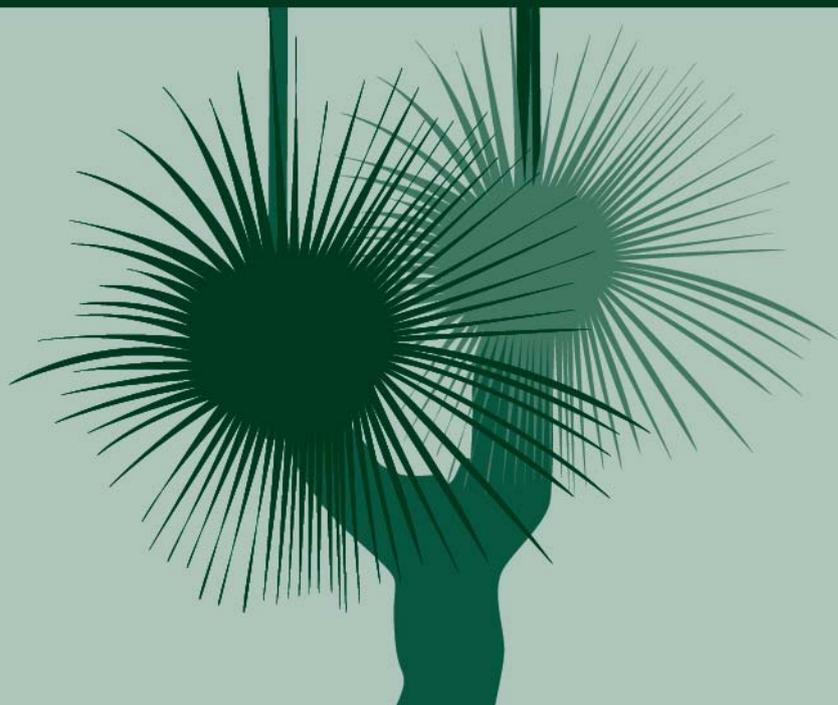


Monitoring the Ramsar status of the Coorong, Lakes and Murray Mouth: a case study using birds

Technical Report 2012/03



Department of
Environment and
Natural Resources



Government
of South Australia

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Executive Summary

The Coorong, Lower Lakes and Murray Mouth (CLLMM) site is recognised as a “Wetland of International Importance” under the Ramsar Convention. This project provides a detailed and quantitative review of the CLLMM Ramsar status using bird data. In doing so, we were able to assess whether changes in CLLMM bird communities have affected the site’s Ramsar status across years, and if current monitoring programs provide sufficient data to detect this. We also provide clarified guidelines for the application of bird data to relevant Ramsar criteria. The findings of this report can be summarised as follows:

- Ten bird monitoring datasets were available for analysis in this project, nine of which were used to justify Ramsar criteria. Annual waterbird census data were the most useful for providing total numbers of individuals across the site. Smaller, species-specific surveys within the CLLMM provided valuable breeding records and population counts for rarer species.
- CLLMM meets all five Ramsar criteria that are relevant to birds (Criteria 2-6). In particular, the CLLMM supports 15 threatened species, 15-27 species that regularly breed at the site, 57 species that are listed on migratory bird agreements, 56 species that use the site for moulting, >20,000 waterbirds every year, and >1% of the Flyway population size for 10 waterbird species.
- While Criteria 5 and 6 were regularly met by up to 16 waterbird species, six of these species (Curlew Sandpiper, Grey Teal, Hoary-headed Grebe, Red-capped Plover, and Fairy Tern) had higher populations in 1985 (South Lagoon only) compared to recent annual population sizes across the entire CLLMM site (2000-2012). This highlights the limitations of Ramsar criteria for detecting potentially critical bird declines within the CLLMM.
- In order to rigorously assess Ramsar criteria using bird data, it is recommended that future monitoring efforts should include: a total census of all waterbird species across the site (annual), species-specific population surveys for threatened birds, and breeding activity surveys for a broader range of species that regularly breed at the site.

This information can be used to update the Ramsar Information Sheet in an upcoming revision of the Ecological Character Description of the CLLMM. It also provides important preliminary data that can be used to define thresholds of acceptable change for CLLMM bird communities.

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Introduction

Background

The Coorong, Lower Lakes and Murray Mouth (CLLMM) region was listed as a “Wetland of International Importance” under the Ramsar Convention in 1985. As a contracting partner to the Ramsar Convention, Australia has made a commitment to plan for the sustainable use of this wetland in order to maintain its ecological character.

The CLLMM Ramsar site is ranked as South Australia’s most important wetland and Australia’s fourth most important wetland in terms of the numbers of waterbirds that it supports (Kingsford et al. 2012). Maintaining the range and quality of wetland bird habitat is highly dependent on the system receiving sufficient flows from the River Murray. These flows contribute to CLLMM water levels, which in turn influence food availability and habitat connectivity for birds (Paton 2010). Reduced water flows to the CLLMM due to upstream over-allocation of water resources have resulted in habitat declines (Paton 2010; Kingsford et al. 2011). This decline was evident at least 20-30 years before listing and continues until the present day (Phillips and Muller 2006; Paton 2010).

Numerous studies show that CLLMM waterbird numbers have also declined over at least the past 20 years (Rogers and Paton 2008; Wainwright and Christie 2008; Kingsford and Porter 2009; Paton et al. 2009; Paton and Rogers 2009b; Paton 2010; Thiessen 2011). In Australia’s commitment to maintain the ecological character of this wetland (DEH 2000), we are obliged to monitor and report on significant changes in bird communities utilising the CLLMM, and use these changes to guide management of the site (DEWHA 2008). There is a requirement to determine whether changes in CLLMM bird communities have affected the Ramsar status of the site across years, and assess whether current monitoring programs provide sufficient data to detect this.

In order to maintain the integrity of Australian Ramsar wetlands and detect changes in ecological character, it is recommended that an Ecological Character Description (ECD) be produced for each site (DEWHA 2008). The ecological character of the CLLMM Ramsar site was described by Phillips and Muller (2006). This was produced before the establishment of the new national framework for developing Ecological Character Descriptions (DEWHA 2008), and a recent technical review (Butcher 2011) found that several key sections do not meet the standards in the framework and require updating. In particular, the 2006 ECD is lacking quantitative information to demonstrate how the CLLMM qualifies against each of the Ramsar criteria (Butcher 2011).

The Ramsar Convention currently uses nine criteria to identify a “Wetland of International Importance”- at least one of which needs to be met for a site to be listed. Phillips and Muller (2006) presented lists of species and communities to demonstrate that CLLMM qualified for each criterion, but rarely included actual data (such as population numbers), or clearly described the data sources used. Despite being revised five times since their official adoption in 1980 (Ramsar Convention Undated), most Ramsar criteria retain ambiguous language and/or lack well defined quantitative thresholds for their application. This effectively leaves these criteria open to subjective interpretation, and has contributed to inconsistent methods for justifying Australian and International wetlands under the convention. This could be

partially addressed by managers or authors explicitly and transparently documenting their interpretation of criteria and how assessments are undertaken.

The Department of Environment and Natural Resources (DENR) is currently updating the CLLMM Ecological Character Description so that it conforms to DEWHA (2008) and includes new information following significant new monitoring and research in the region. DENR intends to provide an updated version by 2016 for endorsement by the Australian government. There is a need for clearly articulated rationale for interpreting and applying the current (2005) Ramsar criteria within the context of the new ECD framework. Clear, documented, less ambiguous interpretation of Ramsar guidelines and the presentation of suitable data will help to indicate where “certain benefits and values of the wetland that might be lost as a result of change in the ecological character” (Ramsar Convention 2011). Quantitative data in the form of bird population numbers can also be used to identify “Limits of Acceptable Change” during the development of the updated ECD. Limits of Acceptable change are thresholds that identify acceptable variation in a particular feature of ecological character (Phillips and Muller 2006; DEWHA 2008).

Although multiple government and research groups collect bird data in the CLLMM, these studies are not specifically designed with the aim of addressing Ramsar criteria per se. Most resulting reports and research papers examine population changes within sub-sets of the bird community within specific areas of the site. These studies therefore have limited use for assessing the Ramsar status of the entire CLLMM. In this report, we have consolidated and assessed all available datasets to determine which data is suitable for meeting Ramsar criteria. Thus an important outcome of this project will be to describe bird-monitoring strategies that will improve the rigour of CLLMM Ramsar assessments in the future.

Aims and Objectives

- 1) Clarify the current definitions of Ramsar criteria 2-6 and provide clear definitions for ambiguous terms and concepts, particularly as they relate to an assessment of the CLLMM site.
- 2) Assess whether the CLLMM site currently meets the criteria set out in the strategic framework for listing Wetlands of International Importance.
- 3) Review current bird monitoring programs in terms of their ability to address Ramsar criteria.

Methods

Ramsar Criteria

The Ramsar convention currently uses nine criteria for identifying “Wetlands of International Importance”, at least one of which needs to be met for a site to be listed (Ramsar Convention 2011). The first criteria were officially adopted under the Ramsar Convention in 1980 but were revised in 1987, 1990, 1996, and again in 2005 when the current criteria were implemented. Table 1 shows the criteria and justification used to list the CLLMM in 1985, and Table 2 lists the current (2005) Ramsar criteria. The 1985 Ramsar Information Sheet (RIS) contains comparatively little information to demonstrate how the criteria have been met. This is not unexpected given the role of the RIS, but it poses a challenge when retrospectively describing and assessing the ECD of the site.

Table 1 Description of the criteria met by the CLLMM at the time of listing (taken from 1985 RIS).

Basis	Number	Description	Justification (1985)
Specific criteria based on waterfowl	1a	It regularly supports 10,000 ducks, geese and swans; or 10,000 coots or 20,000 waders.	Ducks and waders
	1b	It regularly supports 1% of the individuals in a population of one species or subspecies of waterfowl.	Cape Barren Goose
	1c	It regularly supports 1% of the breeding pairs in a population of one species or subspecies of waterfowl.	Black Swan
General criteria based on plants and animals	2a	It supports an appreciable number of rare, vulnerable or endangered species or subspecies of plant or animal.	Cape Barren Goose
	2b	It is of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna.	Unique ecological significance of Coorong complex
	2c	It is of special value as the habitat of plants or animals at a critical stage of their biological cycle.	Important pelican and other waterbird breeding areas
	2d	It is of special value for one or more endemic plant or animal species or communities.	Hypersaline Lagoon Community, e.g. musk grass (<i>Lamprothamnium papulosum</i>)
Criteria for representative or unique wetlands	3	It is a particularly good example of a specific type of wetland characteristic of the region.	Hypersaline Lagoon (Southern Coorong), Freshwater Lake (Lakes Alexandrina and Albert).

This report focuses on evaluating the five current Ramsar criteria that are applicable to birds (Criteria 2-6), and not the remaining four criteria which pertain to either wetland type (Criterion 1), fish ecology (Criteria 7-8), or non-avian species (Criterion 9)(Table 2).

Table 2 Current Ramsar criteria as given in the 2011 Ramsar Manual.

Criteria 2-6 (shaded) will be assessed in this report using bird data.

<p>Group A of the criteria Sites containing representative, rare or unique wetland types</p>		<p>Criterion 1: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.</p>
<p>Group B of the criteria Sites of international importance for conserving biodiversity</p>	<p>Criteria based on species and ecological communities</p>	<p>Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.</p>
		<p>Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.</p>
		<p>Criterion 4: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.</p>
	<p>Specific criteria based on waterbirds</p>	<p>Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.</p>
		<p>Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.</p>
	<p>Specific criteria based on fish</p>	<p>Criterion 7: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.</p>
		<p>Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.</p>
	<p>Specific criteria based on other taxa</p>	<p>Criterion 9: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.</p>

Clarifying Ramsar Guidelines for the CLLMM

The first objective of the project is to provide clear guidelines for the use of Ramsar criteria 2-6 within the context of the CLLMM. The guidelines developed here are based on those given in the Ramsar Strategic Framework (Ramsar Convention 2009) and are revised from those presented by Philips and Muller (2006). A review of how Ramsar guidelines are interpreted and applied in 20 other Australian wetlands was also undertaken to inform guideline development. The technical recommendations made by Butcher (2011) focused on improving the 2006 CLLMM ECD as part of the development of a new national framework for Ecological Character Descriptions (DEWHA 2008). To clarify ambiguous terms this report provides a glossary (page 20) that is adapted from the Ramsar strategic framework (Ramsar Convention 2006).

Only wetland-dependent species are used to justify Ramsar criteria in this report. Wetland dependency ratings are based on those given by Ecological Associates (2010), and D. Rogers (pers obs). Information on non-wetland dependent species are provided in Appendix 1.

