WATERBIRDS OF PEEL-HARVEY ESTUARY

IN

1998-99

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Cover photograph of Red-necked Stint (*Calidris ruficollis*) by A.G. Wells, AFIAP, ARPS.

The Red-necked Stint was most the abundant bird on Peel-Harvey Estuary during the 1998-99 surveys, with numbers reaching 16,000 in February 1999. Most were found on intertidal feeding grounds of south-eastern Peel-Inlet and the southern end of Harvey Estuary. These small, yet remarkable, birds migrate to Peel-Harvey each year from breeding grounds in arctic Siberia, a return journey of 25,000 kilometres.

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SUMMARY

Peel-Harvey Estuary, 70 km south of Perth, Western Australia, is listed jointly with Lakes McLarty, Mealup and the Yalgorup Lakes as a Wetland of International Importance under the Ramsar Convention. Surveys in the mid 1970s and 1980s have shown that tens of thousands of waterbirds make regular use of the estuary's extensive, shallow and highly productive waters. In early 1977, waterbird numbers exceeded 100,000.

During the 1960s to 1990s, Peel-Harvey became increasingly eutrophic due to leaching of agricultural fertilisers from its catchment. Public objections to odours emanating from decaying macro-algae and the increasing occurrence of blue-green algae blooms resulted in government and community action to alleviate these problems.

One component of the government's strategy was to increase flushing of the estuary by constructing a second entrance to the ocean. This entrance - the Dawesville Channel - was completed in April 1994.

A condition of government approval of the Channel was that monitoring be undertaken so that impacts could be assessed and, where practicable, managed.

This report presents results from one component of the Peel-Harvey Estuary monitoring program - the 1998-99 surveys of waterbird species, numbers and distributions on Peel-Harvey. Results of surveys undertaken in 1996-97 have previously been reported.

The 1998-99 data show that, 4-5 years following construction of the Dawesville Channel, Peel-Harvey Estuary remained one of the most important waterbird habitats in Western Australia. Approximately 42,000 birds were counted in December 1998 and at least 45,000 birds of 56 species made use of this estuary at some time during the survey period.

During 1998-99, most birds were found in southern and eastern parts of Peel Inlet, at the southern end of Harvey Estuary and in north-central parts of Peel Inlet on either side of the natural entrance channel. This is consistent with the findings of previous surveys. The first and last areas are largely within conservation reserves. The southern end of Harvey Estuary has a conservation reserve adjoining its eastern shore but is otherwise unprotected.

The 1998-99 data indicate that Peel-Harvey Estuary continues to meet the Ramsar Convention waterbird criteria under which it was listed in 1990.

Before a proper assessment can be made of possible impacts of the Dawesville Channel on Peel-Harvey waterbird species, numbers and distributions it will be necessary to report the results of baseline surveys conducted in the mid 1970s. This work is underway.

1. INTRODUCTION

Peel-Harvey Estuary, 70 km south of Perth, Western Australia, is recognised as one of the most important waterbird habitats in Western Australia. At least 86 species have been recorded, with many in great abundance. In February 1977, a survey of the estuary revealed more than 100,000 birds (J. Lane, unpubl. data). In November 1982, a survey of the eastern part of Peel Inlet alone produced c. 41,000 (ANCA 1996). No other wetland in south-western Australia is known to support as many waterbirds.

In recognition of its significance, Peel-Harvey has been listed, jointly with Lakes McLarty, Mealup and the Yalgorup Lakes, as a Wetland of International Importance under the Ramsar Convention (Government of Western Australia 1990, 2000).

Use of agricultural fertilisers in the Peel-Harvey Estuary catchment has resulted in the estuary becoming eutrophic. Public complaints during the 1960s and 1970s about the accumulation of decaying algae led to government and community efforts to solve the problem. Following lengthy investigation it was decided that a multi-faceted approach should be taken. Key elements were to be modification of fertilizer use in the catchment and excavation of a channel - the Dawesville Channel - to provide a second connection to the sea, thereby increasing tidal exchange (EPA 1988).

The proposal to construct a channel at Dawesville was approved in principle by the Western Australian Government in January 1989. Works began in February 1992 and the Channel was opened in April 1994.

A condition of approval for construction of the Channel was a requirement that monitoring be undertaken so that impacts could be assessed and, where practicable, managed (EPA 1988, PIMA 1994).

One component of the monitoring program was to be an assessment of waterbird use of the estuary following completion of the Channel. This work was to be done by the Western Australian Department of Conservation and Land Management because of its expertise and responsibilities in this area and its significant, pre-Channel, waterbird data sets. Funding arrangements for the Dawesville Channel monitoring program were determined by Government in February 1994, enabling studies to commence later that year.

A progress report (Lane, Pearson & Clarke 1997) completed in September 1997 gave an overview of work undertaken by the Department of Conservation and Land Management following opening of the Channel. Seven projects were described.

In relation to one of these projects - "Waterbird species, numbers and distributions" - the background, rationale and methodology were outlined and some preliminary impressions concerning the status of several waterbird species were presented. Few data were presented, however, as the process of transcribing the 1996-97 waterbird survey recordings from audiocassettes to maps and analysing these figures had not been completed. This work has now been done. Results of the 1996-97 waterbird surveys were reported earlier this year (Lane, Clarke & Pearson 2002). Results of the 1998-99 surveys are presented below.

2 PROJECT AIMS

The aims of the "Waterbird species, numbers and distributions" project are:

- To determine the species, numbers and distributions of waterbirds on Peel-Harvey Estuary following construction of the Dawesville Channel.
- To identify significant impacts of construction of the Dawesville Channel on waterbird species, numbers and distributions.
- To determine whether Peel Harvey Estuary continues to meet Ramsar Criteria, relating to waterbirds, for ongoing listing as a Wetland of International Importance.

The aims of this report are to present data collected during the second year (1998-99) of waterbird surveys following construction of the Channel and to use these data to address the project aims.

3. PROJECT DESIGN

Opening of the Dawesville Channel had the potential to affect the suitability of Peel-Harvey for use by waterbirds in a number of ways. The number of high tide roost sites, some of which are sand cays and low islets, could be reduced by an increase in tide heights. Higher tides could also cause flooding of pelican nesting grounds and the death of fringing vegetation used by waterbirds for feeding, refuge, roosting and breeding. Changes in the estuary's salinity regime, when combined with an increase in tide heights, could also contribute to the death of vegetation. Increased tide heights, particularly during summer, could result in an increase in disturbance, by permitting human access to important waterbird feeding and loafing areas that were previously too shallow for boats. Altered water levels, salinities and circulation patterns could also have largely unpredictable effects on food webs supporting the estuary's waterbird populations. Clearly most if not all species could be affected in some way (some perhaps positively) by creation of the Channel. For this reason it was decided that comprehensive surveys to determine use of the estuary by all waterbird species should be conducted.

In order to establish a baseline it would have been preferable for surveys to have been conducted for at least two years immediately prior to the Channel being opened. This, however, was not achievable. The only baseline data on waterbird use of the entire estuary come from comprehensive surveys undertaken by the principal author (JL), with assistance from one of the co-authors (GP), in the mid-1970s. These surveys could be repeated precisely as full details of survey methodologies, routes, times etc. had been recorded and the same personnel were available. It was therefore decided to repeat the 1976-77 surveys during two of the five years programmed for post-Channel monitoring.

Two years of surveys were planned in order to obtain an indication of year-to-year variability in waterbird numbers and distribution. Post-Channel years two and five (1996-97 and 1998-99) were chosen as it was considered likely that at least some of the effects of the Channel would take several years to be expressed. Whereas in 1976-77 six surveys were conducted at two monthly intervals from August 1976 onwards, in 1996-97 and 1998-99 this was not possible, due to other demands on staff time. For this reason the 1996-97 and 1998-99 surveys were limited to October, December and February. These months were chosen because both total waterbird numbers and the number of species, particularly of transequatorial migrants, were expected to be greatest at this time of the year.

4. STUDY AREA

The study area was the entire Peel-Harvey Estuary (area c. 136 km^2, shoreline length c. 75 km) including open waters, shallows, tidal flats, tidal marshes and shorelines (Figure 1). The delta and lower reaches of the Harvey River were also included.

5. METHODOLOGY

5.1 Waterbird Species

Species typically regarded as waterbirds include swans, ducks, grebes, cormorants, pelicans, herons, egrets, ibis, spoonbills, waterhens, sandpipers, stilts, plovers, gulls and terns (Rose & Scott 1997). However, several other bird species that are not always regarded as waterbirds make substantial use of estuarine and other wetland habitats in south-western Australia. These are the Osprey, Whistling Kite, White-bellied Sea-Eagle, Swamp Harrier, White-fronted Chat and Little Grassbird. For the purposes of this study, these species were included. This approach is consistent with the suggestions of Rose & Scott (p4).

