Cryptic and Colonial-nesting waterbirds in the Coorong, Lower Lakes and Murray Mouth: distribution, abundance and habitat associations 2013

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Foreword

The Department of Environment, Water and Natural Resources (DEWNR) is responsible for the management of the State's natural resources, ranging from policy leadership to on-ground delivery in consultation with government, industry and communities.

High-quality science and effective monitoring provides the foundation for the successful management of our environment and natural resources. This is achieved through undertaking appropriate research, investigations, assessments, monitoring and evaluation.

DEWNR's strong partnerships with educational and research institutions, industries, government agencies, Natural Resources Management Boards and the community ensures that there is continual capacity building across the sector, and that the best skills and expertise are used to inform decision making.

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Acknowledgements

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Summary

This report presents the results of targeted waterbird surveys in the Coorong, Lower Lakes and Murray Mouth (CLLMM) region. The aim of these surveys was to improve our understanding regarding the spatial and temporal distribution of:

- reed-dependent, "cryptic" waterbirds;
- colonial nesting waterbirds

The results of these surveys complement existing, general waterbird surveys that have been undertaken in the CLLMM since the mid 1980s, but that have not been designed to comprehensively determine the distribution and abundance of these more specialists groups of birds.

This report presents the results of targeted surveys undertaken in Spring and Summer 2013-14, the second time that these surveys have been undertaken (the first having been undertaken in 2012-13). The key findings of this current survey are:

- for cryptic waterbirds, slightly fewer individuals were recorded across all species in 2013-14 than in 2012-13. However, only one species recorded in 2012-13 was not recorded in 2013-14 (Little Bittern);
- the relationship between the distribution of cryptic waterbird species and habitat attributes of each survey site reinforced those patterns detected in 2012-13, further strengthening our understanding of the habitat requirements of these otherwise poorly known species;
- for colonial nesting waterbirds, the number of nests recorded for the dominant breeding species in the Coorong (Australian Pelican and Crested Tern) were lower in 2013-14 than 2012-13 (although survey effort was also lower in 2013-14). However the number of nests recorded for the dominant breeding species in the Lower Lakes (Australian White Ibis and Straw-necked Ibis) were higher in 2013-14 than in 2012-13;
- while there was some overlap in the spatial distribution of colonial waterbird breeding sites between 2012-13 and 2013-14, waterbird breeding was also recorded at two new sites in 2013-14.

Introduction

The Coorong, Lakes Alexandrina and Albert, and Murray Mouth is internationally recognised as a Wetland Of International Significance under the Ramsar Convention. A major reason for this recognition is the important of the site for waterbirds (Eckert 2000; Phillips and Muller 2006; Rogers and Paton 2009). The diversity of wetland habitats within the CLLMM regularly support >200,000 individual waterbirds every summer, and act as an important drought refuge for many of South Australia's wetland bird populations (Paton and Bailey 2010).

Our strong understanding of the ecology of the CLLMM's waterbird communities comes largely from a series of long-term waterbird monitoring programs. Most significantly, these monitoring programs have informed our understanding of how waterbird populations respond to environmental change in the CLLMM, particularly in relation to changes in water regime. However, the generalist nature of these monitoring programs has meant that they fail to adequately detect a number of highly specialist species that are strongly associated with emergent fringing aquatic vegetation (reedbeds). Furthermore, while these monitoring programs provide excellent information regarding the abundance and distribution of most species, they don't necessarily provide complete coverage of particular breeding habitats. Both comprehensive waterbird breeding surveys, and surveys of specialist reed-dependent birds, require targeted survey effort that complement the more general surveys that currently occur.

In 2012, the South Australian Department of Environment, Water and Natural Resources (DEWNR) recognised the need for these targeted surveys, and undertook an initial survey through the CLLMM Recovery Program. The results of this initial survey were presented in (O'Connor et al. 2013). This report presents the results of a repeat of these surveys undertaken in 2013. The aims of the survey were:

1. Improve the existing dataset for reed-dependent waterbirds and breeding waterbirds within the CLLMM wetland system;
2. Compare the results of surveys performed in 2012 and 2013, and relate the observed differences to changes in the wetlands' hydrology and other environmental conditions.

Methodology

Reed-dependent "Cryptic"Waterbirds

Study sites

This study was conducted at 15 wetland sites around the edges of Lakes Alexandrina, Albert and their tributaries (Figure 1). Two rectangular 2 ha plots were sampled at each of the 15 study sites, (2ha plots were chosen based on the standard BirdLife Australia sampling method). All plots included wetland edges, which are defined as the maximum extent of water bodies in September (e.g. lake shoreline, river edge or other wetland border). A summary of habitat characteristics and GPS co-ordinates for each of the 2 ha survey plots (15 sites, 30 survey plots) is provided in (O'Connor et al. 2013).

Figure 1. Lakes Albert and Alexandrina and associated tributaries. The 15 sites surveyed for cryptic birds in 2012 and 2013 are shown as red points on the map. Reedy Island (shown in yellow) was only surveyed in September 2012. Its replacement site: Goolwa, was surveyed from October to December 2012 and September to December 2013.

Survey Methods

Surveys were conducted over a 3-4 day period on a monthly basis between September and December 2013 (survey dates for 2012 are listed in (O'Connor et al. 2013). Survey dates for 2013 were as follows: Survey 1, September 2-4; Survey 2: September 29 & 30, October 8 & 9; Survey 3: November 18-20; Survey 4: December 4-6 2013. To obtain survey data, observers searched one of the two 2 ha plots at each site and recorded all birds (including non-target species) that were heard or seen within a 40 minute period. Each plot was systematically searched by one observer (Plots A and B were searched at the same time by one of the two observers). GPS co-ordinates for all four corners of each 2 ha plot are provided in Appendix 2 of (O'Connor et al. 2013).

In each of the monthly surveys, the following information was recorded at each site:

- Weather conditions (wind, temperature etc.)
- Minimum and maximum water depth at each 2 ha plot
- Estimated % cover of water at each 2 ha plot

For each observation, the following information was recorded and used in this study:

- Species identity
- Number of individuals
- Evidence of nesting/breeding behaviour

Surveys commenced at approximately 6am, and were completed by 8pm. In the case of inclement weather (strong winds or high temperatures), surveys were stopped until conditions improved. Over the four survey visits, each site was surveyed twice in the morning and twice in the afternoon. Every site was surveyed at least once in early morning (before 9am) or late afternoon (after 4pm), when bird activity was expected to be at its peak.

To estimate the effects of local habitat variables on cryptic bird abundance, information was collected about the plant species and communities that were present within each 2 ha plot (these floristic data were collected only once for each plot, during the November 2012 bird survey). Habitat and vegetation types were mapped using GIS. A full description of how this information was collected and analysed using GIS software is provided in (O'Connor et al. 2013).