The criteria used for assessing the CLLMM Ramsar site may also be useful for assessing other Ramsar sites.

Criteria are presented in the following format:

- 1) brief description of Ramsar Criterion,
- 2) clarified guidelines for the assessment of each criterion (Ramsar Convention 2011)
- 3) recommendations for improving the presentation of Ramsar information based on a technical review (Butcher 2011) of the 2006 CLLMM Ecological Character Description (Phillips and Muller 2006)(see below).

Criterion number:

Brief description of Ramsar Criterion

Ramsar guidelines for the Criterion:

To qualify for this criterion, the CLLMM must:

- a. Description of critical criteria or sub-criteria that must be met. These guidelines are based on that presented in the Ramsar manual but are clarified to aid interpretation.

In addition:

2. Further guidelines for the assessment of critical criteria are given here.

Butcher (2011) recommendations for the Criterion:

- Recommendations based on Butcher's (2011) technical review of Ramsar information presented in the 2006 CLLMM Ecological Character Description (Phillips and Muller 2006).

Assessment of Waterbird Data with Regard to Ramsar Criteria

An evaluation of the data required to address Ramsar Criteria 2-6, and a summary of the data that are available for analysis is presented in Table 3. Datasets that were identified as being potentially useful for meeting criteria include ten bird survey datasets as well as species conservation and migratory status lists. A summary of the methods used for each of the ten bird surveys are provided in Table 4.

Table 3. Summary of data required to address Ramsar Criteria 2-6, and the data that are available for analysis.

Required data	Crucial for Criteria:	Supports Criteria:	Available datasets/information
Presence/Absence of bird species	2,3 & 4		<ul style="list-style-type: none"> - Birds Australia - David Paton's total population census - David Dadd's point count surveys
Bird population numbers	5 & 6	2,3 & 4	<ul style="list-style-type: none"> - Australian Wader Study Group (AWSG) wader population census - Orange-bellied parrot survey - Mount Lofty Ranges Southern Emu-wren survey
Conservation status of threatened birds	2 & 3		<ul style="list-style-type: none"> - Regional Species Status Assessments: South East Region (Gillam and Urban 2011)
Bird breeding records	4	2 & 3	<ul style="list-style-type: none"> - Beach-nesting Birds Project (Birds Australia): 4 species - Fairy Tern survey - Malleefowl survey - Australian Pelican survey - Literature search & expert opinion - Mount Lofty Ranges Southern Emu-wren survey
Migratory status of bird species	4		<ul style="list-style-type: none"> - Lists of species included under the following agreements: ROKAMBA, JAMBA, CAMBA, CMS, and list of migratory species under the EPBC act
Bird species that use the site for drought refuge	4		<ul style="list-style-type: none"> - Literature search & expert opinion
Bird species that use the site for moulting	4		<ul style="list-style-type: none"> - Literature search & expert opinion

Population survey data

Four multi-species population count datasets were available for this project (see Table 4 for a summary of data collection methods). The uses and limitations of the four datasets were evaluated (Table 5), and three datasets were chosen to be used for further analysis: David Paton's total census data, David Dadd's point count survey data, and Birds Australia's presence/absence data. Included in this project are data that were collected up to and including February 2012.

Annual total population census provides a snapshot of the total number of birds for all waterbird species in the Coorong (Jan, 2000-12) and Lower Lakes (Jan, 2009-12). These count data were used to justify/support all five Criteria. Monthly point count surveys provide data on the number of birds observed across 64 points around the CLLMM water edges. This dataset was used to justify/support Criteria 2 & 3, and December data was used to justify Criterion 5. The Birds Australia dataset and species-specific surveys (Table 4) were used to detect records of rarer species to justify/support Criteria 2, 3 & 4.

Breeding data

Breeding data was obtained from 5 datasets: The Beach Nesting Birds Project (Birds Australia), as well as species-specific surveys for: Fairy Terns, Australian Pelicans, Mount Lofty Ranges Southern Emu-wren and Malleefowl (Table 4). Additional data on bird breeding were obtained through literature searches and consultation with experts (e.g. D. Dadd (Coorong Nature Tours), C. Manning and D. Rogers (DENR)).

Table 4. Summary of data collection methods for all datasets used within this review.

Dataset	Years	Timing*	Months/ year	# Days	Sites (# sites)**	Location within CLLMM	Survey type	Survey method/area	Data recorded	Data used in this report.	Ref
Birds Australia	1896-2006	M.	10-12	~1-7	LAX, LAB, NL, SL	Lake edges -East/West Coast of Coorong	4 options see Barrett et al. (2003)	Observed-no method stated (BDBSA)	Species presence (not numbers) of all bird species.	Bird records (Criteria 2 & 3)	Barrett et al. (2003)
David Dadd (Coorong Nature Tours)	2001-2012 (see site info)	M.***	8-12	4-7	LAX (22), Lab (8), NL (24): 2003-12 SL(10): 2001-12	-Lake edges -East Coast Coorong (all on foot)	Point Count (Spatially irregular)	Birds observed over a 1.5km arc for 30mins/site.	Number of individuals for each waterbird species.	December count data, 2003-2011 (Criteria 2, 3 & 5)	Theissen (2011)
David Paton (Adelaide University)	1985, 2009- 12 (see "Sites" column)	An.	1 (Jan)	8-17	LAX, LAB: 2009-12 NL:2000-12, SL: 1985, 2000-12	-Lake edges -East/West Coast of Coorong (foot) -Central Lagoon + islands (boat)	Total census	1km sections (in 3 components: land shoreline, sea shoreline, lagoon centre).	Number of individuals for each waterbird species.	All data (Criteria 2,3,4,5,6)	Rogers & Paton (2009)
Australian Wader Study Group (AWSG)	1981-82 1987 2000-8 2010-12	An.	1 (Feb)	2	NL (17), SL (14)	-East/West Coast of Coorong (boat or foot)	Total census	26 sections of either the East or West coast. Sections are ~5- 12km long	Number of individuals for wader species only.		Wainwright & Christie (2008)
Beach-nesting Birds Project (Birds Australia)	2008 2010 2011	Bi. & An.	1 (Nov) & 8	1 & 1	MM, YHP	-Ocean beaches Between MM and 42 Mile Crossing	Total census & Breeding survey	Count completed by buggy + foot. Highest # of obs is 'best' estimate.	Number of individuals & breeding activity for Hooded & Red-capped Plovers, Sooty & Pied Oystercatchers	Breeding data (Criteria 3 & 4)	Beach-nesting Birds Project (BirdLife Australia)
Fairy Tern Survey	1997,1999, 2008-2012	An. count, M. breeding surveys	Sep-Apr	1-2	NL, SL, MM, YHP. 10 sites.	-East/West Coast of Coorong (boat) -Ocean beaches (foot)	Total census & Breeding survey	Systematic census via land & boat (annual, but done 3 times over 2011/12), then breeding surveys until fledging.	Number of Fairy Terns & breeding activity.	Breeding data (Criterion 4)	Baker-Gabb & Manning (2011)
Malleefowl Survey	1996-2012	An.	1	2	SL	-East Coast Coorong (mallee scrub).	Total census & Breeding survey	Grid search (31 grids across SA, 1x 3.6km ² grid in Coorong).	Number of Mallee Fowl & breeding activity.	Breeding data (Criterion 4)	Gillam (2011)
Orange-bellied Parrot Survey	1979-2012	An.	1 Winter	2	LAX, Lab, NL, SL	-Lake edges -East/West Coast of Coorong	Total census (non- breeding season)	Opportunistic sightings, no standard method.	Number of Orange-bellied parrots.	Count data (Criterion 2)	
Australian Pelican Survey	2006-2012	M.	Up to 12	~1-2	NL, SL	-Pelican Islands	Total census & Breeding survey	Complete counts on islands.	Number of Pelicans & breeding activity.	Breeding data (Criterion 4)	DENR (2010 and 2011)
Mount Lofty Ranges Southern Emu-wren Survey	1993-2011	An. or Bi.	Up to 12	~1-2	Goolwa Tributaries	Currency Creek and Finniss River	Point census & Breeding Survey	Area-search or transect presence/ absence surveys. Song playback used.	Number of MLR Southern Emu-wrens and breeding activity	Breeding and count data (Criteria 2 & 4)	

Some surveys are conducted on a national or state-wide basis; however site information is reported for surveys within the CLLMM Ramsar boundaries only. **Timing* is classed as Annual (An.), Biennial (Bi.) or Monthly (M.), **Lake Alexandrina (LAX), Lake Albert (LAB), North Lagoon (NL), South Lagoon (SL), Murray Mouth (MM), Youngusband Peninsula (YHP), *** No data collected in the following locations, years & months: South Lagoon : 2001 (Jan, Feb, Mar, May, Jun, Jul, Sep, Nov), 2002 (Jan, Mar, May, Jul, Sep or Nov), 2003 (Jan, May, Jul, Sept), 2004 (May, Jul, Sep), 2005 (May, Jul, Sep, Oct), 2006-2009 (Jun, Jul); North Lagoon: 2003 (Jan, Feb, Apr, Jul, Sep), 2004 (May, Jul, Sep), 2005 (May, Jul, Sep, Oct), 2006-2008 (Jun, Jul). Lakes: 2005 (Jul, Oct), 2006-2011 (Jun, Jul)

Table 5. Comparison of the four multi-species population surveys within the CLLMM for use in assessing Ramsar criteria.

Dataset	Survey type	Used for Criteria:	Usefulness of dataset for this project	Limitations of dataset
David Paton	Total census of all waterbirds.	2,3,4,5,6	<ul style="list-style-type: none"> • Gives an annual “snapshot” of the total abundances of all waterbird species across all sites. • Includes a 1985 census (South Lagoon only). 	<ul style="list-style-type: none"> • Restricted to one annual count in Jan and cannot detect temporal differences in bird abundance. For example, Dadd’s data shows that peak bird abundance varies between Sept-March across years. • The Coorong has been surveyed since 2000, but the Lower Lakes have only been surveyed since 2009.
David Dadd	Point count census of all waterbirds.	2,3,5	<ul style="list-style-type: none"> • The only survey that collects monthly data for all waterbird species, and therefore captures temporal variation in peak bird abundance (across all sites). 	<ul style="list-style-type: none"> • Difficult to accurately calculate total population estimates from point counts because they are taken at spatially irregular intervals. • Raw bird count data therefore does not reflect “total” population numbers, and are best reported as a “minimum” population size or purely used for relative comparisons across years. • The timing and frequency of surveys have not been consistent across years. For example counts were conducted in 4-12 months of the year since 2001. The north lagoon was not surveyed until 2003. Gaps in data collection probably reflect lack of funding during these time periods.
AWSG	Total census of wader species only.	none	<ul style="list-style-type: none"> • Includes a 1981 and 1982 census. 	<ul style="list-style-type: none"> • Data should show similar trends to that collected by Paton. • Counts are limited to 34 wader species, hence the dataset lacks information on other important waterbirds (i.e. pelicans, cormorants and Anatidae species), which fit the Ramsar Criteria. • Counts are restricted to the Coorong only (Lower Lakes are excluded).
Birds Australia	Presence /absence of all bird species	2,3	<ul style="list-style-type: none"> • Contains records from 1896 onwards. 	<ul style="list-style-type: none"> • The data shows presence/absence of bird species but not population counts. • Methods for data collection are not stated.

Results

Ramsar guidelines and an assessment of Criteria 2-6.

The following section provides guidelines for the application of bird data to Ramsar Criteria 2-6, and presents qualitative and quantitative evidence to show how each Criterion is met.

Criterion 2

“A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.”

Ramsar guidelines for Criterion 2:

To qualify for this criterion, the CLLMM must:

3. Support at least one **species** or **community** that is listed as Vulnerable, Endangered or Critically Endangered under:
 - a. **National legislation:** EPBC act.
 - b. **International frameworks:** IUCN Red List, Appendix I of CITES.

In addition:

4. Species must be **wetland dependent** and **non-vagrant**.
 - a. Based on ecological records and/or expert opinion

Butcher (2011) recommendations for Criterion 2:

- Provide a list (species and common names) and an assessment on the strength of evidence that a species uses the site, i.e. give details of sightings, + likelihood that habitat is critical for the species.

The CLLMM meets Criterion 2 because:

1. it supports 4 wetland-dependent bird species that are listed under National legislation and International frameworks (Table 6). An additional 8 non wetland-dependent species that meet this criterion are shown in Appendix 1a.

Table 6. Criterion 2: wetland-dependent species that are listed as Vulnerable, Endangered or Critically Endangered under National legislation and International frameworks.