5.2 Survey Program

Surveys of all species of waterbirds throughout the Peel-Harvey Estuary were conducted in October 1998, December 1998 and February 1999. Modes of transport (plane, boat and foot), equipment used (binoculars, audio cassette recorder, notebook, maps), survey routes, survey times and personnel were the same as, or similar to, those of surveys conducted in the same months of 1976-77. The same areas were surveyed as in 1976-77, plus additional areas described below. The date of survey of each sector, and the personnel involved, are shown in Appendix 10.

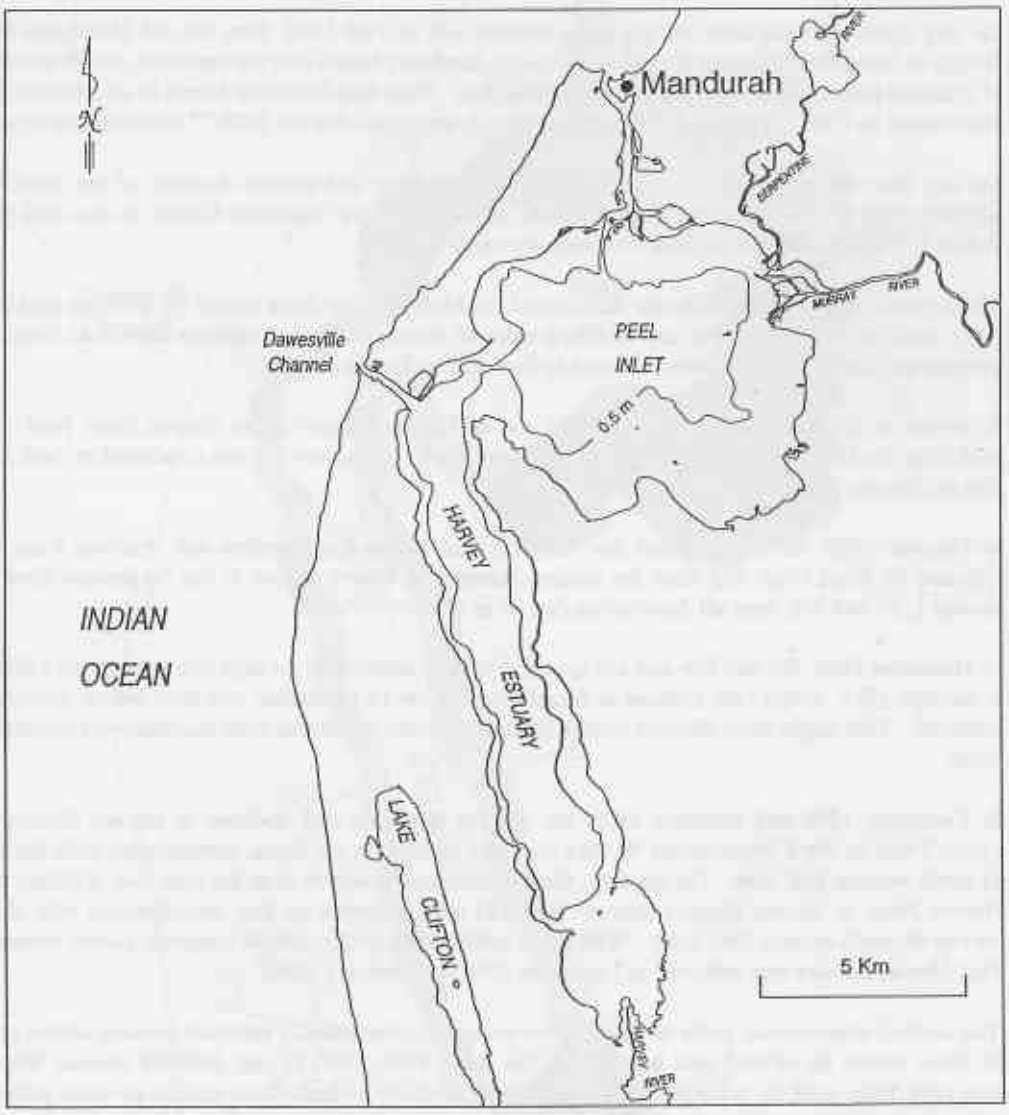

Figure 1. Peel-Harvey Estuary.

The general approach was as follows. On the first day of each survey, pelican numbers and distribution on Peel Inlet and Harvey Estuary were determined by aerial census, using a single-engine, high wing, four seater aircraft with commercial pilot and observer (GP). Black Swan numbers and distribution on Harvey Estuary were also determined during this aerial survey. Swans in south-eastern Peel Inlet could not be effectively surveyed by plane due to the breadth (several kilometres) of the shallows in this part of the estuary, the large number (potentially) and spread of birds and the relative difficulty (compared with

pelicans) of seeing the birds against the darkness of the shallows, most of which were covered by abundant submerged aquatic plants. Instead, the swans of Peel Inlet were surveyed by boat, this being a 3.5 metre, flat-bottomed punt with 15 horsepower outboard motor operated by a single observer.

On the second day, a survey was made by boat of the numbers and distributions of all waterbird species from the old Mandurah Traffic Bridge downstream to the ocean mouth (sector 1 of Figure 2). Waterbirds on the north-eastern side of Peel Inlet upstream from the same bridge to the mouth of the Serpentine River (sectors 2a and 3), including Creery and Channel Islands and the Creery marshes, were also surveyed on day two, by boat and on foot

On day three, all waterbirds on the north-western side of Peel Inlet, from the old Mandurah Traffic Bridge to Ward Point (sectors 2b and 4), including Boundary Island and the samphire islands to the west of Channel Island, were surveyed by boat and on foot. Note that Boundary Island is an artificial island constructed in 1987 (Pszczola, J. 1998, pers. comm.), ten years after the 1976-77 waterbird surveys.

On day four, all waterbirds on the shoreline and the inner and middle shallows of the eastern and southern side of Peel Inlet, from the artificial lagoon adjoining Yunderup Canals to the west side of Robert Bay (inner and middle sector 6), were surveyed on foot.

The western shoreline and adjacent shallows of the Murray River delta (sector 5), plus the middle and outer shallows on the eastern and southern sides of Peel Inlet from Yunderup Canals to Robert Bay (middle and outer sector 6), were surveyed by boat and on foot on day five

A survey of all waterbirds at the southern end of Harvey Estuary (from Herron Point Ford south), including the lower reaches and delta of the Harvey River, (i.e. sector 10) was conducted by boat and on foot on day six, the last day of the surveys.

In October 1998, the day two and day three surveys, minus the shoreline and shallows from Sticks Channel to Ward Point and from the eastern entrance of Creery lagoon to the Serpentine River, (i.e. sectors 1, 2a and 2b), were all done in one day, as in October 1976.

In December 1998, the day five and day six surveys were delayed by six days due to temporary illness of a surveyor (JL). Some rain (7.8mm at Mandurah) fell on 15 December, two days before surveys were resumed. This might have affected results by causing some additional (and unmeasured) movement of birds.

In December 1998 and February 1999, the western shoreline and shallows of Harvey Estuary from Island Point to Ward Point (sector 9) were surveyed by boat on day three, simultaneous with the survey of north-western Peel Inlet. On day four, the shoreline and shallows from the west side of Robert Bay to Herron Point in Harvey Estuary (sectors 7 and 8) were surveyed on foot, simultaneous with the foot survey of south-eastern Peel Inlet. With these additional surveys, almost-complete survey coverage of Peel-Harvey Estuary was achieved in December 1998 and February 1999.

The central, deeper-water parts of Peel-Harvey were not systematically surveyed because ad-hoc surveys of these waters by aircraft and boat during the mid 1970s, 1996-97 and 1998-99 showed they were generally little used by waterbirds. Waterbirds most likely to have been missed in these parts were cormorants, small numbers of grebes and pelicans, and occasional terns, gulls and darters.

Note that the sectors described above were defined on the basis of survey practicalities, primarily the maximum area that could be thoroughly surveyed in a single day by a single observer under varying weather and tidal conditions.