Occupancy, abundance, and habitat variables

Generalized Linear Models (GLM) were used to identify which habitat variables were associated with cryptic bird occupancy and abundance in 2012 and 2013. Occupancy data (binary presence/absence data) were analysed using a binomial distribution and a logit-link function. Abundance data were

analysed using a Poisson distribution. The wetland habitat features used in these models are described in Table 1. Since the Little Bittern, Baillon's Crake, Buff-banded Rail, Dusky Moorhen and Lewin's Rail each made up less than 1% of overall cryptic bird detections (n=1-16 observations per species per year), they were not included in the habitat analyses.

To reduce the number of models to be considered for each species, two 'full' models were analysed with survey visit (8 surveys over the 2 years) as an ordinal variable. Model 1 contained all 14 habitat variables (Table 3) at the local (2 ha) scale, whereas Model 2 contained all 14 habitat variables at a broader landscape scale (within a 100m buffer zone from the centre point of the 2 ha plot). The model outputs were inspected for non-significant terms, which were removed from further analyses (Step 1). Next, 10 different models were run: one null model, one model that considered local reed cover only, one 'full' model at the local scale, one "full" model at the broader landscape scale, and 6 models that included the most likely combinations of significant variables from Step 1 (see discussion in Burnham and Anderson 2002 pages 333-334). Model selection was based on ΔAIC (Akaike Information Criteria) values that were calculated using corrected AIC values (AIC_C).

AIC_C was calculated using the equation below:

$AIC_C=AIC+\underline{2K(K+}$

ΔAIC is a measure of each model relative to the 'best' model and is calculated as:

$\Delta AIC=\Delta_i=AIC_i-minAIC.$

Only models within 2 units of the ΔAIC value were retained for further consideration (Burnham and Anderson 2002). Analyses of occupancy and abundance data were run separately.

Table 1.Details of habitat variables included in GLM analyses

	Variable
Vegetation Characteristics	Reeds
	Sedges <1m
	Sedges >1m
	Samphire
	Aquatic herbs>1m
	Aquatic Herbs<1m
	Lignum
	Aquatic ferns
	Grasses
Physical features of the site	Mudflat (wet)
	Open water
	Minimum water level in the 2 ha plot in October
	Maximum water level in the 2 ha plot in October
	% of the 2 ha plot that was inundated with water in October

Colonial-nesting waterbirds

Survey methods were repeated from (O'Connor et al. 2013), with the exception that breeding activity in both the lakes and Coorong were recorded on the same date in the 2013-14 survey period. The entire perimeter of the Lower Lakes and Coorong was again surveyed for signs of waterbird breeding activity. Survey dates are as following: October 29 2013, December 16 2013, and February 6 2014. Surveys were conducted >6 weeks apart to avoid duplicate counting of the same active nests during their incubation periods. The incubation period of all species is <5 weeks (Marchant and Higgins 1990)

Surveys were conducted from a Cessna aircraft flown at a height of 500 feet at an airspeed of 90-110 knots. Two observers trained in waterbird identification took part in each survey; each person observing activity from their side of the aircraft. Upon location of breeding colonies, one observer recorded the following data: species identity, estimated number of breeding birds present, and GPS location. The second observer took photographs of each colony, which were later used to verify species identity, number of active nests, number of non-nesting adults, and number of young (pelicans only) at each colony.

Results

Reed-dependent, "Cryptic"Waterbirds

Detection and abundance

A total of 1,474 records of cryptic birds were recorded across the four surveys undertaken in 2013. This compared with 1,951 bird recordsacross four surveys in 2012. Between 3-9 cryptic species were detected at each site in 2013 (Table 2). Table 2 shows the maximum number of each cryptic bird species observed at each site in any of the four survey months. A summary of the total number of observations of each species at each site in 2013 is provided in Appendix 1. The highest number of species (9) was detected at Clayton Bay (Figure 1;Table 2).

Table 2. Summary of the maximum number of each cryptic bird species (per month) detected at the 15 surveyed sites in 2013**.** The total number of species is also provided for each site.

	Boggy Creek	Finniss River	Goolwa**	Jacobs	Kennedy Bay	ClaytonBay	Loveday Bay	Milang Snipe	Pomanda Point	Narrung Narrows	Poltalloch	Reedy Point	Tolderol	Tookayerta	Waltowa
Australasian Bittern				2			1		1				1		
Australian Reed-warbler	5	5	10	19	1	5	7	7	11	14	1	4	13	11	6
Australian Spotted Crake		2	2			1		1	3			3	2	2	5
Baillon's Crake						2									
Buff-banded Rail						2									6
Dusky Moorhen	1		1												
Golden-headed Cisticola		5	2		9	18	3	5	8	4	1	9	16	2	4
Latham's Snipe						1	1	7				1			
Lewin's Rail	1	1			2								1	3	1
Little Bittern															
Little Grassbird	9	2	13	14	11	8	5	6	24	16	3	6	11	13	17
Purple Swamphen	16	1	10	9	3	32	4	9	16	7		1	6	1	6
Spotless Crake	1	4	5	3	1	1			4	2		2	4	8	3
Total # species	**6**	**7**	**7**	**5**	**6**	**9**	**6**	**6**	**7**	**5**	**3**	**7**	**8**	**7**	**8**

All species other than the Australian Painted Snipe were detected in at least three of the eight surveys undertaken across the two years (2012-13). The Little Bittern was detected in low numbers in 2012 (3 records), but was not observed in 2013. This species is rarely recorded in the Lower Lakes (O'Connor et al. 2013) or Lower Murray River generally, and its lack of detections in the Lower Lakes in 2013 is not necessarily a strong indicator of changes in habitat quality.

The three Passerine species (Australian Reed-warbler, Little Grassbird and Golden-headed Cisticola), and the Purple Swamphen were the most abundant species in both 2012 and 2013 (O'Connor et al. 2013), Appendix 1). These four species were detecteda total of 200-460 times between September and December 2013. The two crake species and Latham's Snipe were the next most common group, with 20-76 detections in 2013. The following species were rarely recorded in 2013 with only 2-13 observations across the four month survey period: Australasian Bittern, Baillon's Crake, Buff-banded Rail, Dusky Moorhen, and Lewin's Rail.

Of the 3238 cryptic bird records across 2012 and 2013, 27% were seen and 73% were heard. Nesting activity in 2013 was only recorded for the Purple Swamphen (2 nests with chicks), although the Australian Reed-warbler, Golden-headed Cisticola and Little Grassbird were sometimes seen carrying nesting material.

The Endangered Mount Lofty Ranges Southern Emu-wren, Stipiturus malachurus intermedius, was again recorded at the Finniss site in 2013 (although it was not a focal species for this study). 14 individual were observed over three surveys.