IUCN RedList or EPBC status is shown as CR (Critically Endangered), EN (Endangered), or VU (Vulnerable). IUCN criteria for allocating categories of extinction risk are shown in parentheses.

Scientific name	Common name	IUCN	EPBC	CITES	Records	Habitats and Site Usage
<i>Neophema chrysogaster</i>	Orange-bellied Parrot	CR(C2b)	CR	I	Last record: 4 birds in 2011, Western shores of Lake Alexandrina ¹ .	Uses non-breeding sites in the Coorong. Preferred habitat is <10km from coast (Orange-bellied Parrot Recovery Team 2006).
<i>Botaurus poiciloptilus</i>	Australasian Bittern	EN (C1)	EN	-	Last record: 7 birds in 2012 ²	Occurs mainly in densely vegetated reed habitat (freshwater) in the Lower Lakes (Seaman 2003).
<i>Stipiturus malachurus intermedius</i>	Mount lofty Ranges Southern Emu-wren	-	EN	-	Last record: 3 birds in 2011 ³	Approximately 250ha of the swamp habitat used by this species is within the Ramsar area (T. Vale, pers. comm in Phillips and Muller 2006).
<i>Sternula (Sterna) nereis</i>	Fairy Tern	VU (C1)	VU	-	Last record: 362 birds in 2012 (mainly South Lagoon) ⁴	Breeding colonies (>50 nests + fledglings) on Southern Coorong islands 2011/12 ⁵

¹ Orange-bellied parrot survey, ² CLLMM monthly point count survey, ³MLR Southern Emu-wren survey, ⁴ CLLMM annual total census, ⁵Fairy Tern survey

Criterion 3

“A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.”

Ramsar guidelines for Criterion 3:

To qualify for this criterion, CLLMM must meet at least one of the following sub-criteria:

1. Demonstrates high species richness and/or species diversity.
2. Supports significant numbers of endemic species (high endemic species richness).
3. Supports the majority (>50%) of species or habitat types found in the bioregion.
4. Supports species adapted to special environmental conditions of the site (such as temporary wetlands in semi-arid or arid areas).
5. Supports species that are listed as threatened under state legislation and/or regional listings (this is the only sub-criterion currently applied to the CLLMM site).

Butcher (2011) recommendations for Criterion 3:

- Needs to be set in the context of the bioregion and not only concerned with species of conservation significance.
- Each of the Ramsar criteria should be addressed and comparisons to other sites in the Murray Darling Basin should be made.
- Need to emphasise the site as supporting biodiversity values representative of the bioregion.

The CLLMM meets Criterion 3 because it:

- 1. Demonstrates high species richness**
 - a. The CLLMM Ramsar site supports high bird species richness. BDBSA records 307 bird species within 1km of the CLLMM Ramsar site, 119 of which utilise wetland habitat (Ecological Associates 2010). CLLMM also supports the highest waterbird species richness and abundance of any of the six Living Murray Icon Wetland sites (Barmah-Millewa; Gunbower-Koondrook-Pericoota; Hattah Lakes, Chowilla-Lindsay-Wallpolla; Lower Lakes-Coorong-Murray Mouth; River Murray Channel)(Kingsford and Porter 2008). For example, an aerial survey in 2007 found that the CLLMM site supported 92% of the ~250,000 waterbirds counted across all six icon sites, and contained 44 of the 46 waterbird species surveyed (Kingsford and Porter 2008; Kingsford and Porter 2009).
- 3. Supports the majority of species or habitat types found in the bioregion.**
 - b. The CLLMM contains the majority of waterbird species that occur in the Murray Darling bioregion. Aerial surveys of 6 wetland sites across the bioregion found that the CLLMM contained 96% (44 of 46) and 84% (38 of 45) of surveyed waterbird species in 2007 and 2008 respectively (Kingsford and Porter 2008; Kingsford and Porter 2009).
- 5. Supports species that are listed as threatened under state legislation and/or regional listings** (the only sub-criterion that has previously been applied to the CLLMM).
 - c. The CLLMM supports 11 species of birds that meet this sub-criterion (Table 7). Conservation ratings are based on Gillam and Urban (2011).

The following two sub-criteria are not met:

- 2. Supports significant numbers of endemic species (high endemic species richness).**
 - a. CLLMM supports only one locally endemic species: The Mount Lofty Ranges Southern Emu Wren (*Stipiturus malachurus intermedius*), and is therefore not considered to meet this sub-criterion. Most individuals of this species are known to occur outside of the Ramsar boundary (pers. com. M. Pickett)

4. Contains species adapted to special environmental conditions of the site
 b. CLLMM is a permanent wetland, does not contain any species that are restricted to the site, and is therefore not considered to meet this sub-criterion.

Table 7. Criterion 3: wetland-dependent species that are listed as VU (Vulnerable) or EN (Endangered) under state legislation (NPW Act) or CR (Critically Endangered), EN (Endangered), VU (Vulnerable) under Regional listings.

Scientific name	Common Name	NPW listing	Region listing	Most recent record	% years (n) species recorded 2000-2012	Habitats and Site Usage
<i>Sternula (Sterna) albifrons</i>	Little Tern	EN	CR	1 bird in 2008 ¹	31% (4) ^{1,2}	Prefers sheltered coastal environments around the Coorong and Murray Mouth (Seaman 2003).
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	EN	EN	6 birds in 2012 ¹	69% (9) ^{1,2}	CLLMM site is an important foraging area for sub-adult sea eagles (Denis et al. 2011).
<i>Rostratula australis (benghalensis)</i>	Australian Painted Snipe	VU	CR	2 birds in 2002 ²	8% (1) ²	Uses terrestrial shallow freshwater wetlands and samphire swamps within the region (Seaman 2003).
<i>Cladorhynchus leucocephalu</i>	Banded Stilt	VU	VU	>11,000 birds in 2012 ¹	100% (13) ^{1,2,3}	Common across the North & South Lagoon. Opportunistic breeding when brine shrimp present (e.g. 2006).
<i>Numenius madagascariensis</i>	Eastern Curlew	VU	EN	11 birds in 2012 ¹	100% (13) ^{1,2,3}	Forage in shallow water/ along the water edge in the Coorong and Murray Estuary.
<i>Stictonetta naevosa</i>	Freckled Duck	VU	VU	37 birds in 2012 ³	69% (9) ^{1,2,3}	Uses freshwater habitat around Lakes Albert and Alexandrina and Salt Creek.
<i>Thinornis rubricollis</i>	Hooded Plover	VU	EN	21 birds in 2012 Coorong beaches ⁴	100% (13) ^{1,2,3,4}	Breeds on Youngusband Peninsula beaches ⁴ . A few records from salt lake at the southern end of the system; e.g. Pipeclay Lake, Swan Lake (pers. obs. D. Rogers).
<i>Lewinia (Rallus) pectoralis</i>	Lewin's Rail	VU	EN	2 birds in 2010 ³	54% (7) ^{1,2}	Uses densely vegetated, fresh, brackish or saline wetlands with the CLLMM site (Seaman 2003).
<i>Anas rhynchotis</i>	Australasian Shoveler	RA	NT	19 birds in 2012 ¹	100% (13) ^{1,2,3}	Uses freshwater habitat around Lakes Albert and Alexandrina, and the Murray Estuary.
<i>Oxyura australis</i>	Blue-billed Duck	RA	VU	4 birds in 2012 ¹	69% (9) ^{1,2,3}	Uses freshwater habitat around Lakes Albert and Alexandrina and Salt Creek.
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	RA	VU	4 birds in 2012 ¹	100% (13) ^{1,2,3}	Uses beach habitat on Youngusband Peninsula and at the Murray Mouth ⁴ .

¹ CLLMM annual total census, ² Birds Australia, ³ CLLMM monthly point count survey, ⁴ Beach Nesting Birds Project

Criterion 4

“A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.”

Ramsar guidelines for Criterion 4:

To qualify for this criterion, CLLMM must support birds that use the site for at least one of the following purposes:

1. Migration
2. Breeding events
3. Drought refuge
4. Moulting

Guidelines for using Criterion 4 sub criteria (see sections 83-84 of the Ramsar Convention (2011))

1. **Migratory birds** included within the following international agreements: JAMBA, CAMBA, ROKAMBA, CMS (if spp. is within Annex 1- Endangered), and the list of migratory species under the EPBC act.
2. Bird species that regularly **breed** at the site (3 out of 5 years on average).
3. Bird species that use the site as a **drought refuge**.
4. Non-migratory species that are unable to evade adverse climatic conditions and use the site as **critical refugia**. Include continental nomadic species that breed opportunistically in inland wetlands (wet years) and move to permanent water sources (CLLMM) when central lakes are dry.
5. Species that regularly use the site for **moulting** (3 out of 5 years on average).

Butcher (2011) recommendations for Criterion 4:

- Information on Criterion 4 needs to be consolidated into one section
- Include details on the size of any notable breeding events.

The CLLMM meets Criterion 4 because it supports birds that use the site for:

1. Migration

- a. 57 wetland-dependent species are listed within international and national migratory agreements (Table 8). An additional 3 non wetland-dependent species are shown in Appendix 1b.

2. Breeding events

- a. 15 species are known to breed regularly at the site (Table 9). One additional non wetland-dependent species that regularly breeds at the site is shown in Appendix 1c. An additional 11 species that probably breed regularly at the site, but are data-deficient, are shown in Appendix 2.

3. Drought refuge

- a. Bird species that breed in large numbers at Lake Eyre after high rainfall events but breed in the CLLMM in lower numbers during drier years include: Australian Pelican, Grey Teal, Silver Gull, and Caspian Tern (Kingsford and Porter 1993; BirdLife International 2012). Other species that rely on the Coorong and Lower Lakes for adult survival when inland lakes are dry include the Red-necked Avocet (pers. comm. D. Rogers), Chestnut Teal, Australian Shelduck (Delroy 1974), and Banded Stilt (Paton et al. 2011).

4. Moulting

- a. At least 56 birds regularly use the CLLMM site as critical refugia while moulting. The Australian Shelduck, Chestnut Teal and Black Swan (Paton 2010) drop all of their flight feathers at once and use permanent Coorong

wetlands as refuge during their period of flightlessness (Paton 2010). Other waterbird species also use the CLLMM site as refuge while they gradually (a few at a time) replace their flight feathers over a period of about 3 months during Summer/Autumn (Paton 2010). Australian waterbirds that use the CLLMM for this purpose include: Banded and Black-winged Stilts, Red-necked Avocets, and Australian Pelicans (Paton 2010). All international migrants gradually replace their flight feathers upon landing at the site in summer (Paton 2010) and therefore qualify for this sub-criterion- see the 49 species listed under ROKAMBA, JAMBA and CAMBA agreements in Table 8.

Table 8. Criterion 4: bird species that are listed on International and National Migratory agreements.

Included are species that are listed on the: Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), the Convention on Migratory Species (CMS), and the list of migratory species under the EPBC act (EPBC).