5.3 Counting Techniques

Whenever possible, birds were counted individually. This was usually achievable with flocks of tens or low hundreds of individuals, but rarely achievable with flocks of high hundreds or thousands. In these latter instances, the commonly used (Conder 1978, Bibby et al 2000) technique of counting in tens,

twenties or larger estimated groupings was employed. Some very large flocks (thousands) were broken by eye into a number of equal-sized parts and the number in one of these parts was counted or estimated

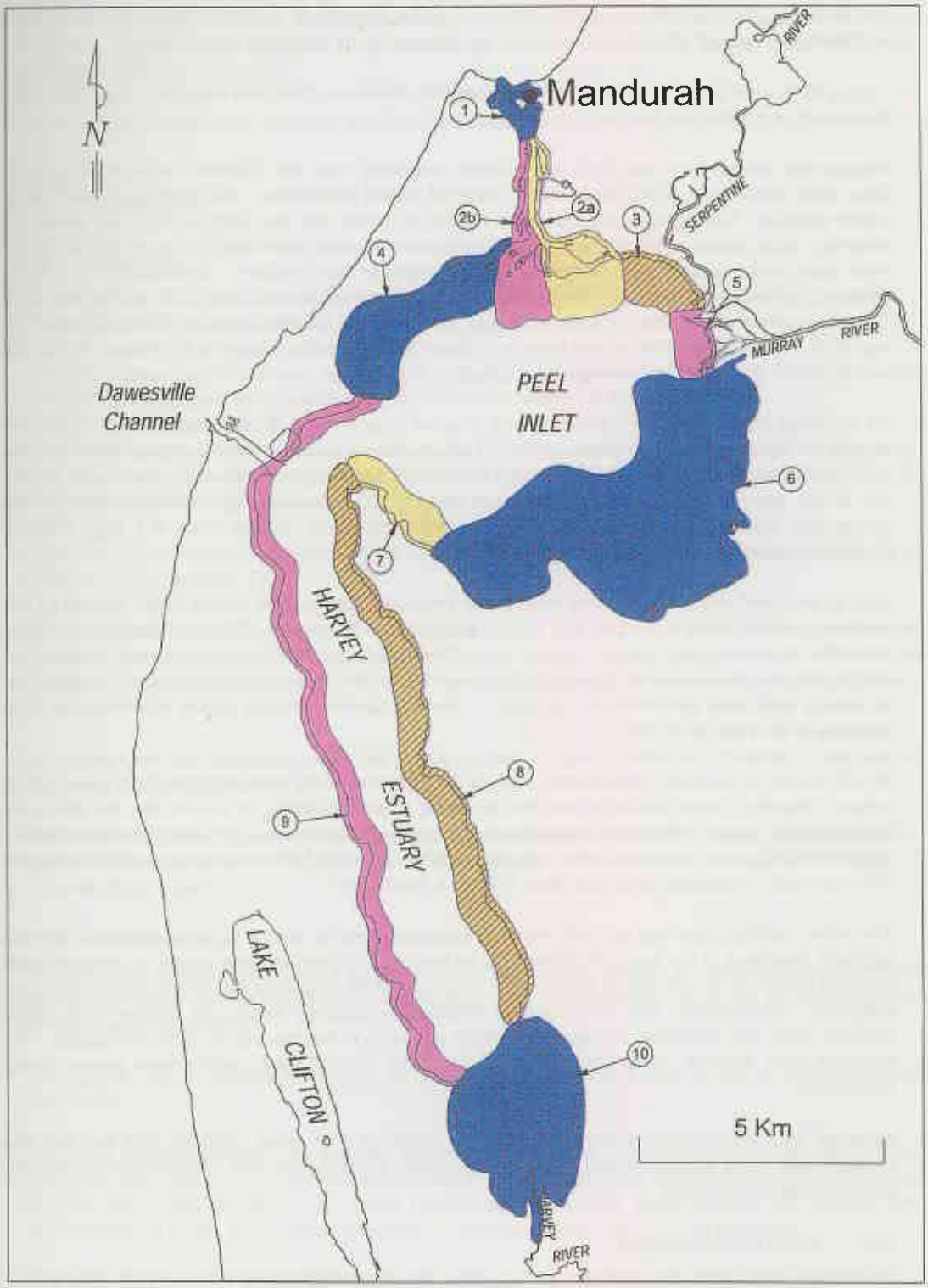

Figure 2. Survey sectors of Peel-Harvey Estuary.

and then multiplied by the number of parts. Where practicable this process was repeated two or more times to improve the estimate. Sometimes it was not possible to determine the identity of birds because

they were too far away for the observer to discern distinguishing features. On these occasions they were recorded as "unidentified ducks", "unidentified cormorants", etc.

Single, small, vagrant shorebirds in large flocks of similar common species, could at times have been overlooked. This is not of concern because, while uncommon vagrant shorebirds are of some ornithological interest, they are of little or no significance in the context of this report.

Flying birds were included in sector counts except for occasions when they were seen flying high above the estuary, e.g. rising on thermals.

Because the ground (boat and foot) surveys were conducted over four (October) to eleven (December) days, some movement of birds undoubtedly occurred during the surveys. Allowance was made for this where possible. During each day's survey a record or mental note was kept of birds seen passing the observer, either ahead or behind, and count figures were adjusted accordingly. Day-to-day movements were more problematic. No measure of these movements was possible. Impressions were gained, however, as some previously surveyed areas were passed on subsequent days while on the way to and from new survey areas. Survey areas were also "re-visited" at the margins when adjoining areas were surveyed. On this basis, the authors have confidence that most birds present on the estuary during each survey period were not double-counted or omitted.

As indicated above, Australian Pelicans were counted from an aircraft, with each survey of the entire estuary taking no more than 45-65 minutes. These surveys were undertaken in the middle of the day, when pelicans are often resting and relatively few movements, compared with early morning or evening, are taking place. Flocks too large to count from the air were photographed and numbers later determined from prints as described in section 5.4. For these reasons there is a high degree of confidence in the accuracy of the pelican count data.

Also as indicated above, Black Swan numbers on Peel Inlet were counted during single surveys by boat, with each survey taking around 3.5 to 5.5 hours to complete. The swans of Harvey Estuary were counted from the air during the pelican survey. The Peel Inlet and Harvey Estuary swan surveys were undertaken simultaneously and during the day, when swans are usually quietly grazing on aquatic plants or resting with little movement taking place. There is therefore a high degree of confidence in the accuracy of the swan count data.

It will be seen in following sections that none of the count data have been rounded. This is because the authors consider it more useful, in this first reporting of survey results, to present the raw data rather than rounded figures. However, when these data are put to other uses, for example comparisons of numbers with those of other wetlands, it is suggested that all totals be rounded to two significant figures. This approach is consistent with that taken in Rose & Scott (1997).

The survey methodology was not well suited to detecting secretive species of waterbirds such as crakes and rails (members of the family Rallidae). To be confident of locating these species an observer needs to spend periods of 10 minutes or more quietly observing likely habitats, e.g. rushbeds, from unobtrusive positions. Alternatively, tape recordings or humane live-trapping techniques can be used. These methods were not employed during the 1998-99 or previous surveys due to time constraints. It is therefore quite possible, in fact highly likely, that some birds of these species were present though unrecorded.

Although bird behaviours (principally feeding or roosting) were often recorded, this was not done routinely due to the magnitude and, at times, complexity of the survey task. Behaviours are therefore not presented in this report.

5.4 Data Management

Pelican and swan count data collected on "day one" of each survey were recorded directly onto maps of the estuary or were recorded on audiotape (hand-held cassette recorder) and later transcribed to maps. A hand-held 35mm camera was used to photograph pelican flocks too large to count from the air and bird

numbers were later determined from photographic prints using a dissecting microscope at low power.

All other waterbird data were recorded on audiotape or, less frequently, in notebooks. These audiotape recordings were later transcribed onto maps of the estuary. The estuary was divided into ten survey sectors and the number of birds of each species was totalled for each sector. These sector totals were then summed, using Microsoft Excel, to produce totals for Peel Inlet and Harvey Estuary individually and Peel-Harvey Estuary combined.

Copies of the 1998-99 data, including detailed distributional data, have been stored off-site for security.

6. RESULTS

6.1 Species

Fifty six species of waterbirds were recorded during the 1998-99 waterbird surveys. These represented 16 families and 40 genera (Table 1).

16 were transequatorial migratory species with their breeding grounds in the northern hemisphere. All of these migrant species are "shorebirds", also commonly referred to as "waders".

21 of the 56 species are listed on the Japan-Australia (JAMBA) or China-Australia (CAMBA) Migratory Bird Agreements (Commonwealth of Australia 1995a, 1995b). 18 species are listed on JAMBA and 20 are listed on CAMBA. 17 species are listed on both agreements.

46 species were recorded during the October 1998 survey; 45 were recorded in December 1998 and 48 in February 1999 (Appendix 1).

All ten sectors (Figure 2) were surveyed in December 1998 and February 1999. However, in October 1998 only sectors 1, 2, 6 and 10 were surveyed. The numbers of waterbird species recorded in these four sectors in October 1998, December 1998 and February 1999 were 46, 44 and 46 respectively (Appendix 2).

39 species were each recorded in all three survey months; 10 species were each recorded in only one of the survey months (Appendix 1).

Three domestic geese (*Anser* sp.) were seen on the estuarine pool near the City of Mandurah offices (Sector 1) on 16 February 1999. These introduced birds are not included in any appendices, tables or analyses of this report.

6.2 Abundance

The minimum number of waterbirds that made use of Peel-Harvey Estuary at some time during 1998-99 was 44,939 (Table 1). This is the sum of the maximum monthly (October, December or February) count of each individual species.

The highest single monthly (Oct, Dec or Feb) count of all species was 41,643 in December 1998 (Appendix 1).