Table 3.**Summary of monthly and total records of each focal cryptic bird species across the 15 sites surveyed in 2013.**

Species	Sept	Oct	Nov	Dec	Total records per species
Australasian Bittern	4	3	1	0	8
Australian Reed-warbler	85	95	78	51	309
Australian Spotted Crake	13	9	7	3	32
Baillon's Crake	2	0	0	0	2
Buff-banded Rail	0	2	0	0	2
Dusky Moorhen	1	0	2	0	3
Golden-headed Cisticola	40	50	70	40	200
Latham's Snipe	0	6	5	9	20
Lewin's Rail	5	3	4	1	13
Little Bittern	0	0	0	0	0
Little Grassbird	129	127	118	86	460
Purple Swamphen	96	68	47	40	251
Spotless Crake	24	24	22	6	76
Total birds/month	399	387	354	236	

Relation of species occupancy/abundance to habitat variables

The 'best' models (ΔAIC = 0) for predicting occupancy and abundance in 2012 and 2013 used different habitat variables for each species. For example the best abundance modelfor the Australasian Bittern included only two parameters: reed

cover and visit (Table 4, Figure 2a). Abundance models for other species, such as the Australian Reed-warbler, Golden-headed Cisticola and Purple Swamphen (Figures 2b-d,), were more complex (models for all three species contained 11 parameters (Table 4)). Samphire (Figure 2e) and aquatic herb cover (>1m) and year were positivelyassociated with occupancy of Latham's Snipe, whereas reed cover had a negative effect(Figure 2f). No local habitat variables were significant predictors of Latham's Snipe abundance, possibly because this species was found at only few sites that had very different habitat characteristics (see (O'Connor et al. 2013)).

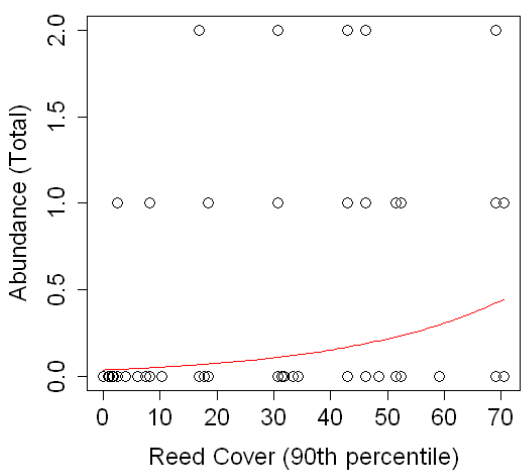
Ten GLMs included habitat variables within the 2ha study plots, and the 6 remaining models included variables within the 100m buffer zone. For example, the Spotless Crake responds to lignum cover at the broader landscape scale (buffer zone), whereas Little Grassbird abundance was positively associated with Lignum at a local (2ha) scale (Table 4).

GLMs for each species now include data from both the 2012 and 2013 surveys, hence some of the 'best models' now differ slightly from those given in (O'Connor et al. 2013). These differences should represent improvements on the original models due to increased sample sizes. An example of one change in model parameters is that the Australasian Bittern responded to reed cover in the buffer zone using 2012 data only, but was found to respond to reed cover at a local scale (2ha) using data from 2012 and 2013. This may be influenced by the repeated observation (n=3) of one individual at Loveday Bay, which has a small area of reeds within the 2ha plot, but very little outside of that area.

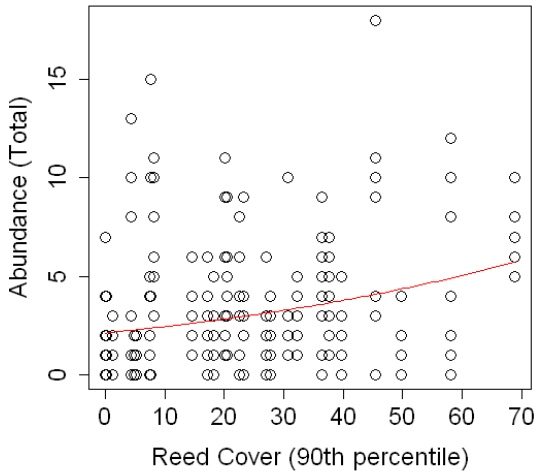
GLMs were not performed for the following species: Baillon's Crake, Lewin's Rail, Buff-banded Rail, Dusky Moorhen and Little Bittern due to the low number of detections over 2012-13. Habitat associations of these species in regard to co-occuring species are discussed in (O'Connor et al. 2013).

Table 4. Habitat relationship model results by species, in 2 ha plots (2 ha) or the 2 ha plot+ 100mbuffer zone (Buffer). *K*=number of parameters included in model. See Table 1 for descriptions of variables. Abundance and occupancy data analyses are shown. Non-significant model parameters are indicated in parentheses (probability of inclusion >.05).Parameters in bold font had a positive effect on abundance or occupancy, whereas parameters in normal font had a negative effect. The number of alternative models (where ΔAIC_c=<2; change in Akaike's Information Criterion adjusted for small sample size) are indicated in the final column, with associated model details in Appendix 2.

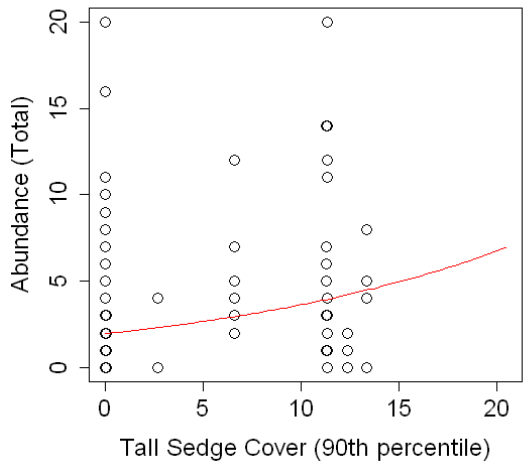
Species	Analysis	Area	Model parameters	*K*	# Alternative Models
Australasian Bittern	Abundance	2 ha	**Reeds,** Visit	2	1
	Occupancy	2ha	**Reeds**	1	0
Australian Reed-warbler	Abundance	Buffer	**Reeds,** Sedges>1m**, Samphire,** Aquatic Herbs>1m**, Aquatic Herb<1m, Mudflat, Aquatic Ferns, Grasses, % inundated, Max Water Level, Visit**	11	0
	Occupancy	2 ha	**Reeds, Aquatic Ferns**	2	0
Australian Spotted Crake	Abundance	2 ha	**Reeds, Sedges<1m, Lignum,** Year**, Visit**	5	0
	Occupancy	Buffer	**Reeds, Lignum, Month**	3	0
Golden-headed Cisticola	Abundance	Buffer	**Sedges<1m, Sedges>1m, Samphire, Aquatic Herbs>1m,** Aquatic Herbs<1m**, Lignum,** Aquatic Ferns**,** % inundated**, Max Water Level, Visit, Year**	11	0
	Occupancy	2ha	Sedges<1m, Samphire, Aquatic Herbs>1m, **Mudflat,** Aquatic Ferns,	5	1
Little Grassbird	Abundance	2 ha	**Lignum, % inundated, Min Water Level, Visit,** Year	5	0
	Occupancy	2 ha	Samphire, Visit, Year	3	0
Purple Swamphen	Abundance	2 ha	**Reeds, Sedges<1m, Sedges>1m,** Aquatic Herbs>1m**, Aquatic Herbs<1m, Lignum, Aquatic Ferns, % inundated, Year, Visit**	10	1
	Occupancy	Buffer	Sedges<1m**, Aquatic Ferns, Min Water Level,** Visit**, Year**	4	0
Spotless Crake	Abundance	Buffer	**Aquatic Herbs<1m, Lignum, % inundated**	3	0
	Occupancy	Buffer	Aquatic Herbs<1m**, Lignum, % inundated**	3	0
Latham's Snipe	Abundance	2 ha	**Full Model** Reeds, Sedges<1m, Sedges>1m, Samphire, **Aquatic Herbs>1m**, Aquatic Herbs<1m, Lignum, Open Water, Mudflat, Aquatic Ferns, Grasses, **% inundated**, Max Water Level, **Min Water Level**, **Visit**, Year	15	0
	Occupancy	2 ha	**Samphire, Aquatic Herbs>1m, Year**	3	1