Family	Scientific name	Common Name	Agreements
ACANTHIZIDAE	<i>Cygnus atratus</i>	Black Swan	CMS
ACCIPITRIDAE	<i>Himantopus himantopus</i>	Black-winged Stilt	CMS, EPBC
ACCIPITRIDAE	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	CAMBA, EPBC
ANATIDAE	<i>Anas rhynchotis</i>	Australasian Shoveler	CMS, EPBC
ANATIDAE	<i>Tadorna tadornoides</i>	Australian Shelduck	CMS, EPBC
ANATIDAE	<i>Cereopsis novaehollandiae</i>	Cape Barren Goose	CMS, EPBC
ANATIDAE	<i>Anas castanea</i>	Chestnut Teal	CMS, EPBC
ANATIDAE	<i>Biziura lobata</i>	Musk Duck	CMS, EPBC
ARDEIDAE	<i>Ardea ibis</i>	Cattle Egret	JAMBA, CAMBA, EPBC
ARDEIDAE	<i>Ardea modesta (alba)</i>	Eastern Great Egret, (White Egret)	JAMBA, CAMBA
CHARADRIIDAE	<i>Charadrius bicinctus</i>	Double-banded Plover	CMS
CHARADRIIDAE	<i>Charadrius leschenaultii</i>	Greater Sand Plover	ROKAMBA, JAMBA, CAMBA, EPBC
CHARADRIIDAE	<i>Pluvialis squatarola</i>	Grey Plover	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
CHARADRIIDAE	<i>Thinornis rubricollis</i>	Hooded Plover	CMS,
CHARADRIIDAE	<i>Charadrius mongolus</i>	Lesser Sand Plover	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
CHARADRIIDAE	<i>Charadrius veredus</i>	Oriental Plover	ROKAMBA, CMS, EPBC
CHARADRIIDAE	<i>Pluvialis fulva</i>	Pacific Golden Plover	ROKAMBA, CMS, EPBC
COLUMBIDAE	<i>Anas gracilis</i>	Grey Teal	CMS
GLAREOLIDAE	<i>Vanellus miles</i>	Masked Lapwing	CMS
LARIDAE	<i>Hydroprogne (Sterna) caspia</i>	Caspian Tern	CAMBA, EPBC
LARIDAE	<i>Sterna hirundo</i>	Common Tern	ROKAMBA, JAMBA, CAMBA, EPBC
LARIDAE	<i>Thalasseus (Sterna) bergii</i>	Crested Tern	JAMBA
LARIDAE	<i>Sternula (Sterna) albifrons</i>	Little Tern	ROKAMBA, JAMBA, CAMBA, EPBC
LARIDAE	<i>Chlidonias leucopterus</i>	White-winged Black Tern	JAMBA, CAMBA, EPBC
MELIPHAGIDAE	<i>Erythrogonys cinctus</i>	Red-kneed Dotterel	CMS
ROSTRATULIDAE	<i>Rostratula australis (benghalensis)</i>	Australian Painted Snipe	CAMBA, EPBC
SCOLOPACIDAE	<i>Limosa lapponica</i>	Bar-tailed Godwit	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Limosa limosa</i>	Black-tailed Godwit	ROKAMBA, JAMBA CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Limicola falcinellus</i>	Broad-billed Sandpiper	ROKAMBA, JAMBA,

Family	Scientific name	Common Name	Agreements
			CAMBA, EPBC
SCOLOPACIDAE	<i>Tringa nebularia</i>	Common Greenshank	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Tringa totanus</i>	Common Redshank	ROKAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Actitis hypoleucos</i>	Common Sandpiper	ROKAMBA, CAMBA, CMS
SCOLOPACIDAE	<i>Calidris ferruginea</i>	Curlew Sandpiper	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Numenius madagascariensis</i>	Eastern Curlew	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Calidris tenuirostris</i>	Great Knot	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Phalaropus fulicarius (fulicaria)</i>	Grey Phalarope	CAMBA, EPBC
SCOLOPACIDAE	<i>Tringa (Heteroscelus) brevipes</i>	Grey-tailed Tattler	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Gallinago hardwickii</i>	Latham's Snipe	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Numenius minutus</i>	Little Curlew	ROKAMBA, JAMBA, CAMBA, EPBC
SCOLOPACIDAE	<i>Calidris minuta</i>	Little Stint	ROKAMBA
SCOLOPACIDAE	<i>Calidris subminuta</i>	Long-toed Stint	ROKAMBA, JAMBA, CAMBA, EPBC
SCOLOPACIDAE	<i>Tringa stagnatilis</i>	Marsh Sandpiper	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Calidris melanotos</i>	Pectoral Sandpiper	ROKAMBA, JAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Calidris canutus</i>	Red Knot	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Phalaropus lobatus</i>	Red-necked Phalarope	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Calidris ruficollis</i>	Red-necked Stint	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Arenaria interpres</i>	Ruddy Turnstone	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Philomachus pugnax</i>	Ruff	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Calidris alba</i>	Sanderling	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Xenus cinereus</i>	Terek Sandpiper	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Tringa incana</i>	Wandering Tattler	ROKAMBA, JAMBA, CAMBA, CMS
SCOLOPACIDAE	<i>Numenius phaeopus</i>	Whimbrel	ROKAMBA, JAMBA, CAMBA, CMS, EPBC
SCOLOPACIDAE	<i>Tringa glareola</i>	Wood Sandpiper	ROKAMBA, JAMBA, CAMBA, EPBC
SYLVIIDAE	<i>Acrocephalus australis</i>	Australian Reed Warbler, (Clamorous Reed-Warbler)	ROKAMBA, CAMBA, EPBC
SYLVIIDAE	<i>Acrocephalus arundinaceus</i>	Great (Oriental) Reed-Warbler	CAMBA, EPBC
THRESKIORNITHIDAE	<i>Plegadis falcinellus</i>	Glossy Ibis	CAMBA, EPBC

Table 9. Criterion 4: species that regularly breed (3 out of 5 years on average) within the Coorong, Lower Lakes and Murray Mouth Ramsar site.

Breeding frequency is listed as “regular” (3 out of 5 years on average) according to expert opinion if sufficient breeding records are not available. Annual breeding records are only available for species with annual breeding surveys, or species with obvious breeding behaviour that can be detected during annual population censuses.

Scientific name	Common Name	Breeding Freq.	Breeding Records	Sites	Notes
<i>Pelecanus conspicillatus</i>	Australian Pelican	Annual	Active nests with eggs & chicks recorded in 2006, 2009, 2010, 2011, 2012 ^{1,2}	Teal, North Pelican, Pelican & Seagull Islands (South Lagoon).	Historic breeding: unspecified Coorong islands in 1929, 1932, 1935, 1937, 1962-63, (Chapman 1963) & Pelican Island in 1986 ² .
<i>Threskiornis molucca</i>	Australian White Ibis	Regular	Nests in 2011 ³ Breeds annually at Snake Island (Eckert 2000).	Lakes Alexandrina & Albert	
<i>Cygnus atratus</i>	Black Swan	Annual	Cygnets recorded 2010-2012 ³	Goolwa channel, Lakes Alexandrina & Albert	Historic breeding records: 1910's to 1930's (White 1918; Paton 2010)
<i>Hydroprogne (Sterna) caspia</i>	Caspian Tern	Regular	Regular breeding activity (Paton 2010). Nests & chicks in 1997; juveniles recorded in 2009 ^{3,4}	South Lagoon islands	
<i>Anas castanea</i>	Chestnut Teal	Regular	2011: 6 juveniles in census ³ . Regular breeding in the Finniss Estuary (Eckert 2000).	Lakes Alexandrina & Albert	
<i>Sternula (Sterna) nereis</i>	Fairy Tern	Annual	Nesting activity recorded 1997, 1999, 2008 & 2009-2012 ^{1,4,5} . >50 active nests in 2012 ⁵ .	South Lagoon islands & Murray Mouth.	Annual breeding surveys. Breeding success dependent on prey availability (hardyhead fish) close to predator-free nesting islands.
<i>Thalasseus (Sterna) bergii</i>	Greater Crested Tern	Annual	>1000 pairs per year (Paton, 2010). >900 nests with eggs in 1997, fledged young recorded in 2009 ^{4,5}	South Lagoon islands	
<i>Thinornis rubricollis</i>	Hooded Plover	Annual	Nesting activity recorded annually 2002-2012 ⁴	Ocean beaches, occasionally coastal saline wetlands	Annual surveys for breeding activity.
<i>Anas superciliosa</i>	Pacific Black Duck	Regular	Juveniles recorded in Lake Alexandrina 2011 ³	Lakes Alexandrina & Albert	
<i>Phalacrocorax varius</i>	Pied Cormorant	Regular	2007: breeding at Lake Albert (Kingsford and Porter 2008). 2011: 420 large nestlings at Lake Alexandrina ³ . Regular breeding at Lake Alexandrina (Eckert 2000).	Lakes Alexandrina & Albert	Historic records: South Lagoon islands, 1930's (Sutton 1933), & Snake Island, 1980 ²
<i>Haematopus longirostris</i>	Pied Oystercatcher	Regular	Juveniles in 1997 ^{4,5} . Nests in 2002 ⁴ , & 2011 (per obs. D. Rogers).	Youngusband Peninsula beaches, Murray Mouth ⁵ , Coorong islands (Paton 2010)	
<i>Charadrius ruficapillus</i>	Red-capped Plover	Regular	Regular breeding (Paton 2010). Nests in 2011 (pers obs. D. Rogers).	Youngusband Peninsula beaches & Murray Mouth.	Historic record: nest with eggs in 1931 (Sutton 1931)
<i>Platalea regia</i>	Royal Spoonbill	Regular	Nests in 2011 ³ . Regular breeding at Snake Island (Eckert 2000).	Lakes Alexandrina & Albert	Historic breeding records near Snake Island 1978 ²
<i>Chroicocephalus novaehollandiae</i>	Silver Gull	Regular	Regular breeding activity (Paton 2010)	South Lagoon islands.	Historic breeding records (Sutton 1931)

Scientific name	Common Name	Breeding Freq.	Breeding Records	Sites	Notes
<i>Threskiornis spinicollis</i>	Straw-necked Ibis	Regular	2007: breeding at Lake Albert (Kingsford and Porter 2008). 2011: 160 nestlings at Lake Alexandrina ³ . Regular breeding at Snake Island (Eckert 2000).	Lakes Alexandrina & Albert	Historic breeding records near Snake Island 1978 ²

¹ Data sourced from South Australian Department for Environment and Natural Resources Database of SA. Recordset number DENRBDBSA120123-1, ² Australian Pelican Survey, ³ David Paton CLLMM census, 2011, ⁴ Beach-nesting Birds Project (Birds Australia), ⁵ Fairy Tern Survey, ⁶ Malleefowl Survey

Criterion 5

“A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.”

Ramsar guidelines for Criterion 5:

To qualify for this criterion, the CLLMM must:

1. Support **>20,000 birds in 3 out of 5 years on average.**

In addition:

2. To be included under this criterion, each **species must regularly (at least 3 in 5 years on average) account for at least 1,000 individuals (5% of 20,000),** irrespective of season.

Butcher (2011) recommendations for Criterion 5:

- Actual count data must be presented
- Graph data to indicate the concept of regularly supports.

The CLLMM meets this criterion because:

- Annual census data shows that 71,000-329,000 birds are supported within the CLLMM Ramsar site across years (Tables 10 & 11, Figure 1).
 - Appendix 3 presents data to explain the contribution of one species (Banded Stilt) to high waterbird abundances in 2009.
 - Appendix 4 includes a brief discussion of population trends for individual species.

Table 10. Criterion 5: species that contribute to total waterbird abundances of >20,000 individuals per year using January total census data.

CLLMM Counts above 1000 individuals are indicated in bold font. Species that were not listed in the 1985 RIS are indicated with an asterisk.

Survey (month)	Scientific name	Common name	South Lagoon Only	Coorong Only									Coorong and Lower Lakes				% Years qualify since 2000
			1985	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
David Paton (Jan)	<i>Pelecanus conspicillatus</i>	Australian Pelican	6045	4672	5656	4072	2924	2918	2293	3203	3124	1575	5425	7384	7260	8987	100% (13)
	<i>Tadornis tadornoides</i>	Australian Shelduck	6059	4630	8581	2738	8201	8315	8536	20461	2613	6148	28483	41203	31849	29688	100% (13)
	<i>Cladorhynchus leucocephalus</i>	Banded Stilt	6208	2354	15475	14774	6762	6356	32305	74859	64552	23470	213109	49448	18054	11691	100% (13)
	<i>Cygnus atratus</i>	Black Swan	676	2600	2500	1227	3488	1012	706	1764	1529	1807	1782	3400	4381	2767	92% (12)
	<i>Anas castanea</i>	Chestnut Teal	660	7312	15293	21228	13143	17123	7149	13318	3037	5258	7073	5049	5149	8681	100% (13)
	<i>Calidris ferruginea</i>	Curlew Sandpiper*	9449	8157	2324	3633	2364	1830	2188	4513	5073	1642	938	1988	217	50	77% (10)
	<i>Thalasseus bergii</i>	Greater Crested Tern	6687	4941	4800	2783	1300	2767	5638	1908	8564	4016	7719	11958	4090	7140	100% (13)
	<i>Anas gracilis</i>	Grey Teal	59113	10811	17901	39510	30607	11435	12260	11077	5068	5443	19644	21388	1026	46910	100% (13)
	<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe	16766	8461	3069	2983	2324	2432	2636	4949	4419	4435	14961	9120	0	7403	92% (12)
	<i>Charadrius ruficapillus</i>	Red-capped Plover	2158	1223	1638	625	1576	769	474	1094	1245	1393	2729	1598	73	1320	69% (9)
	<i>Calidris ruficollis</i>	Red-necked Stint	29020	25524	27047	28413	43300	33752	23606	37207	17478	13930	44050	48671	6605	21284	100% (13)
	<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	6013	13022	4399	13335	17473	10135	11581	33897	10046	12069	25693	31086	178	5681	92% (12)
	<i>Larus novaehollandiae</i>	Silver Gull	4090	7756	10418	7909	8474	5218	8118	16398	6479	5448	14017	13618	17668	11239	100% (13)
<i>Chlidonias hybridus fluviatilis</i>	Whiskered Tern	2656	4660	4603	3163	3593	3913	4569	17259	7549	5416	14718	9070	235	12172	92% (12)	
Total waterbird abundance per year (>20,000 waterbirds)			155600	106123	123704	146393	145529	107975	122059	241907	140776	92050	400341	254981	96785	175013	

Table 11. Criterion 5: Additional species that contribute to total waterbird abundances of >20,000 individuals per year using December point count data.