The most abundant species (11 species; each more than 1,000 individuals) were Red-necked Stint (16,436), Grey Teal (4,581), Australian Shelduck (3,890), Silver Gull (3,383), Little Black Cormorant (2,636), Red-capped Plover (1,754), Little Pied Cormorant (1,693), Black-winged Stilt (1,400), Red-necked Avocet (1,399), Sharp-tailed Sandpiper (1,322) and Black Swan (1,130) (Table 1).

The minimum number of identified ducks that made use of Peel-Harvey Estuary during 1998-99 was 9,318 (Table 1). The highest single monthly count of all ducks, including ducks unidentified to species, was 8,618 in December 1998 (Appendix 4). The most numerous (more than 1,000 individuals) were

Table 1. Waterbird species and maximum numbers counted on Peel-Harvey Estuary during 1998-99. (Scientific and common names are those of Christidis & Boles 1994. Transequatorial migrants are denoted by [M], JAMBA species by [J] and CAMBA species by [C]).

Family Name	Group and Scientific Names	Common Name	Max. Count
ANATIDAE	**Ducks & allies**		
	Biziura lobata	Musk Duck	48
	Cygnus atratus	Black Swan	1130
	Tadorna tadornoides	Australian Shelduck	3890
	Chenonetta jubata	Australian Wood Duck	4
	Anas superciliosa	Pacific Black Duck	693
	Anas rhynchotis	Australasian Shoveler	100
	Anas gracilis	Grey Teal	4581
	Malacorhynchus membranaceus	Pink-eared Duck	2
PODICIPEDIDAE	**Grebes**		
	Podiceps cristatus	Great Crested Grebe	18
ANHINGIDAE	**Darters**		
	Anhinga melanogaster	Darter	79
PHALACROCORACIDAE	**Cormorants**		
	Phalacrocorax melanoleucos	Little Pied Cormorant	1693
	Phalacrocorax varius	Pied Cormorant	727
	Phalacrocorax sulcirostris	Little Black Cormorant	2636
	Phalacrocorax carbo	Great Cormorant	30
PELECANIDAE	**Pelicans**		
	Pelecanus conspicillatus	Australian Pelican	774
ARDEIDAE	**Herons, Egrets, Bitterns**		
	Egretta novaehollandiae	White-faced Heron	126
	Egretta garzetta	Little Egret	78
	Egretta sacra [C]	Eastern Reef Egret	2
	Ardea alba [CJ]	Great Egret	88
	Nycticorax caledonicus	Nankeen Night Heron	2
THRESKIORNITHIDAE	**Ibises, Spoonbills**		
	Threskiornis molucca	Australian White Ibis	70
	Platalea flavipes	Yellow-billed Spoonbill	10
ACCIPITRIDAE	**Osprey, Kite, Eagles, Harriers**		
	Pandion haliaetus	Osprey	1
	Haliastur sphenurus	Whistling Kite	8
	Haliaeetus leucogaster [C]	White-bellied Sea-Eagle	3
	Circus approximans	Swamp Harrier	4
RALLIDAE	**Rails, Crakes, Water hens, Coot**		
	Porphyrio porphyrio	Purple Swamphen	2
	Fulica atra	Eurasian Coot	2
SCOLOPACIDAE	**Sandpipers, Knots, Stint & allies**		
	Limosa lapponica [CJM]	Bar-tailed Godwit	137
	Numenius phaeopus [CJM]	Whimbrel	4
	Numenius madagascariensis [CJM]	Eastern Curlew	24
SCOLOPACIDAE contd.	*Tringa nebularia* [CJM]	Common Greenshank	319
	Xenus cinereus [CJM]	Terek Sandpiper	2
	Actitis hypoleucos [CJM]	Common Sandpiper	18
	Heteroscelis brevipes [CJM]	Grey-tailed Tattler	9
	Arenaria interpres [CJM]	Ruddy Turnstone	2

Table 1 continued.

Family Name	Group and Scientific Names	Common Name	Max. Count
	Calidris tenuirostris [CJM]	Great Knot	37
	Calidris canutus [CJM]	Red Knot	34
	Calidris ruficollis [CJM]	Red-necked Stint	16436
	Calidris acuminata [CJM]	Sharp-tailed Sandpiper	1322
	Calidris ferruginea [CJM]	Curlew Sandpiper	566
HAEMATOPODIDAE	**Oystercatchers**		
	Haematopus longirostris	Pied Oystercatcher	20
RECURVIROSTRIDAE	**Stilts, Avocets**		
	Himantopus himantopus	Black-winged Stilt	1400
	Cladorhynchus leucocephalus	Banded Stilt	186
	Recurvirostra novaehollandiae	Red-necked Avocet	1399
CHARADRIIDAE	**Plovers, Dotterels**		
	Pluvialis fulva [CJM]	Pacific Golden Plover	29
	Pluvialis squatarola [CJM]	Grey Plover	81
	Charadrius ruficapillus	Red-capped Plover	1754
	Charadrius leschenaultii [CJM]	Greater Sand Plover	3
LARIDAE	**Gulls, Terns**		
	Larus novaehollandiae	Silver Gull	3383
	Sterna caspia [C]	Caspian Tern	298
	Sterna bergii [J]	Crested Tern	121
	Sterna nereis	Fairy Tern	167
	Chlidonias hybridus	Whiskered Tern	337
MELIPHAGIDAE	**Honeyeaters, Australian Chats**		
	Ephthianura albifrons	White-fronted Chat	28
SYLVIDAE	**Old World Warblers**		
	Megalurus gramineus	Little Grassbird	22
TOTALS		**56 species**	**44 939 birds**

Grey Teal (4,581) and Australian Shelduck (3,890). The next most abundant (more than 100 individuals) was Pacific Black Duck (693).

The minimum number of identified cormorants that made use of Peel-Harvey Estuary during 1998-99 was 5,086 (Table 1). The highest single monthly count of all cormorants, including cormorants unidentified to species, was 4,325 in December 1998 (Appendix 5). The most numerous (more than 1,000 individuals) were Little Black Cormorant (2,636) and Little Pied Cormorant (1,693). Great Cormorants were not abundant (maximum of 30 in December 1998).

The minimum number of identified terns that made use of Peel-Harvey Estuary during 1998-99 was 923 (Table 1). The highest single monthly count of all terns, including terns unidentified to species, was 691 in December 1998 (Appendix 8). The two most abundant species were Whiskered Tern (337) and Caspian Tern (298).

The minimum number of transequatorial migratory shorebirds that made use of Peel-Harvey Estuary during 1998-99 was 19,023 (Table 1). The most numerous (more than 1,000 individuals) of these were Red-necked Stint (16,436) and Sharp-tailed Sandpiper (1,322). The next most abundant (more than 100 individuals) were Curlew Sandpiper (566), Common Greenshank (319) and Bar-tailed Godwit (137).

The highest single monthly count of knots was 98 (including 27 unidentified to species) in October 1998 (Appendix 6). The highest counts of Great Knot and Red Knot were 37 and 34 respectively.

The most recent compilation of maximum counts of individual waterbird species on wetlands across the south-west of Western Australia (Kalbarri – Cape Arid) is that of Jaensch, Merrifield & Raines (1993) and covers the period 1981-92. Maximum 1998-99 Peel-Harvey counts of 14 species were equal to or greater than those reported by Jaensch, Merrifield & Raines (Table 2).

Table 2. The 14 species with equal or higher 1998-99 Peel-Harvey counts than reported for any wetland in south-western Australia for the period 1981-92.

Species	Max. 1998-99 Peel-Harvey Count	Max. 1981-92 SW Wetlands Count	Location of Maximum 1981-92 South-West Wetlands Count
Darter	79	45	West Corio Swamp (near Pinjarra)
Little Pied Cormorant	1693	1000	Carraburmup Swamp (near Peel Inlet)
Pied Cormorant	727	519	Peel Inlet East & South
Australian Pelican	774	750	Vasse-Wonnerup Estuary
Little Egret	78	21	Creery Marshes (Peel Inlet)
Eastern Reef Egret	2	1	Not given
White-bellied Sea-Eagle	3	2	Not given
Eastern Curlew	24	23	King River Mouth (Oyster Harbour)
Common Greenshank	319	213	Peel Inlet East & South
Common Sandpiper	18	18	Peel Inlet Entrance
Red-necked Stint	16436	10000	Alfred Cove (Swan River)
Caspian Tern	298	60	Peel Inlet
Crested Tern	121	113	Gordon Inlet
Fairy Tern	167	102	Alfred Cove (Swan River)

The minimum number of individuals of bird species listed under JAMBA or CAMBA that made use of Peel-Harvey Estuary during 1998-99 was 19,535 (Table 1). The most numerous (more than 1,000 individuals) of these were Red-necked Stint (16,436) and Sharp-tailed Sandpiper (1,322). The next most abundant (more than 100 individuals) were Curlew Sandpiper (566), Common Greenshank (319), Caspian Tern (298), Bar-tailed Godwit (137), and Crested Tern (121).

Fifteen of the 56 species had maximum counts of less than 10 individuals (Table 1).