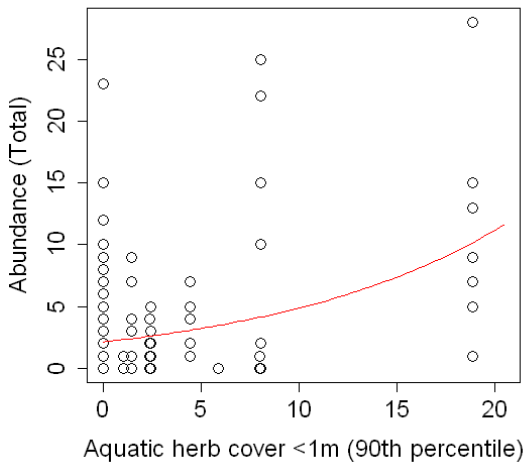
a. Australasian Bittern



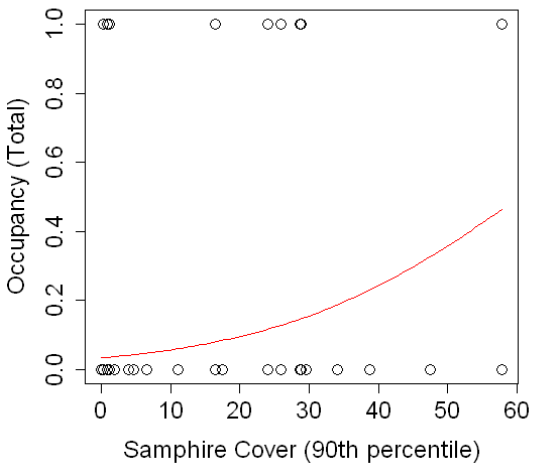
b. Australian Reed-warbler



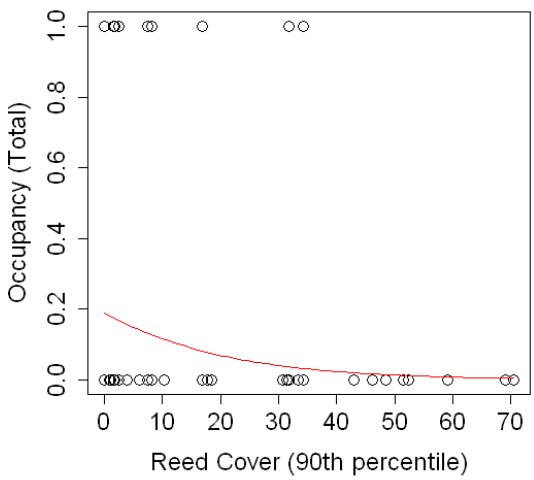
c. Golden-headed Cisticola



d. Purple Swamphen



e. Latham's Snipe



f. Latham's Snipe

Figure 2. The relationship between a) reed cover (2ha plot) and Australasian Bittern abundance, b) aquatic herb cover (2ha plot) and Purple Swamphen abundance, c) tall sedge (>1m) cover (buffer zone) and Golden-headed Cisticola abundance, d) reed cover (2 ha plot) and Latham's Snipe site occupancy, e) Samphire cover (2ha plot), and Latham's Snipe Occupancy, and f) reed cover (buffer zone) and Australian Reed-warbler abundance. Occupancy refers to whether a species was detected at the site at

each visit (0=no, 1=yes), whereas Abundance refers to the total number of each species detected per site per visit.

Colonial-nesting waterbirds

2013-2014 Survey Results

Waterbird breeding colonies were detected at five locations in the Lakes (Figure 5; Table 5) and on four different islands in the Southern Coorong (Figure 6; Table 5) between October 2013 and February 2014. The largest colonies at a single location included those of Crested Terns (1750 nests on Teal Island), Australian Pelicans (1142 nests on North Pelican Island), and Straw-necked Ibis (1555 nests at Boggy Lake). Straw-necked and Australian White Ibis commonly nested in large mixed colonies (Table 5, Figure 5).

Appendix 3 lists breeding records from the Coorong and Lakes by date and location in 2012 and 2013.

Nesting activity in the Southern Coorong could not be observed in the February 2014 survey due to inclement weather. However, on-ground and boat surveys conducted by the University of Adelaide (D. Paton), show that the large Crested Tern and Australian Pelican breeding colonies detected in aerial surveys (October and December 2013) were still active on the 9th of January 2014. 1850 Crested Tern nests were observed on Teal Island, and 620 Australian Pelican nests were recorded on North Pelican Island (D. Paton unpublished data). Of note, the University of Adelaide surveys also identified smaller colonies (2-165 nests) of Crested, Caspian, Little and Fairy Terns across 6 islands in the Coorong, which were not detected in our aerial surveys.

Trends across 2012-13 and 2013-14 survey periods

62% (8/13) of breeding locations supported active breeding colonies in both the 2012-13 and 2013-14 survey periods (Table 6). New breeding locations that were not active in the 2012-13 period include an island in the Muldungawa Salt Lakes (227 Silver Gull nests) and Goat Island (6 Royal Spoonbill nests).

Temporal patterns in species breeding activity were similar across the two survey periods. For example, ibis colonies were active in all Spring and early Summer surveys, but were inactive by February in 2013 and 2014. Pied Cormorant nesting occurred from December onwards, and Australian Pelican breeding activity was observed in all

surveys (excluding the February 2014 survey when thick cloud cover prevented observation of Southern Coorong Islands).