Counts above 1000 individuals are indicated in bold font. Species that were not listed in the 1985 RIS are indicated with an asterisk. These point count data do not represent total population counts and should instead be interpreted as “minimum” population sizes.

Survey (month)	Scientific name	Common name					Coorong and Lower Lakes									% Years qualify since 2003
			1985	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
David Dadd (Dec)	<i>Fulica atra</i>	Eurasian Coot*					5706	4522	1372	7960	3222	458	57	7	4241	67% (6)
	<i>Phalacrocorax carbo carbooides</i>	Great Cormorant					1519	1880	2700	1526	2286	959	152	5067	5815	78% (7)
	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant					1542	1391	1123	3810	2250	230	802	1368	3336	78% (7)
	<i>Recurvirostra novaehollandiae</i>	Red-necked Avocet					3256	749	1344	6012	1056	1459	23	42	1412	78% (7)
Total waterbird abundance per year (>20,000 waterbirds)							12023	8542	6539	19308	8814	3106	1034	6484	14804	

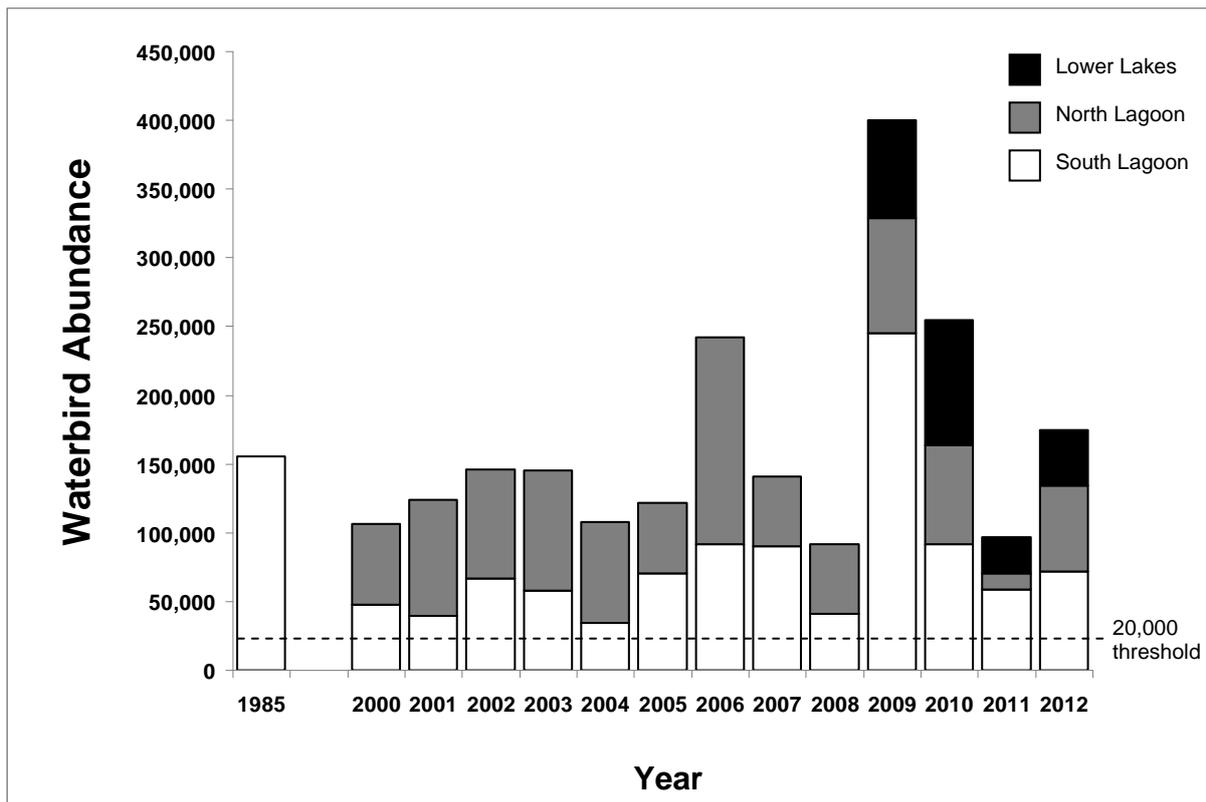


Figure 1. Waterbird abundance per year at the CLLMM Ramsar site.

Shown are data for 14 species that qualify for Criterion 5 using annual total census data. Note that 1985 data is for the South Lagoon only, 2000-2008 data is from the Coorong only (South Lagoon and North Lagoon), and 2009-2012 is for the Coorong and Lower Lakes.

Criterion 6

“A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.”

Ramsar guidelines for Criterion 6:

To qualify for this criterion, the CLLMM must:

1. Support 1% of the Flyway population size of at least one waterbird species

In addition:

2. Indicator species should:
 - a. Represent at least 1% of the Flyway population in 3 out of 5 years on average.
3. Provide the following information:
 - a. Global population estimates*
 - b. Flyway population estimates*
 - c. CLLMM population numbers

*Global and Flyway estimates accessed via Wetlands International's "Waterbird Population Estimates" (online download)(Appendix 5) .Last estimates reported in 2006.

Butcher (2011) recommendations for Criterion 6:

- Justification should include illustration of each species “regularly supporting” 1% of their population- best done as a series of graphs, which illustrate the 1% estimate
 - o *Note that data is presented in a table and not as a series of graphs in this report due to the large number of species that qualify for Criterion 6.*

The CLLMM meets this criterion because:

- Annual census data shows that 1% of the Flyway population of 10 waterbird species are regularly supported within the CLLMM Ramsar site (Table 12).

Glossary of terms (adapted from Ramsar glossary):

“Regularly” (Criteria 5 & 6)

- The requisite number of birds is known to have occurred in two thirds of the seasons for which adequate data are available (over at least 3 seasons).

“Supports” (Criteria 2, 4, 5 & 6)

- Provides habitat for the species.
 - Habitat is important to the species for any period of time.
- Occupation of the habitat need not be continuous.
 - May be dependent on natural phenomena: flooding/drought etc.

“Waterbird” (Criteria 5 & 6)

- "birds ecologically dependent on wetlands" (Article 1.2). This definition thus includes any wetland bird species. However, at the broad level of taxonomic order, it includes the following especially (only orders found within the CLLMM are listed):
 - grebes: *Podicipediformes*;
 - wetland related pelicans, cormorants, darters and allies: *Pelecaniformes*;
 - herons, bitterns, storks, ibises and spoonbills: *Ciconiiformes*;
 - screamers, swans, geese and ducks (wildfowl): *Anseriformes*;
 - wetland related raptors: *Accipitriformes* and *Falconiformes*;
 - wetland related cranes, rails and allies: *Gruiformes*;
 - wetland related jacanas, waders (or shorebirds), gulls, skimmers and terns: *Charadriiformes*;
 - coucals: *Cuculiformes*; and
 - wetland related owls: *Strigiformes*;

Table 12. Criterion 6: Species for which 1% of the East Asian-Australasian Flyway population are supported by CLLMM wetlands.

Global population sizes and flyway estimates (Appendix 4) are based on the latest (4th) edition of Wetland International's "Waterbird Population Estimates". For international migrants, 1% flyway estimates were included for populations and subspecies with breeding/wintering/core non-breeding ranges within Australia. Shown are data from total annual waterbird censuses (see Table 4). Counts that are above the 1% Flyway population estimate are indicated in bold. Species that were not listed in the 1985 RIS are indicated with an asterisk.

Scientific name	Common name	1% Population	1985	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	% Years qualify since 2000
<i>Haematopus longirostris</i>	Australian Pied Oystercatcher	110	142	115	165	157	216	159	168	220	113	145	206	186	131	130	100% (13)
<i>Tadornis tadornoides</i>	Australian Shelduck	2,400	6059	4630	8581	2738	8201	8315	8536	20461	2613	6148	16461	25416	17551	29688	100% (13)
<i>Cladorhynchus leucocephalus</i>	Banded Stilt	2,100	6208	2354	15475	14774	6762	6356	32305	74859	64552	23470	213013	49448	18054	11691	100% (13)
<i>Hydroprogne (Sterna) caspia</i>	Caspian Tern	20	329	531	1362	782	664	227	415	856	359	153	267	219	375	1531	100% (13)
<i>Anas castanea</i>	Chestnut Teal	1,000	660	7312	15293	21228	13143	17123	7149	13318	3037	5258	6419	4747	4713	8681	100% (13)
<i>Calidris ferruginea</i>	Curlew Sandpiper*	1,800	9449	8157	2324	3633	2364	1830	2188	4513	5073	1642	872	962	217	50	69% (9)
<i>Sterna nereis nereis</i>	Fairy Tern*	25	1330	632	687	349	385	175	326	283	279	439	301	326	164	362	100% (13)
<i>Calidris ruficollis</i>	Red-necked Stint	3,200	29020	25524	27047	28413	43300	33752	23606	37207	17478	13930	20323	17533	6505	21284	100% (13)
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	1,600	6013	13022	4399	13335	17473	10135	11581	33897	10046	12069	16455	17836	146	5681	92% (12)
<i>Larus novaehollandiae</i>	Silver Gull	5,500	4090	7756	10418	7909	8474	5218	8118	16398	6479	5448	10274	10134	14839	11239	85% (11)

Discussion

Guidelines for Applying Ramsar Criteria

This study of birds in the CLLMM site recognised that a number of Ramsar criteria were poorly defined or ambiguous, limiting the accuracy of any assessment of Ramsar status. This limitation has also been confounded in past assessments of the CLLMM site by a lack of quantitative data for determining bird population patterns and trends. Thus the clarified guidelines presented here provide a more concise and logical format for the presentation of relevant data.

Ramsar Criteria 2, 5, and 6 are straightforward to interpret due to the relatively unambiguous guidelines and/or quantitative thresholds already provided by Ramsar (Ramsar Convention 2011). However, one issue is that assessment of the 1% Flyway threshold provided for Criteria 5 relies on the Global and Flyway population numbers provided by Wetlands International. Unfortunately, these have not been updated since 2006 and may not be entirely accurate.

Some components of Criteria 3 and 4 were the most difficult to clarify because of the ambiguous language and lack of thresholds provided for these criteria within Ramsar guidelines. For example, Ramsar guidelines for Criterion 3 recommend including sites that are “‘hotspots’ of biological diversity and are evidently species-rich”. The term ‘hotspot’ can be interpreted specifically as a site that contains at least 1,500 species of vascular plants (> 0.5 percent of the world’s total) as endemics, and has lost at least 70 percent of its original habitat (Mittermeier et al. 1999). This definition cannot be applied to CLLMM.

Secondly, species richness is a widely used concept in ecology because it seems to provide a simple measure of biodiversity. Unfortunately, this simplicity is illusory due to debate about a range of issues such as the species concept and different sampling approaches and challenges (Magurran 2004). The Ramsar guidelines do not define a threshold for “high” species richness, leaving it open to interpretation. We have had to rely on presenting the raw data (i.e. counts from the SA biological database) and on making a comparison between the CLLMM site and six Living Murray Icon Wetland sites to establish a pattern of high species richness.

Similarly the term “supports” is used ambiguously in regard to qualifying species against Criteria 2, 4, 5, & 6. According to the Ramsar glossary, a wetland “supports” species by providing habitat for them for any period of time. Hence a species may only need one vagrant record within the site to qualify under these criteria and may not actually have any dependency on CLLMM habitat. We have interpreted ‘supports’ in this broad sense to provide evidence against Criteria 2, 4, 5 and 6, but have listed any non wetland-dependent species within the appendices.

A review of other Ramsar Information Sheets for listed Australian wetlands shows that the poorly defined criteria with ambiguous language (particularly 3 & 4), are usually poorly justified, with little data used for support. To use the Bool Lagoon RIS as an example, no actual breeding records are provided to verify the 29 “regularly breeding” bird species that are incorrectly used to justify Criterion 3, nor the 48 breeding species that were also used to justify Criterion 4. Similarly, the Pittwater-Orielton Lagoon RIS incorrectly lists migratory birds under Criterion 3 instead of Criterion 4.

Conversely, the quantitative thresholds provided in Criteria 5 & 6 generally encourage the presentation of population numbers for relevant bird species, and will be useful for comparing trends across years.