6.3 Distribution

In each of the three survey months, more waterbirds were recorded in south-eastern Peel Inlet (sector 6) than in any other survey sector of Peel-Harvey (Appendix 1). The highest number recorded in this sector was 20,324 in December 1998. The lowest number in this sector was 6,439 in February 1999.

The survey sectors in which waterbirds were generally "next most abundant" were the southern end of Harvey Estuary (sector 10) and north-central Peel Inlet (sector 2). The number of waterbirds counted in sector 10 ranged from 933 in October 1998 to 13,780 in December 1998. The number counted in sector 2 ranged from 3,112 in February 1999 to 3,653 in December 1998.

The most abundant species (Red-necked Stint) was most numerous in sector 10 (11,005 birds in December 1998) and sector 6 (4,881 birds in December 1998). The second most abundant species (Grey Teal) was also most numerous in sectors 6 and 10 (4,165 and 350 respectively in December 1998).

In October 1998, sector 6 had the highest diversity (36) of species. Sector 2 had the highest diversity (36) in December 1998 and sector 10 had the highest (35) in February 1999.

6.4 Breeding

Three species of waterbirds were recorded breeding during the 1998-99 waterbird surveys. These were Black Swan, Pacific Black Duck and Silver Gull (see Appendix 9 for details).

No swan nest mounds were found. Fourteen cygnets, at least six of which were large downy cygnets, were seen in Austin Bay in October 1998. Four large cygnets were at the southern end of Harvey Estuary in December 1998. There were two cygnets near Point Birch in February 1999.

Two broods of Pacific Black Duck ducklings were seen in October 1998, at the eastern end of Creery lagoon and the entrance to Yunderup Canals. A single Pacific Black Duck duckling was encountered at the Harvey River delta in the same month.

Silver Gull nests with eggs were found on Boodalan Island in October 1998 and some recently fledged juveniles were seen there in December 1998.

7. DISCUSSION

7.1 Waterbirds on Peel-Harvey following Construction of Dawesville Channel

It is apparent from the 1998-99 data that, 4-5 years following construction of the Dawesville Channel, Peel-Harvey Estuary remained one of the most important waterbird habitats in Western Australia. Only two other wetlands in south-western Australia have counts higher than the 41,643 recorded on Peel-Harvey in December 1998. These are Lake Muir (51,613 birds in March 1989; Halse et al 1990) and Culham Inlet (an estimate of 44,000 Banded Stilt in October 1986; ANCA 1996).

The number of waterbird species (56 spp) recorded on Peel-Harvey Estuary during the three surveys of 1998-99 is significantly less than a number previously reported (86 spp) for all pre-1996 Peel-Harvey surveys combined (ANCA 1996). That the first-mentioned number is lower is to be expected as waterbirds are highly mobile species and species lists for individual wetlands typically grow as more surveys are conducted. Some of the 86 species are vagrant shorebirds that have been listed as a result of considerable survey effort over several decades. These have a low probability of being recorded in any one year. Also, as mentioned above in section 5.3, the survey methods of 1998-99 were not well suited to finding secretive species such as crakes and rails. Further consideration of species presence/absence data is proposed for a later report, when the results of all three surveys (1976-77, 1996-97 and 1998-99) will be compared.

Waterbirds were unevenly distributed within Peel-Harvey Estuary during the 1998-99 surveys, with the greatest numbers of birds occurring in south-eastern Peel Inlet (Austin and Robert Bays), the southern end of Harvey Estuary and north-central Peel Inlet. This is consistent with the findings of previous surveys. The first and last areas are largely within formal conservation reserves. The southern end of Harvey Estuary has a conservation reserve adjoining its eastern shore but is otherwise largely unprotected.

7.2 Impacts of Dawesville Channel on Waterbirds

The second aim of the project that is the subject of this report is to identify any significant impacts of construction of the Dawesville Channel on waterbird species, numbers and distributions. Before a proper assessment can be made it will be necessary to report the results of the "baseline" surveys that were undertaken in 1976-77 (J. Lane unpublished data). This work is underway.

7.3 Ramsar Convention Status of Peel-Harvey Estuary

In 1990, Peel-Harvey Estuary was listed, jointly with Lakes McLarty, Mealup and the Yalgorup Lakes, as a Wetland of International Importance under the Ramsar Convention. At that time, the estuary met the following three Ramsar Criteria (note that a site need only meet one Ramsar Criterion to be eligible for listing).

1. It is a particularly good example of a specific type of wetland, characteristic of its region.
3a. It regularly supports 20,000 waterfowl.
3c. Where data on populations are available, it regularly supports 1% of the individuals in a population of one species or subspecies of waterfowl.

Since listing in 1990, the Ramsar Criteria have been further developed and re-numbered by Ramsar Conferences of Contracting Parties. The current equivalents of the above Criteria are as follows.

1. It contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
5. It regularly supports 20,000 or more waterbirds.
6. It regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

Of interest in the context of this report is whether or not Peel-Harvey Estuary continues to meet Ramsar Criteria 5 and 6 following opening of the Dawesville Channel in April 1994. However, before addressing these questions it is necessary to consider how the word "regularly" should be interpreted.

Rose & Scott (1997) suggested (with the implication that this approach should be applied where substantial data sets exist) use of five-year averages of annual maxima in waterbird numbers for determining whether the relevant levels (20,000 birds or 1% of population) occur "regularly". The Ramsar Bureau (2000) has supported this approach and also suggested an alternative based on numbers counted in at least two thirds of seasons for which data are available. Importantly, the Bureau has also recognised that situations exist (e.g. drought refuges or difficulty in obtaining data) where data collected over shorter time periods may be acceptable for determining a wetland's importance for waterbirds.

In relation to nomination of Western Australian wetlands for listing under the Ramsar Convention, Jaensch and Watkins (1999) have recommended the following approach.

> "In regard to criterion 3 (a), the existence of reliable counts of 20,000 waterbirds, or highest counts (during one year) of individual species which sum to 20,000 waterbirds, in at least several of the past 25 years and with no clear evidence of recent decline in numbers, was considered an adequate basis for criterion 3 (a) to be met. Where few surveys had been conducted at the site but there was evidence of recurrence in at least several of the past 25 years of the wetland conditions that had on at least one occasion supported 20,000 waterbirds, the criterion was considered met (especially if the highest numbers were well in excess of 20,000 waterbirds, e.g. 100,00)".
>
> "In testing against [criterion 3c], it was decided that there should be no clear evidence of recent decline in numbers to below the 1% level".

The present authors support the approach recommended by Jaensch and Watkins (1999) and have applied this to Peel-Harvey as follows.

Ramsar Criterion 5.

It is clear from the results of the 1998-99 waterbird surveys reported above that Peel-Harvey Estuary supported more than 20,000 waterbirds in 1998-99. At least 44,939 waterbirds made use of Peel-Harvey at some time during 1998-99 and 41,643 waterbirds were present in December 1998. On this basis it is concluded that, in 1998-99, Peel-Harvey Estuary continued to meet Ramsar Criterion 5 (formerly 3a) for inclusion in the List of Wetlands of International Importance.

Ramsar Criterion 6

"One percent of population" levels have been published for 25 of the 56 waterbird species recorded on Peel-Harvey Estuary during 1998-99 (Watkins and AWSG 1993, Rose and Scott 1997). These species are listed in Appendix 11, together with their respective maximum 1998-99 counts and 1% levels.

Five species, Red-necked Stint, Red-necked Avocet, Red-capped Plover, Caspian Tern and Fairy Tern,

had maximum 1998-99 Peel-Harvey counts that were greater than their respective 1% levels (Table 3). On this basis it is concluded that, in 1998-99, Peel-Harvey Estuary continued to meet Ramsar Criterion 6 (formerly 3c) for inclusion in the List of Wetlands of International Importance.

Table 3. Species with maximum 1998-99 Peel-Harvey counts exceeding 1% population levels.

Species	Maximum Peel-Harvey count in 1998-99	One Percent Level of relevant population	Distribution of relevant population (Rose and Scott 1997)
Red-necked Stint	16436	4700	E Siberia/SE&E Asia/Aust/NZ
Red-necked Avocet	1399	1100	Australia
Red-capped Plover	1754	950	Australia
Caspian Tern	298	30	Australia/New Zealand
Fairy Tern	167	60	Western Australia

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APPENDICES

APPENDIX 1. Waterbird species and numbers counted in all survey sectors of Peel-Harvey Estuary during October 1998, December 1998 and February 1999.

