30 PM	Zebra Finch	*Taeniopygia guttata castanotis*	45
C3	04-16-2017	3:00 PM	Zebra Finch	*Taeniopygia guttata castanotis*	12
C4	04-17-2017	8:15 AM	Zebra Finch	*Taeniopygia guttata castanotis*	10
C5	04-17-2017	10:40 AM	Zebra Finch	*Taeniopygia guttata castanotis*	10
C7	04-17-2017	11:25 AM	Zebra Finch	*Taeniopygia guttata castanotis*	10
L3	04-15-2017	8:00 AM	Zebra Finch	*Taeniopygia guttata castanotis*	2
L4	04-15-2017	10:30 AM	Zebra Finch	*Taeniopygia guttata castanotis*	80
L6	04-14-2017	9:40 AM	Zebra Finch	*Taeniopygia guttata castanotis*	2
L9	04-16-2017	8:36 AM	Zebra Finch	*Taeniopygia guttata castanotis*	30