Royal Spoonbill nests were detected in low numbers in the lakes (≤26 nests in total) in each survey period. Fairy Tern colonies were not detected across the entire 2012-2014 survey period using the aerial survey method, even when the aircraft flew over nesting sites that were known to be to active.

Both ibis species nested in larger numbers in 2013 compared to 2012 (Table 5). Nearly twice as many straw-necked Ibis nests were observed in 2013 compared to 2012 (3664 nests and 1957 nests respectively).

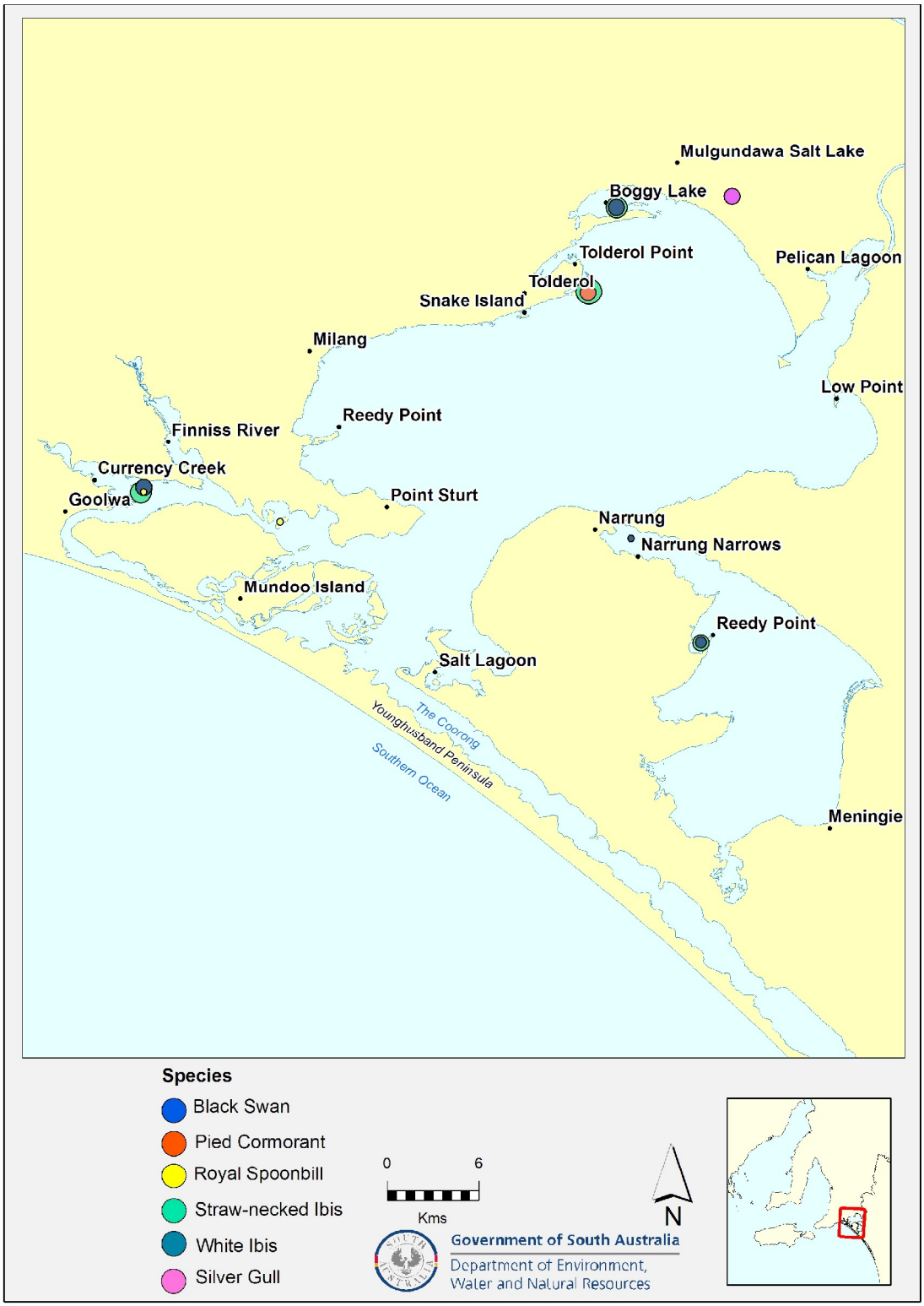


Figure 3. Distribution and abundance of waterbird breeding activity (active nests) in the Lower Lakes, October 2013- December 2013 (no active nests were observed in the February 2014 survey)