In conclusion, this project has attempted to provide the best possible clarification and interpretation of these guidelines considering the limitations of the actual criteria.

Evaluation of knowledge gaps and recommendations for monitoring

The evaluation of knowledge gaps is based on a review of how current bird monitoring programs can be utilised to address Ramsar criteria.

Monitoring programs within the CLLMM consist of four multi-species population surveys and six localised species-specific population surveys (five of which systematically collect breeding data)(Table 4). This project has identified the data that is required in order to accurately address Ramsar Criteria 2-6, and whether current monitoring programs provide adequate data within this context (Table 13). In order to produce rigorous assessments of the CLLMM Ramsar status, future and continued monitoring programs should aim to fill knowledge gaps identified in this report. The methodology of CLLMM bird monitoring programs should follow a consistent and rigorous approach to data collection, with particular consideration as to how and why the data will be analysed.

Population counts

The annual total waterbird census dataset was the most useful for evaluating the CLLMM Ramsar status and were used to justify all five criteria. The three other bird survey datasets may be useful in other contexts, but lack at least one of the following benefits: 1) total census counts, 2) counts for all waterbird species, 3) surveys across the entire CLLMM site (Tables 4 & 5).

Knowledge gaps and some data overlap are evident within the four multi-species population surveys (Tables 4 & 5), the efforts of which could be realigned to systematically conduct population counts across an optimal temporal and geographical range (Table 13).

A knowledge gap for population counts is that monthly population counts are not always conducted consistently during the crucial period for detecting peak bird population

abundance (September-March), making it difficult to assess temporal differences in bird abundance for different species.

Breeding data

Current breeding surveys are generally species and location-specific, and are only conducted for 9 of the 27 species that breed in the CLLMM (Table 9). Detailed accounts of breeding activity and nest location exist for iconic species such as the Fairy Tern (Baker-Gabb and Manning 2011), and Australian Pelican (DENR 2010, 2011). However, cryptic species, such as those that inhabit dense reed beds, remain largely unstudied (Appendix 2). In particular, the Australasian Bittern is the only nationally threatened species in the CLLMM for which we have little understanding and no regular assessment of its ecology (particularly breeding ecology). Another nationally threatened species, the Mount Lofty Ranges Southern Emu Wren, is surveyed for population numbers and breeding activity throughout its range from the Mount Lofty Ranges to Fleurieu Peninsula.

A knowledge gap for breeding surveys is that they are not conducted for all of the species that regularly breed within the region (see Table 9 & Appendix 2). To fully understand the role of CLLMM as a bird-breeding habitat, a broader range of locations and species need to be monitored. Information collected should include: species identity, location, breeding activity type (based on BDBSA method numbers & descriptions), and (if possible) breeding outcome.

Table 13. CLLMM bird data requirements for assessing Ramsar Criteria 2-6.

Ramsar Criteria	Need to identify:	Minimum data requirements	Minimum monitoring requirements (methods)	Monitoring requirements currently met	Knowledge gaps
2	2a) Nationally &/or internationally threatened bird species.	2a) Presence/absence of listed birds and evidence that these species regularly use CLLMM habitat.	2a) Surveys for the presence/absence of threatened bird species.	2a) 3 species: Orange-bellied parrot ¹ , Fairy Tern ² , Mount Lofty Ranges Southern Emu-wren ³	2a) Australasian Bittern
3	3a) High bird species richness. 3b) Endemic species. 3c) Presence of locally threatened species.	3a-c) Presence/absence of bird species. 3c) Current status of species under state legislation or regional listings.	3a,b) Surveys for the presence/absence of bird species. 3c) Annual population counts of threatened species (species-specific censuses) to show that these species are regularly present.	3a,b) Multiple species ^{4, 5, 6, 7} 3c) 2 species: Hooded Plover & Sooty Oystercatcher ⁸	3c) 9 species: Little Tern, White-bellied Sea Eagle, Australian Painted Snipe, Banded Stilt*, Eastern Curlew, Freckled Duck, Lewin's Rail, Australasian Shoveler, Blue-billed duck <i>* well represented in annual total waterbird censuses and may not require a species-specific program.</i>
4	4a) Migratory bird species 4b) Species that use the site for drought refuge 4c) Breeding activity 4d) Moulting events	4a) Migratory status of bird species. 4a,b) Presence/absence of bird species. 4c) Numbers and locations of breeding pairs and/or nests. 4b-d) Information on bird ecology and/or life history strategies.	4a,b) Surveys for the presence/absence of bird species. 4c) Weekly or monthly surveys within critical periods to document breeding activity. 4d) Opportunistic records of moulting events during other surveys. 4b-d) Improved ecological information	4a) 57 migratory species listed in Table 8 ^{4, 5, 6, 7} 4b) 7 species: Australian Pelican ¹⁰ , Australian Shelduck, Caspian Tern, Chestnut Teal, Grey Teal, Red-necked Avocet, Silver Gull ^{4, 5, 6, 7} 4c) 7 species: Australian Pelican ¹⁰ , Fairy Tern ² , Hooded Plover ⁸ , Malleefowl ⁹ , Mount Lofty Ranges Southern Emu-wren ³ , Pied Oystercatcher ⁸ , Sooty Oystercatcher ⁸	4b) Ecological data examining the role of the CLLMM as a drought refuge. Many more species may qualify for this sub-criterion. 4c) 20 species: Australian White Ibis, Black Swan, Caspian Tern, Chestnut Teal, Greater Crested Tern, Pacific Black Duck, Pied Cormorant, Red-capped Plover, Royal Spoonbill, Silver Gull, Straw-necked Ibis, Australasian Bittern, Australian Reed-Warbler, Dusky Moorhen, Eastern Great Egret, Golden-headed Cisticola, Grey Teal, Musk Duck, Nankeen Night Heron, Purple Swamphen. 4d) all Anatidae species
5	5a) >20,000 waterbirds at the site per year 5b) Species with population sizes >1000 individuals in 3 out of 5 years on average	5-6. Population counts for all waterbird species.	5-6) Annual population counts (total census of all waterbird species during the same month each year).	5-6) All waterbird species ⁴	
6	6a) >1% of the individuals flyway population of a species at the site- in 3 out of 5 years on average				

¹ Orange-bellied parrot survey, ² Fairy Tern survey, ³ Mount Lofty Ranges Southern Emu-wren survey, ⁴ CLLMM annual total waterbird census, ⁵ Monthly point count waterbird survey, ⁶ Birds Australia survey, ⁷ AWSG wader census, ⁸ Beach Nesting Birds Project (Birds Australia), ⁹ Malleefowl survey, ¹⁰ Australian Pelican Survey

Bird Ecology and the Ramsar Criteria

Summary of CLLMM status and Limitations of Ramsar Criteria

In Australia's commitment to maintain the ecological character of this wetland, we are obliged to monitor and report on significant changes in bird communities at the site, and use these changes to guide management of the site. This report shows that the CLLMM site comfortably meets Ramsar Criteria 2-6, based on available bird survey data.

The site provides important habitat for threatened species, and supports high bird species richness and abundance, regular breeding colonies, and large numbers of international migrants. This report has provided a comprehensive assessment of population changes across years in 23 of the 55 bird species that were listed on the original 1985 RIS (Tables 10-12). The reported fluctuations in population numbers need to be considered within the context of changing environmental conditions when defining Limits of Acceptable Change in the revised CLLMM ECD. Importantly, six species (Curlew Sandpiper, Grey Teal, Hoary-headed Grebe, Red-capped Plover, and Fairy Tern) had higher populations in the South Lagoon alone in 1985 compared to their current population sizes across the entire CLLMM site (Tables 10 & 11).

Although bird numbers within the CLLMM are still high enough to justify Ramsar criteria, reaching these targets can effectively mask declines in some species. For example although CLLMM comfortably meets Criterion 5 by supporting >20,000 waterbirds every year, the site has supported 92,000-400,000 waterbirds over the last 12 years (Table 10); variation in which is not flagged by simply meeting a Ramsar population target. Rogers and Paton (2009) similarly found that even though the CLLMM regularly supported 1% of the estimated flyway population for 8 waterbird species, meeting this threshold did not highlight the general decline in half of these species over the 8 year study period.

Another limitation of the Ramsar criteria is that it does not detect spatial redistributions of species in response to changes in environmental conditions (i.e. salinity) within the wetland (Rogers and Paton 2009). For example hypersaline conditions in the Coorong's South Lagoon during conditions of drought and low river flows (2006-2009) resulted in shifts of Fairy Tern populations to the upper North Lagoon/Murray Mouth (Appendix 4) in response to lower salinity conditions and increased Smallmouth Hardyhead fish (*Atherinosoma microstoma*) numbers. This change was of conservation concern for the Vulnerable Fairy Tern population because its breeding success is dependent on prey availability close to predator-free nesting sites (islands), which are virtually absent in the North Lagoon (Paton and Rogers 2009b; Baker-Gabb and Manning 2011).

A concerning trend that has arisen from this review is that population numbers of some waterbird species have not recovered from the adverse conditions over the last decade; despite recent increased water flows, decreased salinity, and increased macrobenthic invertebrate prey abundance (Tables 10-12, Paton 2010 pers. comm. J Keuning; Paton et al. 2011). In response to these concerns, the next step of this project will be to develop

conceptual models that illustrate the complex interactions between birds and CLLMM habitats. This will assist CLLMM managers to predict the response of birds to changing abiotic and biotic conditions at the Ramsar site.

Since Ramsar criteria were designed primarily for identifying and designating “wetlands of international importance”, they are possibly too broad to be used as ongoing criteria for identifying critical ecological changes at every Ramsar site. A revised Ecological Character Description should set specific thresholds (Limits of Acceptable Change) that can identify critical population changes within CLLMM bird populations. These thresholds could be based on measures such as percentage change in bird population numbers. Such measures would need to account for natural variation in population numbers, climatic events, temporal and spatial variability in bird-habitat use, and other responses of waterbirds to ecological changes within their habitats (Butcher 2011). We therefore recommend further study into describing and quantifying the interactions between birds and components of their habitat within the CLLMM. This information will inform the development and inclusion of “Limits of Acceptable Change” within an updated Ecological Character Description of the site.

Appendices

Appendix 1. Species that qualify for Ramsar criteria but are not wetland-dependent.

Appendix 1a. Criterion 2: Non wetland-dependent species that are listed as Vulnerable, Endangered or Critically Endangered under National legislation and International frameworks. IUCN RedList or EPBC status is shown as CR (Critically Endangered), EN (Endangered), or VU (Vulnerable) with IUCN criteria shown in parentheses. NPWS status is also shown (EN=Endangered). IUCN criteria for allocating categories of extinction risk are shown in parentheses. None of these species are listed under CITES Annex I.

Scientific name	Common name	IUCN	EPBC
<i>Lathamus discolor</i>	Swift Parrot	EN (C2d(ii))	EN
<i>Diomedea exulans</i>	Wandering Albatross	VU	VU
<i>Leipoa ocellata</i>	Malleefowl	VU (CA4bce+3ce+4bce)	VU
<i>Diomedea chrysostoma</i>	Grey-headed Albatross	VU (CA4bd)	VU
<i>Pandion cristatus (haliaetus)</i>	Eastern Osprey		EN
<i>Pterodroma mollis</i>	Soft-plumaged Petrel		VU
<i>Pachycephala rufogularis</i>	Red-lored Whistler		VU
<i>Diomedea cauta</i>	Shy Albatross		VU

Appendix 1b. Criterion 4: Non wetland-dependent migratory birds that are included within the following agreements: Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA), Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA), the Convention on Migratory Species (CMS), and the list of migratory species under the EPBC act (EPBC)

Family	Scientific name	Common Name	Agreements
APODIDAE	<i>Apus pacificus</i>	Fork-tailed Swift	JAMBA, CAMBA, EPBC
MOTACILLIDAE	<i>Motacilla flava</i>	Yellow Wagtail	ROKAMBA, JAMBA, CAMBA, EPBC,
MUSCICAPIDAE	<i>Zoothera lunulata</i>	Bassian Thrush	ROKAMBA, JAMBA, CAMBA

Appendix 1c. Criterion 4: Non wetland-dependent species that regularly breed (3 out of 5 years on average) within the Coorong, Lower Lakes and Murray Mouth Ramsar region.

Scientific name	Common Name	Breeding Freq.	Breeding Records	Breeding site/s	Notes
<i>Leipoa ocellata</i>	Malleefowl	Annual	Active nesting mounds recorded annually 1996-2012 ^{1,2}	Mallee Scrub surrounding the Coorong Lagoons.	Annual surveys for breeding activity. Not wetland dependent.