		PEEL								HARVEY				Grand Total
Species	Month	1	2	3	4 [3]	5 [3]	6	7	Total	8	9	10	Total	
Musk Duck	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	40	0	**40**	0	4	4	**8**	**48**
Black Swan	Oct	0	0	0	0	0	1125	0	**1125**	0	0	5	**5**	**1130**
	Dec	0	0	0	0	0	458	0	**458**	0	0	3	**3**	**461**
	Feb	0	26	0	15	0	142	0	**183**	0	0	183	**183**	**366**
Australian Shelduck	Oct	0	297			*6*	3500		**3803**			87	**87**	**3890**
	Dec	0	342	56	22	42	3073	7	**3542**	0	2	129	**131**	**3673**
	Feb	0	140	2	49	24	277	31	**523**	0	10	123	**133**	**656**
Australian Wood Duck	Oct	0	0				0		**0**			4	**4**	**4**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
Pacific Black Duck	Oct	0	155				450		**605**			88	**88**	**693**
	Dec	2	7	17	0	0	224	2	**252**	0	12	100	**112**	**364**
	Feb	9	15	0	95	4	71	2	**196**	0	40	226	**266**	**462**
Australasian Shoveler	Oct	0	0				100		**100**			0	**0**	**100**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
Grey Teal	Oct	0	51				100		**151**			53	**53**	**204**
	Dec	0	28	10	3	0	4165	3	**4209**	3	19	350	**372**	**4581**
	Feb	0	4	0	10	0	372	2	**388**	0	0	300	**300**	**688**
Pink-eared Duck	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	0	0	2	**2**	**2**
Great Crested Grebe	Oct	0	0				18		**18**			0	**0**	**18**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	4	0	**4**	0	0	0	**0**	**4**

APPENDIX 1. Continued.

		PEEL								HARVEY				Grand Total
Species	**Month**	**1**	**2**	**3**	**4** [3]	**5** [3]	**6**	**7**	**Total**	**8**	**9**	**10**	**Total**	
Darter	Oct	11	9		*4*	*1*	7		**32**			11	**11**	**43**
	Dec	4	7	4	2	2	8	0	**27**	3	4	7	**14**	**41**
	Feb	4	5	3	10	21	4	0	**47**	6	7	19	**32**	**79**
Little Pied Cormorant	Oct	27	25			*1*	187		**240**			25	**25**	**265**
	Dec	31	143	0	140	0	203	165	**682**	107	128	15	**250**	**932**
	Feb	33	323	0	195	1	486	261	**1299**	175	154	65	**394**	**1693**
Pied Cormorant	Oct	34	36				310		**380**			2	**2**	**382**
	Dec	20	84	0	5	0	491	13	**613**	82	29	3	**114**	**727**
	Feb	30	58	0	5	0	54	40	**187**	58	15	11	**84**	**271**
Little Black Cormorant	Oct	1	300				8		**309**			5	**5**	**314**
	Dec	2	604	0	4	0	2011	0	**2621**	0	5	10	**15**	**2636**
	Feb	6	34	0	3	180	610	3	**836**	6	2	531	**539**	**1375**
Great Cormorant	Oct	0	1		*1*		10		**12**			2	**2**	**14**
	Dec	0	12	0	0	5	9	0	**26**	2	0	2	**4**	**30**
	Feb	0	6	0	1	6	1	1	**15**	0	0	7	**7**	**22**
Australian Pelican	Oct	28	70	1	47	44	90	4	**284**	36	39	34	**109**	**393**
	Dec	3	121	2	48	20	38	11	**243**	15	10	31	**56**	**299**
	Feb	2	103	39	35	65	361	93	**698**	4	21	51	**76**	**774**
White-faced Heron	Oct	0	4				4		**8**			2	**2**	**10**
	Dec	0	23	2	5	0	64	2	**96**	3	15	3	**21**	**117**
	Feb	0	28	1	12	6	61	2	**110**	6	7	3	**16**	**126**
Little Egret	Oct	0	13			*1*	15		**29**			3	**3**	**32**
	Dec	0	7	1	1	1	40	0	**50**	4	5	8	**17**	**67**
	Feb	0	39	0	1	2	18	0	**60**	1	0	17	**18**	**78**
Eastern Reef Egret	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	2	0	0	0	0	0	0	**2**	0	0	0	**0**	**2**

APPENDIX 1. Continued.

		PEEL								HARVEY				Grand Total
Species	**Month**	**1**	**2**	**3**	**4** [3]	**5** [3]	**6**	**7**	**Total**	**8**	**9**	**10**	**Total**	
Great Egret	Oct	0	7				7		**14**			9	**9**	**23**
	Dec	0	5	5	4	0	33	1	**48**	9	7	8	**24**	**72**
	Feb	0	3	0	5	2	30	4	**44**	4	12	28	**44**	**88**
Nankeen Night Heron	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	2	0	0	0	0	0	0	**2**	0	0	0	**0**	**2**
	Feb	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
Australian White Ibis	Oct	0	4				1		**5**			0	**0**	**5**
	Dec	0	12	0	2	4	0	0	**18**	0	0	1	**1**	**19**
	Feb	0	43	6	5	11	1	0	**66**	3	0	1	**4**	**70**
Yellow-billed Spoonbill	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	0	0	1	0	0	0	**1**	0	0	0	**0**	**1**
	Feb	0	9	0	0	0	0	0	**9**	0	0	1	**1**	**10**
Osprey	Oct	0	1				0		**1**			0	**0**	**1**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	1	0	0	0	**1**	0	0	0	**0**	**1**
Whistling Kite	Oct	0	0				5		**5**			3	**3**	**8**
	Dec	0	0	0	0	1	0	0	**1**	0	0	4	**4**	**5**
	Feb	0	0	0	0	0	1	0	**1**	0	0	2	**2**	**3**
White-bellied Sea-Eagle	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	1	0	0	0	0	0	**1**	0	0	0	**0**	**1**
	Feb	0	0	0	0	0	0	0	**0**	0	0	3	**3**	**3**
Swamp Harrier	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	2	0	0	0	1	0	**3**	0	0	1	**1**	**4**
	Feb	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
Purple Swamphen	Oct	0	0				0		**0**			1	**1**	**1**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	0	0	2	**2**	**2**

APPENDIX 1. Continued.

		PEEL								HARVEY				Grand Total
Species	**Month**	**1**	**2**	**3**	**4** [3]	**5** [3]	**6**	**7**	**Total**	**8**	**9**	**10**	**Total**	
Eurasian Coot	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	2	0	**2**	0	0	0	**0**	**2**
Bar-tailed Godwit	Oct	0	43				2		**45**			0	**0**	**45**
	Dec	9	17	0	4	32	0	0	**62**	0	5	7	**12**	**74**
	Feb	0	64	12	0	57	0	0	**133**	0	0	4	**4**	**137**
Whimbrel	Oct	0	4				0		**4**			0	**0**	**4**
	Dec	0	1	0	0	0	0	0	**1**	0	0	0	**0**	**1**
	Feb	0	2	0	0	0	0	0	**2**	0	0	0	**0**	**2**
Eastern Curlew	Oct	0	15				0		**15**			0	**0**	**15**
	Dec	0	14	0	0	1	9	0	**24**	0	0	0	**0**	**24**
	Feb	0	5	0	0	9	1	0	**15**	0	0	0	**0**	**15**
Common Greenshank	Oct	1	56			*1*	52		**110**			20	**20**	**130**
	Dec	1	79	22	8	10	120	0	**240**	1	2	50	**53**	**293**
	Feb	0	80	1	9	20	77	0	**187**	38	1	93	**132**	**319**
Terek Sandpiper	Oct	0	2				0		**2**			0	**0**	**2**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
Common Sandpiper	Oct	1	1				5		**7**			0	**0**	**7**
	Dec	7	4	0	0	0	1	0	**12**	0	6	0	**6**	**18**
	Feb	0	2	0	0	0	0	0	**2**	0	2	0	**2**	**4**
Grey-tailed Tattler	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	2	0	1	3	0	0	**6**	0	0	3	**3**	**9**
	Feb	0	0	0	7	0	0	0	**7**	0	0	0	**0**	**7**
Ruddy Turnstone	Oct	0	0				2		**2**			0	**0**	**2**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**

APPENDIX 1. Continued.