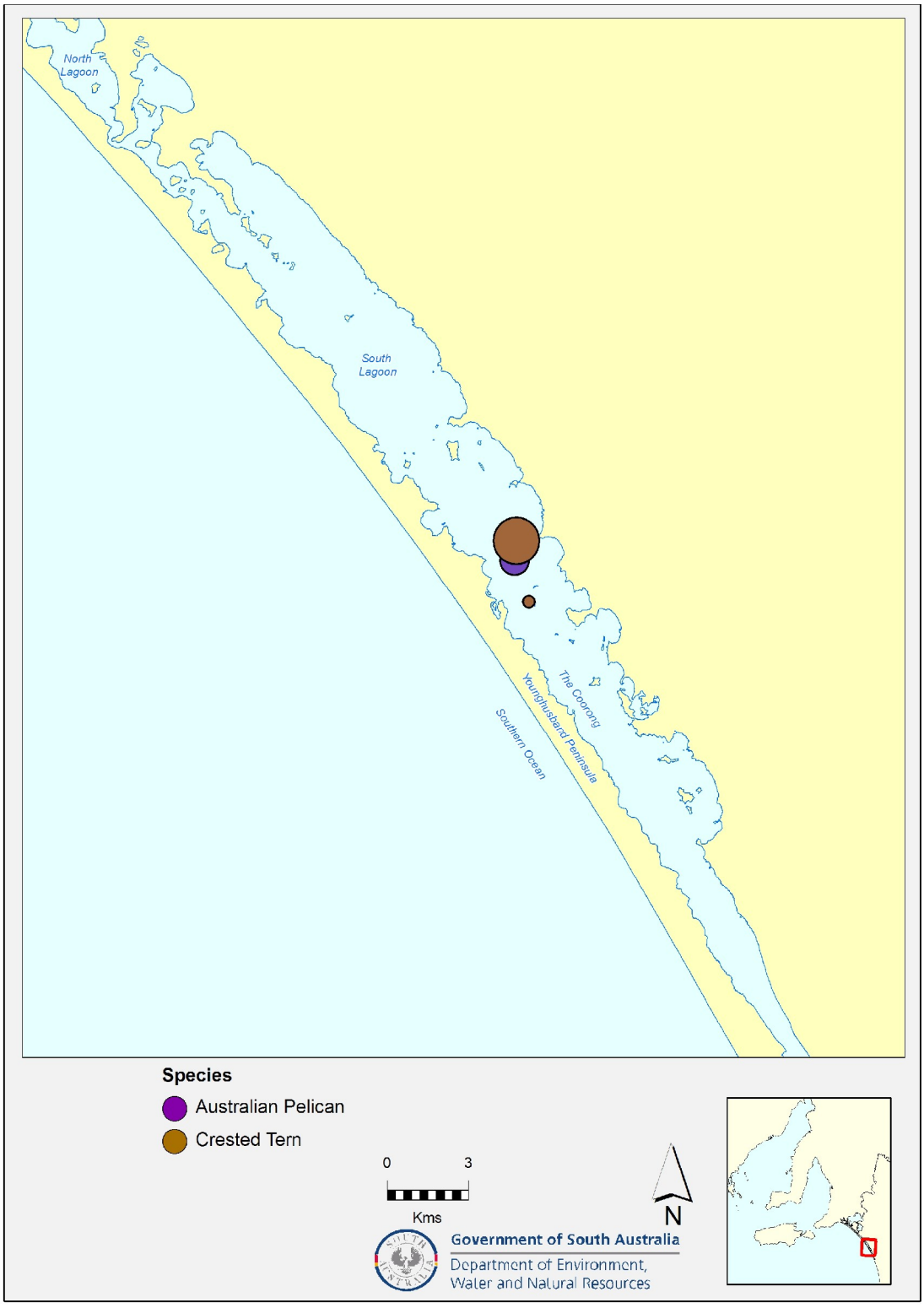


Figure 4. Distribution and abundance of waterbird breeding activity (active nests) in the Coorong, October 2013- December 2013

Table 5. Location and number of active nests (nests with incubating/brooding parent), non-nesting birds and chicks/juveniles observed in the Lakes and Coorong from October 2012 to February 2013, and October 2013 to February 2014. Counts represent cumulative numbers observed over three surveys in each 5-month survey period.

Royal Spoonbill	Lakes	Lake Albert	10	0	0	0	0	0
Silver Gull	Coorong	Muldungawa Salt Lakes	0	0	0	227	0	0
Species	**Area**	**Wetland/island**	**Active**	**Non-**	**Chicks/**	**Active**	**Non-**	**Chicks/**
Straw-necked Ibis	Lakes	Boggy Lake	606	9	0	960	100	0
Straw-necked Ibis	Lakes	Currency Creek	159	0	0	723	0	0
Straw-necked Ibis	Lakes	Lake Albert West	160	0	0	426	0	0
Straw-necked Ibis	Lakes	Tolderol Point	67	3	0	1555	0	0
Straw-necked Ibis	Lakes	Unnamed bay, west of Reedy Point, Lake Alexandrina	1032	10	0	0	0	0
Total			**9912**	**5242**	**868**	**8410**	**1910**	**705**
Australian White Ibis	Lakes	Narrung Narrows	115	0	0	48	0	0
Australian White Ibis	Lakes	Point Sturt	13	12	0	0	0	0
Australian White Ibis	Lakes	Tolderol Point	0	0	0	40	0	0
Australian White Ibis	Lakes	Unnamed bay, west of Reedy Point, Lake Alexandrina	64	5	0	0	0	0
Black Swan	Lakes	Lake Albert (East)	0	0	10	0	0	0
Black Swan	Lakes	Low Point	1	0	0	0	0	0
Black Swan	Lakes	Narrung Narrows (West)	1	0	0	0	0	0
Caspian Tern	Coorong	Pelican Island	40	5	0	0*	0*	0*
Crested Tern	Coorong	Pelican Island	4050	800	0	285*	320*	0*
Crested Tern	Coorong	Teal Island			0	1750*	50*	0*
Pied Cormorant	Lakes	Tolderol Point	916	430	3	270	800	0
Royal Spoonbill	Lakes	Currency Creek	0	0	0	20	0	0
Royal Spoonbill	Lakes	Goat Island	0	0	0	6	0	0

***Coorong South Lagoon was surveyed in October and December 2013 only (poor visibility prevented observations in February 2014), but was surveyed in all three aerial surveys in the prior observation period (14th November and 27th December 2012, and 22nd February 2013).**

Table 6. Total number of active nests observed for each waterbird species over the 2012/13 and 2013/14 survey periods.

		Total Nests	
Common Name	**Scientific name**	**2012-13**	**2013-14**
Australian Pelican	*Pelecanusconspicillatus*	2170	1142*
Australian White Ibis	*Threskiornismoluccus*	700	1046
Black Swan	*Cygnus atratus*	2	0
Caspian Tern	*Hydroprognecaspia*	40	0*
Crested Tern	*Thalasseusbergii*	4050	2035*
Pied Cormorant	*Phalacrocoraxvarius*	916	270
Royal Spoonbill	*Platalearegia*	10	26
Silver Gull	*Chroicocephalusnovaehollandiae*	0	227
Straw-necked Ibis	*Threskiornisspinicollis*	1957	3664

*Coorong South Lagoon was surveyed in October and December 2013 only (poor visibility prevented observations in February 2014).

Discussion

Cryptic Waterbirds

Surveys of cryptic waterbirds conducted in the CLLMM region in 2013-14 found that the distribution, abundance and species recorded were comparable between 2012 and 2013 . One species – the Little Bittern – that was recorded in 2012 was not recorded in 2013. However, this species is rare in the Lower Lakes, and in the Lower Murray more generally, and thus the absence of this species is highly unlikely to reflect important changes in local habitat conditions for this species. While the total number of individuals recorded was lower in 2013 than 2012 for many species, overall the pattern of distribution and abundance for cryptic waterbirds in the CLLMM did not change significantly among the two survey years.

As in 2012, the most common species recorded in this survey were the three passerine reed-dependent species (Australian Reed-warbler, Little Grassbird and Golden-headed Cisticola), and the Purple Swamphen. However, a number of regionally rare species were also recorded, including Latham's Snipe and Australasian Bittern, that suggest the CLLMM continues to provide some habitat for these threatened species, as well as the more common species.

While these patterns suggest a degree of consistency in the reed-dependent waterbird community of the CLLMM region, these data do not reflect the range of environmental conditions under which these species have been (or are likely to be) subjected to. We do not have an adequate understanding, for example, of how the recent drought that occurred in the region affected the distribution and abundance of cryptic waterbirds, although we can infer from natural history that some species were likely to have been significantly affected (e.g. Australasian Bittern). Furthermore, we have limited-no understanding of the distribution and abundance of these species prior to the drought, and so cannot judge whether the patterns we have observed over the last two years reflect longer-term patterns during "good" years, or whether these species are still in post-drought recovery (or declining). While we can indirectly draw some conclusions based on the historic distribution of key habitat features, the only way to address these issues in the future is to ensure that the past two survey years form the basis of a much longer-term monitoring program.