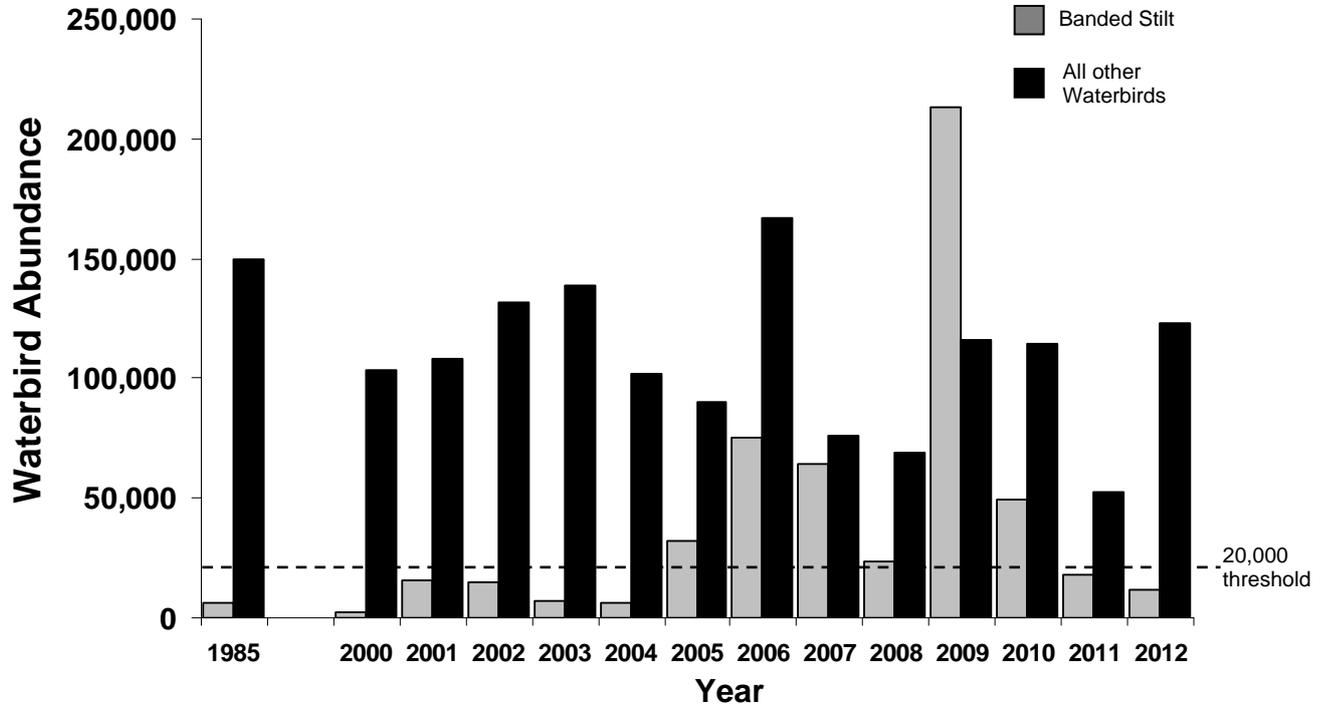
Appendix 2. Criterion 4. Species that probably breed regularly at the CLLMM site but are data-deficient. Included are species that are present at the site during their breeding season, and/or have sparse breeding records (due to lack of monitoring).

Scientific name	Common Name	Breeding records	Known habitat
<i>Botaurus poiciloptilus</i>	Australasian Bittern	None from the region, however the species is a resident and should therefore breed at the site. Breeding records probably lacking due to cryptic behaviour of the species.	Breeds in deep densely vegetated freshwater swamps and pools, building nests in deep cover over shallow water (See Seaman 2003)
<i>Acrocephalus australis</i>	Australian Reed Warbler, (Clamorous Reed-Warbler)	None, however the species uses the site during its breeding season.	Freshwater reed beds
<i>Gallinula tenebrosa</i>	Dusky Moorhen	2011: 3 juv in census at Lake Alexandrina ²	Lakes Alexandrina and Albert
<i>Ardea modesta (alba)</i>	Eastern Great Egret, (White Egret)	None, however the species uses the site during its breeding season.	Lakes Alexandrina and Albert
<i>Cisticola exilis</i>	Golden-headed Cisticola	Nests in 1980 ¹ , and 1931(Sutton 1931)	Freshwater reed beds, Lignum swamps.
<i>Anas gracilis</i>	Grey Teal	2011: 8 juv in census at Lake Alexandrina ²	Lakes Alexandrina and Albert
<i>Biziura lobata</i>	Musk Duck	Breeding at Tolderol Game reserve in 1989 (Eckert 2000).	Shallow, sheltered wetlands.
<i>Nycticorax caledonicus</i>	Nankeen (Rufous) Night Heron	None, however the species uses the site during its breeding season.	Lakes Alexandrina and Albert
<i>Porphyrio porphyrio</i>	Purple Swamphen	2011: 3 juv in census at Lake Alexandrina ²	Lakes Alexandrina and Albert
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	2011: 2 juveniles counted in survey ³	Younghusband Peninsula beaches and Murray Mouth.
<i>Stipiturus malachurus intermedius</i>	Southern Emu-wren (Mt Lofty Ranges ssp)	1982 (near Finniss River) ¹ No recent breeding records from the 3 known populations around Currency Creek/Finniss River. However the persistence of these populations since 1993 implies that breeding has occurred (pers comm M. Pickett)	Dense swamps around Currency Creek and Finniss River

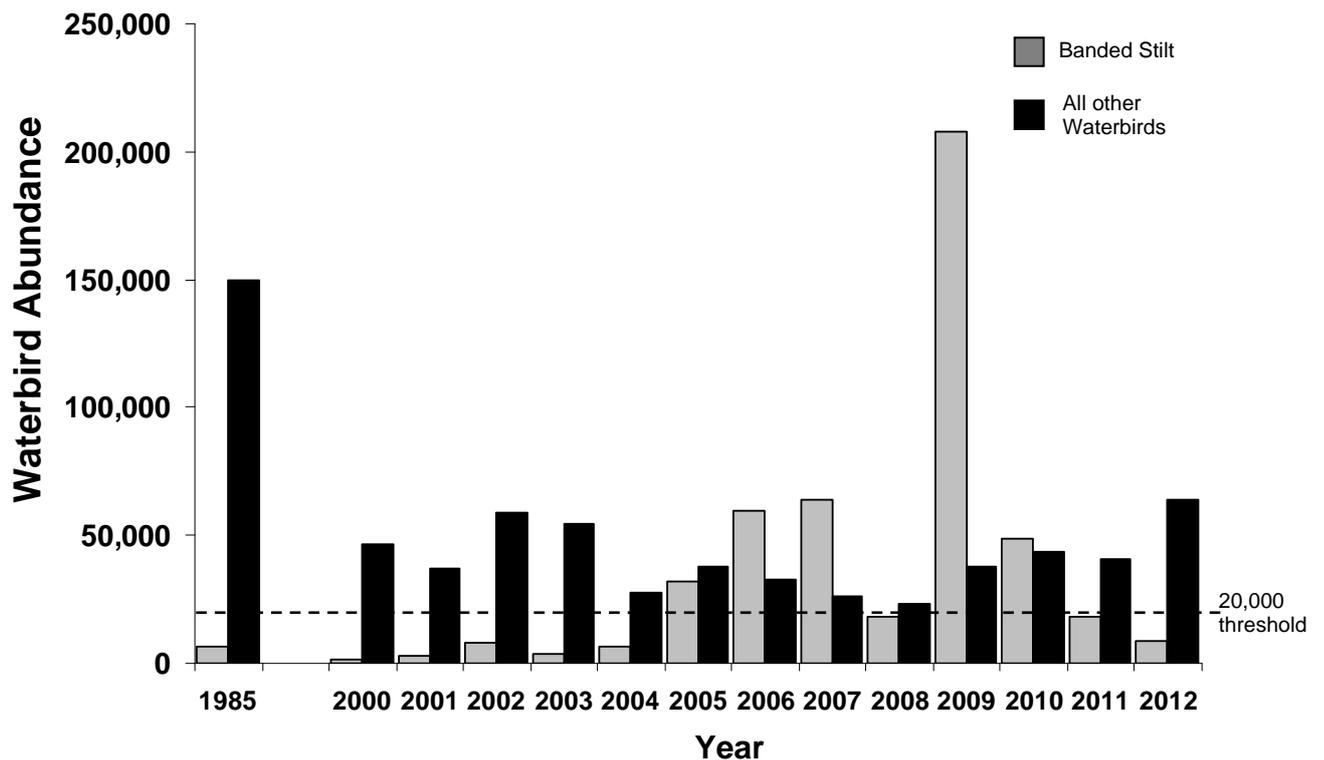
¹Data sourced from South Australian Department for Environment and Natural Resources Database of SA. Recordset number DENRBDBSA120123-1, ² David Paton CLLMM census, 2011, ³ Beach-nesting Birds Project (Birds Australia).

Appendix 3. Contribution of Banded Stilt numbers to high waterbird abundance in 2009.

Appendix 3a. Waterbird abundance at the CLLMM Ramsar site. Note that 1985 data is for the South Lagoon only, 2000-2008 data is from the Coorong only (South Lagoon & North Lagoon), and 2009-2012 is for the Coorong and Lower Lakes. Banded Stilt abundance was unusually high (213,109 individuals) in 2009 in response to increased availability of brine shrimp prey. Brine shrimp abundance had increased in response to extreme hypersaline conditions in the South Lagoon. See Paton and Rogers (2009a) for a more detailed discussion of avian responses to ecological conditions in 2009.



Appendix 3b. Waterbird abundance per year in the Coorong South Lagoon in 1985 and 2000-2012. These appendices, when compared to Figure 1 (page 19), demonstrate the contribution of one species (Banded Stilt) to high waterbird abundances in 2009.



Appendix 4. Changes in the abundance of six key waterbird species from 1985, and 2000-2012 using total annual census data.

Note that 1985 data is for the South Lagoon only, 2000-2008 data is from the Coorong only (South Lagoon and North Lagoon), and 2009-2012 is for the Coorong and Lower Lakes. The information presented in Appendix 4 is not used to qualify Ramsar criteria, and is instead used to show species-specific and location-specific trends in population abundance within the site. Here, we discuss changes in population numbers of two Australian piscivores (Fairy Tern and Australian Pelican), two International migrants (Red-necked Stint and Curlew Sandpiper), and two Australian herbivores (Black Swan and Grey Teal) across years. Appendices 4a-f show that population numbers of all six species has decreased in the South Lagoon since 1985. Specific changes in the distribution and abundance of each species differ across years.

Australian Piscivores

Fairy Terns and Australian Pelicans are piscivores that use the site for breeding and adult survival. The abundance of both species is positively associated with Smallmouth Hardyhead fish prey in the Coorong (Rogers and Paton 2009). The entire CLLMM Fairy Tern population is now consistently less than half the size that was in just the South Lagoon in 1985 (Appendix 4a). The distribution of Fairy Terns follows that of its primary fish prey species: the Smallmouth Hardyhead, which is restricted to habitats where salinity is <120ppt (Paton and Rogers 2009b). Changes in Australian Pelican distribution and abundance follow a pattern that is different to that of the Fairy Tern (Appendix 4b), possibly due to its ability to utilise a broader range of habitats at a local and continental scale (see Kingsford and Porter 2009; Paton 2010; DENR 2011). Pelican numbers appear to be positively associated with water flows to the CLLMM; and have continued to increase after the return of water to site in 2009 (Appendix 4b; Paton et al. 2011).