		PEEL								HARVEY				Grand Total
Species	**Month**	**1**	**2**	**3**	**4** [3]	**5** [3]	**6**	**7**	**Total**	**8**	**9**	**10**	**Total**	
Great Knot	Oct	0	37				0		**37**			0	**0**	**37**
	Dec	0	2	1	0	1	0	0	**4**	0	0	19	**19**	**23**
	Feb	0	0	0	0	0	0	0	**0**	0	0	1	**1**	**1**
Red Knot	Oct	0	33				1		**34**			0	**0**	**34**
	Dec	0	11	0	0	0	0	0	**11**	0	0	2	**2**	**13**
	Feb	0	24	0	0	0	0	0	**24**	2	0	1	**3**	**27**
Red-necked Stint	Oct	0	1290				3592		**4882**			6	**6**	**4888**
	Dec	0	318	170	62	0	4881	0	**5431**	0	0	11005	**11005**	**16436**
	Feb	0	419	63	2	65	1562	0	**2111**	1	10	2822	**2833**	**4944**
Sharp-tailed Sandpiper	Oct	0	41				156		**197**			1	**1**	**198**
	Dec	0	654	40	15	0	192	0	**901**	0	0	421	**421**	**1322**
	Feb	0	241	0	0	14	1	0	**256**	0	0	16	**16**	**272**
Curlew Sandpiper	Oct	0	60				175		**235**			0	**0**	**235**
	Dec	0	0	1	0	0	1	0	**2**	0	0	564	**564**	**566**
	Feb	0	0	0	0	0	0	0	**0**	0	0	336	**336**	**336**
Pied Oystercatcher	Oct	0	3			*2*	4		**9**			2	**2**	**11**
	Dec	0	3	3	4	4	1	0	**15**	0	0	5	**5**	**20**
	Feb	3	2	2	4	0	0	0	**11**	4	0	0	**4**	**15**
Black-winged Stilt	Oct	0	58				292		**350**			11	**11**	**361**
	Dec	0	218	93	21	0	949	0	**1281**	0	0	42	**42**	**1323**
	Feb	0	434	0	19	46	752	1	**1252**	0	0	148	**148**	**1400**
Banded Stilt	Oct	0	0				58		**58**			0	**0**	**58**
	Dec	0	0	3	0	0	12	0	**15**	0	0	0	**0**	**15**
	Feb	0	176	0	0	0	10	0	**186**	0	0	0	**0**	**186**
Red-necked Avocet	Oct	0	0				16		**16**			220	**220**	**236**
	Dec	0	0	561	0	125	329	0	**1015**	0	0	384	**384**	**1399**
	Feb	0	0	1	0	0	0	0	**1**	0	0	0	**0**	**1**

APPENDIX 1. Continued

		PEEL								HARVEY				Grand Total
Species	**Month**	**1**	**2**	**3**	**4** [3]	**5** [3]	**6**	**7**	**Total**	**8**	**9**	**10**	**Total**	
Pacific Golden Plover	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	0	0	0	0	0	0	**0**	0	0	29	**29**	**29**
	Feb	0	0	0	0	0	0	0	**0**	0	0	22	**22**	**22**
Grey Plover	Oct	0	25				0		**25**			7	**7**	**32**
	Dec	4	20	2	1	3	0	0	**30**	3	2	13	**18**	**48**
	Feb	4	33	5	9	8	1	0	**60**	0	2	19	**21**	**81**
Red-capped Plover	Oct	0	85				575		**660**			8	**8**	**668**
	Dec	1	110	40	5	0	1500	0	**1656**	0	2	96	**98**	**1754**
	Feb	0	72	46	1	0	673	0	**792**	4	8	250	**262**	**1054**
Greater Sand Plover	Oct	0	0				3		**3**			0	**0**	**3**
	Dec	0	2	0	0	1	0	0	**3**	0	0	0	**0**	**3**
	Feb	0	0	0	0	0	0	0	**0**	0	2	0	**2**	**2**
Silver Gull	Oct	161	282		*1*	*6*	1138		**1588**			143	**143**	**1731**
	Dec	416	628	136	139	343	1145	12	**2819**	12	196	356	**564**	**3383**
	Feb	542	590	79	138	8	446	6	**1809**	7	201	263	471	**2280**
Caspian Tern	Oct	1	20				16		**37**			13	**13**	**50**
	Dec	0	43	20	8	10	8	4	**93**	2	14	31	**47**	**140**
	Feb	0	96	27	22	17	28	2	**192**	20	27	59	**106**	**298**
Crested Tern	Oct	25	12				23		**60**			0	**0**	**60**
	Dec	4	12	0	1	0	13	1	**31**	1	47	0	**48**	**79**
	Feb	5	18	5	8	0	52	3	**91**	0	14	16	**30**	**121**
Fairy Tern	Oct	22	23				0		**45**			0	**0**	**45**
	Dec	52	32	26	0	0	36	0	**146**	0	21	0	**21**	**167**
	Feb	0	0	0	0	0	0	0	**0**	0	0	50	**50**	**50**
Whiskered Tern	Oct	0	0				213		**213**			124	**124**	**337**
	Dec	0	0	0	0	0	305	0	**305**	0	0	0	**0**	**305**
	Feb	0	0	0	0	0	70	0	**70**	0	0	0	**0**	**70**

APPENDIX 1. Continued

		PEEL								HARVEY				Grand Total
Species	**Month**	**1**	**2**	**3**	**4** [3]	**5** [3]	**6**	**7**	**Total**	**8**	**9**	**10**	**Total**	
White-fronted Chat	Oct	0	24				0		**24**			4	**4**	**28**
	Dec	0	3	0	0	0	3	0	**6**	0	0	0	**0**	**6**
	Feb	0	2	0	0	0	0	0	**2**	0	0	0	**0**	**2**
Little Grassbird	Oct	0	20				2		**22**			0	**0**	**22**
	Dec	0	19	0	0	0	1	0	**20**	0	0	0	**0**	**20**
	Feb	0	16	0	1	0	0	0	**17**	0	0	0	**0**	**17**
Sub Total	**Oct**	312	3107	*1*	*53*	*62*	12262	*4*	**15801**	*36*	*39*	893	**968**	**16769**
Sub Total	**Dec**	558	3590	1215	506	608	20324	221	**27022**	247	531	13702	**14480**	**41502**
Sub Total	**Feb**	640	3112	292	662	566	6208	451	**11931**	339	539	5679	**6557**	**18488**
Unidentified ducks	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	38	0	**38**	0	0	0	**0**	**38**
Unidentified cormorants	Oct	0	0				2		**2**			0	**0**	**2**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
Unidentified knots	Oct	0	27				0		**27**			0	**0**	**27**
	Dec	0	0	0	0	0	0	0	**0**	0	0	28	**28**	**28**
	Feb	0	0	0	0	1	0	0	**1**	0	0	0	**0**	**1**
Unidentified waders (stint/sandpiper size)	Oct	0	4				60		**64**			40	**40**	**104**
	Dec	0	63	0	0	0	0	0	**63**	0	0	50	**50**	**113**
	Feb	0	0	0	0	0	193	0	**193**	2	0	200	**202**	**395**
Unidentified terns	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	3	7	0	**10**	**10**
Sub Total	**Oct**	0	31	*0*	*0*	*0*	62	*0*	**93**	*0*	*0*	40	**40**	**133**
Sub Total	**Dec**	0	63	0	0	0	0	0	**63**	0	*0*	78	**78**	**141**
Sub Total	**Feb**	0	0	0	0	1	231	0	**232**	5	7	200	**212**	**444**

APPENDIX 1. Continued

		PEEL								HARVEY				Grand Total
	Month	1	2	3	4 [3]	5 [3]	6	7	Total	8	9	10	Total	
GRAND TOTAL	**Oct**	312	3138	*1*	*53*	*62*	12324	*4*	**15894**	*36*	*39*	933	**1008**	**16902**
GRAND TOTAL	**Dec**	558	3653	1215	506	608	20324	221	**27085**	247	531	13780	**14558**	**41643**
GRAND TOTAL	**Feb**	640	3112	292	662	567	6439	451	**12163**	344	546	5879	**6769**	**18932**
TOTAL N° OF SPECIES	**Oct**	11	35	*1*	*3*	*7*	36	*1*	**44**	*1*	*1*	28	**28**	**46**
TOTAL N° OF SPECIES	**Dec**	14	36	22	24	18	32	11	**44**	14	17	32	**35**	**45**
TOTAL N° OF SPECIES	**Feb**	11	33	15	26	20	30	13	**42**	16	19	35	**38**	**48**

NOTES

1. In this Appendix, a blank in a sector cell indicates that the relevant sector was not surveyed for birds of that species in that month.
2. In this Appendix, a zero in a sector cell indicates that the sector was surveyed in that month, but no birds of that species were found.
3. In October 1998, sectors 4 and 5 were partially (very small parts) surveyed for all species (fully surveyed for swans and pelicans).
4. Some numbers in this Appendix appear in italics/small font. This is intended to show at a glance that, while some birds were counted, the relevant sector was not surveyed for all birds of that species (or, if a subtotal or total, for all birds of all species) in that month.

APPENDIX 2. Waterbird species and numbers counted in common survey sectors of Peel-Harvey Estuary during October 1998, December 1998 and February 1999.