A final key question that these patterns highlight is: what role do the Lower Lakes ecosystems play in supporting regional populations of these cryptic species? If we are to manage fringing aquatic environments such that they support habitat for these species, what are the implications for regional or global populations? What are the implications of local loss of habitat? As for other waterbird species for which the CLLMM forms only part of their range, an understanding of the regional context within which the CLLMM operate is required to both better predict the response of these species to local intervention, and better understand the local requirements of these species within the broader context which they operate.

Colonial-nesting Waterbirds

Survey flights over the spring/summer waterbird breeding seasons of 2012-2014 have helped to provide a snapshot of colonial-nesting waterbird breeding activity in major CLLMM wetland areas. 23 colonial-nesting species have been recorded nesting in the CLLMM since 1911 (O'Connor et al. 2013), nine of which were recorded in the 2012-2014 aerial surveys.

While the species recorded breeding in 2013-14 and 2012-13 were comparable, there was some variation in the number of nests recorded between these two seasons. For species that breed in the Coorong in abundance (Australian Pelican, Crested Tern), fewer nests were recorded in 2013-14 compared with 2012-13, while for species that breed in the Lower Lakes (Australian White Ibis, Straw-necked Ibis), more nests were recorded in the latter period. The fewer nests recorded in the Coorong can at least partly be attributed to the lower survey effort in 2013-14 (weather conditions precluded a February survey). However this explanation does not preclude other environmentally driven explanations, such as changes in the availability of food in the Coorong in 2013-14 vs 2012-13, or changes in the environmental conditions of sites outside of the CLLMM between these two periods. As with the cryptic bird discussion, the drivers of breeding effort in the CLLMM requires a longer-term dataset, coupled with explicit response models for these species (such as those developed by (O'Connor et al. 2012)). While we don't necessarily have a long-term, consistently collected dataset to support our understanding of breeding responses to environmental change, we do have a collated anecdotal record of breeding waterbirds in the Coorong, that was discussed in detail in (O'Connor et al. 2013).

The aerial survey technique is particularly useful for detecting solitary/small groups of larger species, such as Royal Spoonbills, or large groups of smaller species such as Crested Terns. However, we were not able to detect nests of smaller species such as Fairy Terns, which nest in much smaller colonies than Crested Terns. Similarly, we did not detect nesting activity of solitary-nesting species such as Hooded and Red-capped Plovers or Pied or Sooty oystercatchers. Studies of these species require more intensive on-ground or boat surveys of beach and Coorong island sites in order to identify breeding activity. Oystercatcher and plover nesting at ocean beach sites is currently monitored via the BirdLife beach-nesting birds project (bi-annual), and Fairy Tern breeding success has been monitored annually by the University of Adelaide and DEWNR.

Conclusions

This study shows that the Coorong, Lower Lakes and Murray Mouth wetland habitats support significant numbers of cryptic waterbirds, and breeding activity of colonial-nesting waterbirds.

The presence and abundance of cryptic waterbirds show species-specific patterns relating to habitat assemblages at each survey site. Some species require fairly homogenous reed or samphire dominated wetlands, whereas others prefer more heterogenous assemblages of aquatic plants and other habitat features such as mudflat. Lake water levels (and therefore water delivery to the site), should therefore be maintained at levels that are will support a variety of wetland types in order to provide habitat for cryptic bird populations. Revegetation programs aimed at increasing overall wetland biodiversity could also consider the habitat preference of cryptic bird species as discussed here.

Islands in the Coorong and Lake Alexandrina and Lake Albert supported large numbers of colonial-nesting waterbirds between 2012-2014. The results of the aerial surveys represent waterbird breeding activity in a short period of relatively high water levels following almost a decade of drought. Waterbird breeding activity is closely linked to water availability, therefore the data presented here reflect breeding in relatively 'good' years. However the number of species or individuals breeding in the 2012-2014 surveys may still represent populations that are recovering from the long period of low water flows. Continued monitoring of colonial-nesting waterbirds is required in order to assess longer-term trends in response to water delivery at the site.

Appendices

Appendix 1. Summary of the number of each cryptic bird species detected at each of the 16 surveyed sites. The total number of species and observations are also provided for each site.

	Boggy Creek	Finniss River	Goolwa**	Jacobs	Kennedy Bay	Clayton Bay	Loveday Bay	Milang Snipe Sanctuary	Pomanda Point	Narrung Narrows	Poltalloch	Reedy Point	Tolderol	Tookayerta	Waltowa
Australasian Bittern	0	1	0	2	0	0	2	0	2	0	0	0	1	0	0
Australian Reed-	10	14	28	47	2	13	21	19	38	34	2	9	33	30	9
Australian Spotted	0	3	2	0	0	2	0	2	5	0	0	3	4	6	5
Baillon's Crake	0	0	1	0		0	0	0	0	0	0	0	0	0	0
Buff-banded Rail	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Dusky Moorhen	1	0	2	0	0	0	0	0	0	0	0	0	0		
Golden-headed	0	16	4	0	24	36	6	14	11	8	1	21	47	6	6
Latham's Snipe	0	0	0	0	0	1	1	17	0	0	0	1	0	0	0
Lewin's Rail	1	1	0	0	2	0	0	0	0	0	0	0	1	7	1
Little Bittern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Little Grassbird	30	4	44	44	23	22	12	10	74	47	7	23	34	31	55
Purple Swamphen	36	1	26	21	8	57	11	17	36	15	0	1	9	1	12
Spotless Crake	2	10	11	6	1	1	0	0	7	2	0	2	6	22	6
Total # species	6	8	8	5	7	8	6	6	7	5	3	7	8	7	7
Total Observations	80	50	118	120	61	134	53	79	173	106	10	60	135	103	94

Appendix 2. Alternative habitat relationship model results (ΔAIC_c=<2) by species, in 2 ha plots (2 ha) or the 2 ha plot+ 100m buffer zone (Buffer). K=number of parameters included in mode. Abundance and occupancy data analyses are shown. Non-significant model parameters are indicated in parentheses (probability of inclusion >.05).Parameters in bold font have a positive effect on abundance or occupancy, whereas parameters in normal font have a negative effect.