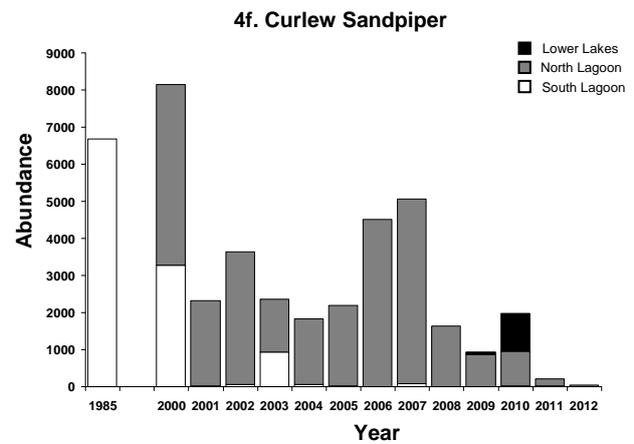
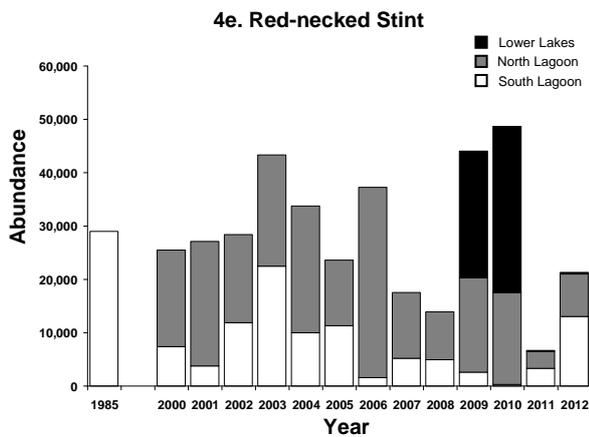
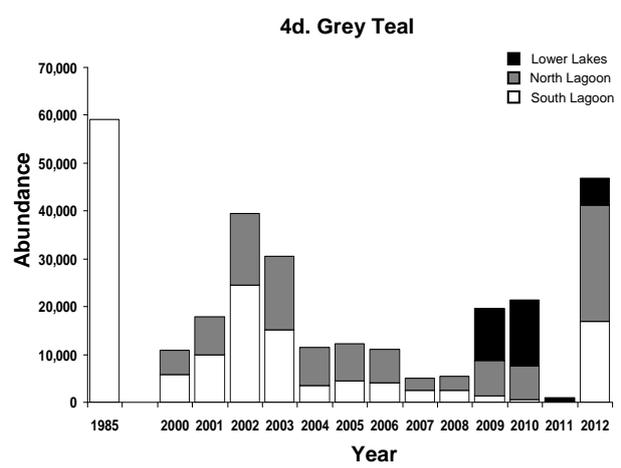
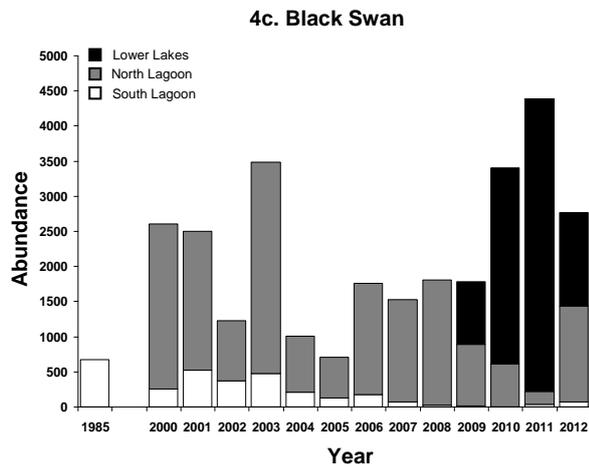
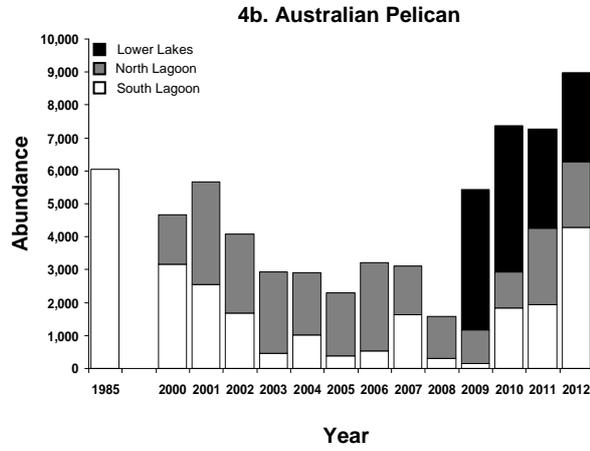
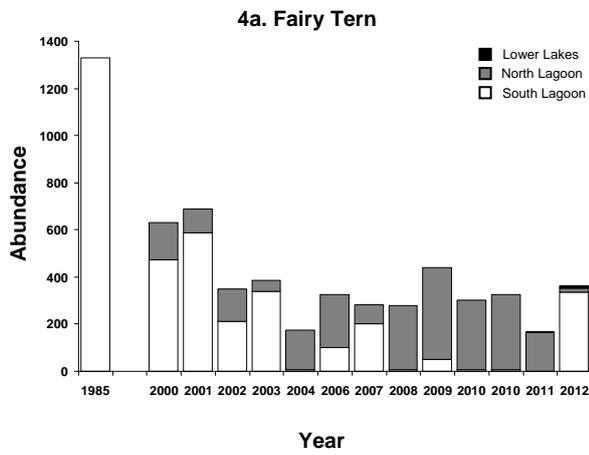
International Migrants

Red-necked Stints and Curlew Sandpipers are international migrants that visit the site to feed predominantly on macroinvertebrate prey over summer (Paton 2010). In recent years, Red-necked Stints appear to have utilised a broader range of CLLMM habitats (Lower Lakes, as well as North and South Coorong Lagoons) than Curlew Sandpipers (mainly North Lagoon)(Appendices 4e-4f). Compared to previous years, the number of Red-necked Stints in the South Lagoon increased in 2012 (Appendix 4e). This may represent a delayed “recovery” of the species in response to increased water flows to the Coorong since 2009. In contrast, numbers of Curlew Sandpipers have continued to decline in recent years, reaching a low of just 50 individuals in 2012 (Appendix 4f). Both species will also be affected by ecological conditions at other sites along the East-Asian Australasian flyway (Bamford et al. 2008; Amano et al. 2010), although the differential response of these two species to local conditions may also have an explanation in how they respond to local changes.

Australian Herbivores

Black Swans and Grey Teal are herbivores that use the site for drought refuge and adult survival (Paton 2010). Both species are known to move between Australian wetland habitats (Marchant and Higgins 1990; Paton et al. 2011), though Grey Teal are particularly opportunistic and will respond rapidly to flooding of inland lakes (Marchant and Higgins 1990). Black swans also use the site for breeding (Eckert 2000; Paton et al. 2011). Black Swan populations increased in 2010-2011 in response to increased freshwater flows to the wetlands in late 2009 (Appendix 4c; Paton et al. 2011). In contrast, Grey Teal populations reached an all-time low in 2011 (1026 individuals), before recovering to a population of 46,910 in 2012 (Appendix 4d). The entire CLLMM Grey Teal population is now consistently less than half the size that was in just the South Lagoon in 1985 (Appendix 4d).

In conclusion, CLLMM census data show species-specific patterns in waterbird abundance across years. To better understand these patterns, we recommend the development of species-specific habitat-models that can be used to predict the response of birds to changing ecological conditions within the CLLMM (also discussed in Paton et al. 2011).



Appendix 5. Estimates of 1% of the East Asian-Australasian Flyway population size for CLLMM waterbirds. Global population sizes and flyway estimates are based on the latest (4th) edition of Wetland International’s “Waterbird Population Estimates”. For international migrants, 1% flyway estimates were included for populations and subspecies with breeding/wintering/core non-breeding ranges within Australia.

Scientific name	Common name	Global	Flyway	1% Population
<i>Pelecanus conspicillatus</i>	Australian Pelican	100,000–1,000,000	100,000–1,000,000	10,000
<i>Haematopus longirostris</i>	Australian Pied Oystercatcher	11,000	11,000	110
<i>Tadornis tadornoides</i>	Australian Shelduck	240,000	240,000	2,400
<i>Cladorhynchus leucocephalus</i>	Banded Stilt	206,000	206,000	2,100
<i>Cygnus atratus</i>	Black Swan	100,000–1,000,000	100,000–1,000,000	10,000
<i>Cereopsis novaehollandiae</i>	Cape Barren Goose	15,000-17,000	16,000	160
<i>Hydroprogne (Sterna) caspia</i>	Caspian Tern	2,000	2,000	20
<i>Anas castanea</i>	Chestnut Teal	105,000	105,000	1000
<i>Calidris ferruginea</i>	Curllew Sandpiper	1,780,000-1,880,000	183,000	1,800
<i>Tringa nebularia</i>	Common Greenshank	440,000-1,470,000	100,000	1,000
<i>Fulica atra</i>	Eurasian Coot	7,950,000-9,750,000	1,000,000	10,000
<i>Sterna nereis nereis</i>	Fairy Tern	2580	2580	25
<i>Phalacrocorax carbo carboides</i>	Great Cormorant*	25,000-1,000,000	512500	5125
<i>Podiceps cristatus</i>	Great Crested Grebe	10,200-25,300	25,000	250
<i>Thalasseus bergii</i>	Greater Crested Tern**	>520,000	500,000	5000
<i>Anas gracilis</i>	Grey Teal	>1,000,000	2,000,000	20,000
<i>Poliiocephalus poliocephalus</i>	Hoary-headed Grebe*	25,000-1,000,000	512500	5100
<i>Thinornis rubricollis</i>	Hooded Plover	4,500	4,500	45
<i>Charadrius ruficapillus</i>	Red-capped Plover	95,000	95,000	950
<i>Haematopus longirostris</i>	Pied Oystercatcher	11,000	11,000	110
<i>Pluvialis fulva</i>	Pacific Golden Plover	100,000	100,000	1,000
<i>Recurvirostra novaeholland</i>	Red-necked Avocet	107,000	107,000	1,100
<i>Calidris ruficollis</i>	Red-necked Stint	315,000	315,000	3,200
<i>Haematopus fuliginosus</i>	Sooty Oystercatcher	4,000	4,000	40
<i>Calidris alba</i>	Sanderling	620,000-695,000	22,000	220
<i>Calidris acuminata</i>	Sharp-tailed Sandpiper	160,000	160,000	1,600
<i>Larus novaehollandiae</i>	Silver Gull*	100,000->1,000,000	550,000	5,500
<i>Chlidonias hybridus fluviatilis</i>	Whiskered Tern	100,000-1,000,000		10,000

*1% flyway estimates not given for this species. 1% flyway estimates were calculated from the mean global population estimate.

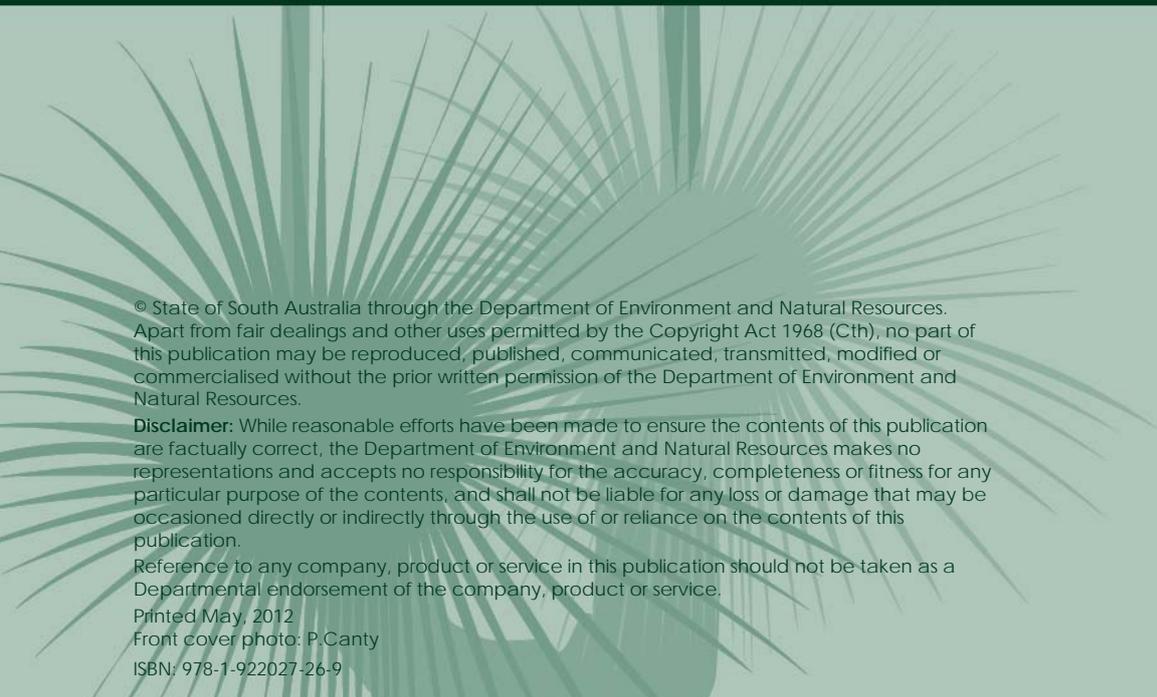
** Global population estimate for *Thalasseus bergii* is calculated using Southern Africa population (Wetlands International) plus Australian population size as estimated by Del Hoyo et al. (1996).

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