Species	Analysis	Area	Model parameters	*K*
Australasian Bittern	Abundance	2 ha	**Reeds,** Year	2
Golden-headed Cisticola	Occupancy	2 ha	Sedges<1m, Samphire, Aquatic Herbs>1m, Aquatic Herbs<1m, **Mudflat**	5
Purple Swamphen	Abundance	2 ha	**Reeds, Sedges>1m, Samphire, Aquatic Herbs<1m,** Aquatic Herbs>1m**, Lignum, Open Water, Mudflat, Aquatic Ferns, Grasses, % inundated,** Month	12
Latham's Snipe	Occupancy	2 ha	**Samophire, Aquatic Herbs>1m,**	2

Appendix 3. Waterbird breeding records by date and location

Date	Species	Nests	Young	Non-nesting birds	Area	Site	Latitude	Longitude
11-Nov-12	Australian Pelican	390	1790	280	Coorong	North Pelican Island	6010256	370116
27-Dec-12	Australian Pelican	360	190		Coorong	Mellor Island	6007537	371655
27-Dec-12	Australian Pelican	950	1180	280	Coorong	North Pelican Island	6010256	370116
15-Jan-13	Australian Pelican	202	188	155	Coorong	Mellor Island	6007537	371655
15-Jan-13	Australian Pelican	21	535	140	Coorong	North Pelican Island	6010256	370116
15-Jan-13	Australian Pelican	247	57		Coorong	Pelican Island	6008715	370620
29-Oct-13	Australian Pelican	830	630	30	Coorong	North Pelican Island	6010256.0	370116.0
16-Dec-13	Australian Pelican	312	75	590	Coorong	North Pelican Island	6010256.0	370116.0
10-Oct-12	Black Swan	10			Lake Albert	Lake Albert (East)	6060394.895	340441.6
10-Oct-12	Black Swan	1			Lake Albert	Narrung Narrows (West)	6067972.046	336423.2
10-Oct-12	Black Swan	1			Lake Albert	Rumply Point	6077528.323	350910
11-Nov-12	Caspian Tern	10	5		Coorong	North Pelican Island	6010256	370116
27-Dec-12	Caspian Tern	30			Coorong	Pelican Island	6008715	370620
11-Nov-12	Crested Tern	700	220		Coorong	North Pelican Island	6010256	370116
27-Dec-12	Crested Tern	3350	580		Coorong	Pelican Island	6008715	370620
29-Oct-13	Crested Tern	285		320	Coorong	Pelican Island	6008718.0	370632.4

Date	Species	Nests	Young	Non-nesting birds	Area	Site	Latitude	Longitude
16-Dec-13	Crested Tern	1750		50	Coorong	Teal Island	6010986	370184
4-Dec-12	Pied cormorant	340	250		Lake Alexandrina	Tolderol	6084024.236	333580.2
15-Jan-13	Pied cormorant	576	180	3	Lake alexandrina	Tolderol	6084149.848	333652.4
16-Dec-13	Pied Cormorant	270		800	Lake Alexandrina	Tolderol	6084084.2	333595.2
15-Jan-13	Royal Spoonbill	10			Lake Albert	Lake Albert	6060780.266	340957.7
16-Dec-13	Royal Spoonbill	20			Tributaries	Currency/Finniss	6071000.0	304461.9
16-Dec-13	Royal Spoonbill	6			Tributaries	Goat Island	6069067	313397
29-Oct-13	Silver Gull	210			Inland Wetland	Muldungawa Salt Lakes	6090395	343038
16-Dec-13	Silver gull		17		Inland Wetland	Muldungawa Salt Lakes	6090395	343038
10-Oct-12	Straw-necked Ibis	445			Lake Alexandrina	Boggy Lake	6088987.979	334753.2
10-Oct-12	Straw-necked Ibis	160			Lake Albert	Narrung Narrows (East)	6060394.895	340441.6
4-Dec-12	Straw-necked Ibis	161	9		Lake Alexandrina	Boggy Lake	6089683.377	335463.4
4-Dec-12	Straw-necked Ibis	159			Tributaries	Currency Creek	6070352.165	304626.9
4-Dec-12	Straw-necked Ibis	67	3		Lake Alexandrina	Tolderol	6084024.236	333580.2

Date	Species	Nests	Young	Non-nesting birds	Area	Site	Latitude	Longitude
4-Dec-12	Straw-necked Ibis	1032	10		Lake Albert	unnamed bay, west of Reedy Pt	6061114.906	340994.4
29-Oct-13	Straw-necked Ibis	760		100	Lake Alexandrina	Boggy Lake	6089683.4	335463.0
29-Oct-13	Straw-necked Ibis	683			Tributaries	Currency/Finniss	6070959.7	304263.5
29-Oct-13	Straw-necked Ibis	1270			Lake Alexandrina	Tolderol	6084149.8	333652.4
29-Oct-13	Straw-necked Ibis	426			Lake Albert	West Lake Albert	6061114.9	340994.4
16-Dec-13	Straw-necked Ibis		200	50	Lake Alexandrina	Boggy Lake	6089683.4	335463.0
16-Dec-13	Straw-necked Ibis	40			Tributaries	Currency/Finniss	6070959.7	304263.5
16-Dec-13	Straw-necked Ibis	285		100	Lake Alexandrina	Tolderol	6084149.8	333652.4
10-Oct-12	White Ibis	80			Lake Alexandrina	Boggy Lake	6088987.979	334753.2
10-Oct-12	White Ibis	90			Lake Alexandrina	Low Point	6077528.323	350910
10-Oct-12	White Ibis	120			Lake Albert	Narrung Narrows (East)	6060394.895	340441.6
10-Oct-12	White Ibis	30			Lake Albert	Narrung Narrows (West)	6067514.2	336678.4
4-Dec-12	White Ibis	79	28		Lake Alexandrina	Boggy Lake	6089683.377	335463.4

Date	Species	Nests	Young	Non-nesting birds	Area	Site	Latitude	Longitude
4-Dec-12	White Ibis	20			Lake Alexandrina	Boggy Lake	6089683.377	335463.4
4-Dec-12	White Ibis	47			Tributaries	Currency Creek	6071293.711	304594.6
4-Dec-12	White Ibis	72			Tributaries	Currency Creek	6070352.165	304626.9
4-Dec-12	White Ibis	10			Lake Albert	Narrung Narrows	6067085.699	335242.4
4-Dec-12	White Ibis	75			Lake Albert	Narrung Narrows	6068067.025	335506.4
4-Dec-12	White Ibis	13	12		Lake Alexandrina	Point Sturt	6071752.843	317349.5
4-Dec-12	White Ibis	64	5		Lake Albert	unnamed bay, west of Reedy Pt	6061114.906	340994.4
29-Oct-13	White Ibis	422		20	Lake Alexandrina	Boggy Lake	6089683.4	335463.0
29-Oct-13	White Ibis	446			Tributaries	Currency/Finniss	6071293.7	304461.9
29-Oct-13	White Ibis	48			Lake Albert	Narrung Narrows	6067972.0	336423.2
29-Oct-13	White Ibis	40			Lake Alexandrina	Tolderol	6084024.2	333580.2
29-Oct-13	White Ibis	90			Lake Albert	West Lake Albert	6061144.9	340994.4
16-Dec-13	White Ibis		100	100	Lake Alexandrina	Boggy Lake	6089683.4	335463.0

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