	October 1998					December 1998					February 1999				
Species	**Sector 1**	**Sector 2**	**Sector 6**	**Sector 10**	**Total**	**Sector 1**	**Sector 2**	**Sector 6**	**Sector 10**	**Total**	**Sector 1**	**Sector 2**	**Sector 6**	**Sector 10**	**Total**
Musk Duck					**0**					**0**			40	4	**44**
Black Swan			1125	5	**1130**			458	3	**461**		26	142	183	**351**
Australian Shelduck		297	3500	87	**3884**		342	3073	129	**3544**		140	277	123	**540**
Australian Wood Duck				4	**4**					**0**					**0**
Pacific Black Duck		155	450	88	**693**	2	7	224	100	**333**	9	15	71	226	**321**
Australasian Shoveler			100		**100**					**0**					**0**
Grey Teal		51	100	53	**204**		28	4165	350	**4543**		4	372	300	**676**
Pink-eared Duck					**0**					**0**				2	**2**
Great Crested Grebe			18		**18**					**0**			4		**4**
Darter	11	9	7	11	**38**	4	7	8	7	**26**	4	5	4	19	**32**
Little Pied Cormorant	27	25	187	25	**264**	31	143	203	15	**392**	33	323	486	65	**907**
Pied Cormorant	34	36	310	2	**382**	20	84	491	3	**598**	30	58	54	11	**153**
Little Black Cormorant	1	300	8	5	**314**	2	604	2011	10	**2627**	6	34	610	531	**1181**
Great Cormorant		1	10	2	**13**		12	9	2	**23**		6	1	7	**14**
Australian Pelican	28	70	90	34	**222**	3	121	38	31	**193**	2	103	361	51	**517**
White-faced Heron		4	4	2	**10**		23	64	3	**90**		28	61	3	**92**
Little Egret		13	15	3	**31**		7	40	8	**55**		39	18	17	**74**
Eastern Reef Egret					**0**					**0**	2				**2**
Great Egret		7	7	9	**23**		5	33	8	**46**		3	30	28	**61**
Nankeen Night Heron					**0**	2				**2**					**0**
Australian White Ibis		4	1		**5**		12		1	**13**		43	1	1	**45**
Yellow-billed Spoonbill					**0**					**0**		9		1	**10**
Osprey		1			**1**					**0**					**0**
Whistling Kite			5	3	**8**				4	**4**			1	2	**3**
White-bellied Sea Eagle					**0**		1			**1**				3	**3**
Swamp Harrier					**0**		2	1	1	**4**					**0**

APPENDIX 2. Continued

	October 1998					December 1998					February 1999				
Species	**Sector 1**	**Sector 2**	**Sector 6**	**Sector 10**	**Total**	**Sector 1**	**Sector 2**	**Sector 6**	**Sector 10**	**Total**	**Sector 1**	**Sector 2**	**Sector 6**	**Sector 10**	**Total**
Purple Swamphen				1	**1**					**0**				2	**2**
Eurasian Coot					**0**					**0**			2		**2**
Bar-tailed Godwit		43	2		**45**	9	17		7	**33**		64		4	**68**
Whimbrel		4			**4**		1			**1**		2			**2**
Eastern Curlew		15			**15**		14	9		**23**		5	1		**6**
Common Greenshank	1	56	52	20	**129**	1	79	120	50	**250**		80	77	93	**250**
Terek Sandpiper		2			**2**					**0**					**0**
Common Sandpiper	1	1	5		**7**	7	4	1		**12**		2			**2**
Grey-tailed Tattler					**0**		2		3	**5**					**0**
Ruddy Turnstone			2		**2**					**0**					**0**
Great Knot		37			**37**		2		19	**21**				1	**1**
Red Knot		33	1		**34**		11		2	**13**		24		1	**25**
Red-necked Stint		1290	3592	6	**4888**		318	4881	11005	**16204**		419	1562	2822	**4803**
Sharp-tailed Sandpiper		41	156	1	**198**		654	192	421	**1267**		241	1	16	**258**
Curlew Sandpiper		60	175		**235**			1	564	**565**				336	**336**
Pied Oystercatcher		3	4	2	**9**		3	1	5	**9**	3	2			**5**
Black-winged Stilt		58	292	11	**361**		218	949	42	**1209**		434	752	148	**1334**
Banded Stilt			58		**58**			12		**12**		176	10		**186**
Red-necked Avocet			16	220	**236**			329	384	**713**					**0**
Pacific Golden Plover					**0**				29	**29**				22	**22**
Grey Plover		25		7	**32**	4	20		13	**37**	4	33	1	19	**57**
Red-capped Plover		85	575	8	**668**	1	110	1500	96	**1707**		72	673	250	**995**
Greater Sand Plover			3		**3**		2			**2**					**0**
Silver Gull	161	282	1138	143	**1724**	416	628	1145	356	**2545**	542	590	446	263	**1841**
Caspian Tern	1	20	16	13	**50**		43	8	31	**82**		96	28	59	**183**
Crested Tern	**25**	**12**	**23**		**60**	4	**12**	**13**		**29**	5	18	52	16	**91**
Fairy Tern	22	23			**45**	52	32	36		**120**				50	**50**
Whiskered Tern			213	124	**337**			305		**305**			70		70

APPENDIX 2. Continued

Species	October 1998					December 1998					February 1999				
	Sector 1	Sector 2	Sector 6	Sector 10	Total	Sector 1	Sector 2	Sector 6	Sector 10	Total	Sector 1	Sector 2	Sector 6	Sector 10	Total
White-fronted Chat		24		4	**28**		3	3		**6**		2			**2**
Little Grassbird		20	2		**22**		19	1		**20**		16			**16**
Sub Total	312	3107	12262	893	**16574**	558	3590	20324	13702	**38174**	640	3112	6208	5679	**15639**
Unidentified ducks					**0**					**0**			38		**38**
Unidentified cormorants			2		**2**					**0**					**0**
Unidentified knots		27			**27**				28	**28**					**0**
Unidentified waders		4	60	40	**104**		63		50	**113**			193	200	**393**
Sub Total	0	31	62	40	**133**	0	63	0	78	**141**	0	0	231	200	**431**
GRAND TOTAL	312	3138	12324	933	**16707**	558	3653	20324	13780	**38315**	640	3112	6439	5879	**16070**
TOTAL N° OF SPECIES	11	35	36	28	**46**	15	36	32	32	**44**	11	33	30	35	**46**

NOTES

1. In this Appendix, a blank in a sector cell indicates that the sector was surveyed for waterbirds in that month, but no birds of that species were found.

APPENDIX 3. Waterbird species and numbers counted in common survey sectors of Peel-Harvey Estuary during December 1998 and February 1999.

	December 1998											February 1999										
Species / Sectors	1	2	3	4	5	6	7	8	9	10	Total	1	2	3	4	5	6	7	8	9	10	Total
Musk Duck											**0**						40			4	4	**48**
Black Swan						458				3	**461**		26		15		142				183	**366**
Australian Shelduck		342	56	22	42	3073	7		2	129	**3673**		140	2	49	24	277	31		10	123	**656**
Pacific Black Duck	2	7	17			224	2		12	100	**364**	9	15		95	4	71	2		40	226	**462**
Grey Teal		28	10	3		4165	3	3	19	350	**4581**		4		10		372	2			300	**688**
Pink-eared Duck											**0**										2	**2**
Great Crested Grebe											**0**						4					**4**
Darter	4	7	4	2	2	8		3	4	7	**41**	4	5	3	10	21	4		6	7	19	**79**
Little Pied Cormorant	31	143		140		203	165	107	128	15	**932**	33	323		195	1	486	261	175	154	65	**1693**
Pied Cormorant	20	84		5		491	13	82	29	3	**727**	30	58		5		54	40	58	15	11	**271**
Little Black Cormorant	2	604		4		2011			5	10	**2636**	6	34		3	180	610	3	6	2	531	**1375**
Great Cormorant		12			5	9		2		2	**30**		6		1	6	1	1			7	**22**
Australian Pelican	3	121	2	48	20	38	11	15	10	31	**299**	2	103	39	35	65	361	93	4	21	51	**774**
White-faced Heron		23	2	5		64	2	3	15	3	**117**		28	1	12	6	61	2	6	7	3	**126**
Little Egret		7	1	1	1	40		4	5	8	**67**		39		1	2	18		1		17	**78**
Eastern Reef Egret											**0**	2										**2**
Great Egret		5	5	4		33	1	9	7	8	**72**		3		5	2	30	4	4	12	28	**88**
Nankeen Night Heron	2										**2**											**0**
Australian White Ibis		12		2	4					1	**19**		43	6	5	11	1		3		1	**70**
Yellow-billed Spoonbill				1							**1**		9								1	**10**
Osprey											**0**				1							**1**
Whistling Kite					1					4	**5**						1				2	**3**
White-bellied Sea Eagle		1									**1**										3	**3**
Swamp Harrier		2				1				1	**4**											**0**
Purple Swamphen											**0**										2	**2**
Eurasian Coot											**0**						2					**2**
Bar-tailed Godwit	9	17		4	32				5	7	**74**		64	12		57					4	**137**
Whimbrel		1									**1**		2									**2**

APPENDIX 3. Continued.

	December 1998											February 1999										
Species / Sectors	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Eastern Curlew		14			1	9					**24**		5			9	1					**15**
Common Greenshank	1	79	22	8	10	120		1	2	50	**293**		80	1	9	20	77		38	1	93	**319**
Common Sandpiper	7	4				1			6		**18**		2							2		**4**
Grey-tailed Tattler		2		1	3					3	**9**				7							**7**
Great Knot		2	1		1					19	**23**										1	**1**
Red Knot		11								2	**13**		24						2		1	**27**
Red-necked Stint		318	170	62		4881				11005	**16436**		419	63	2	65	1562		1	10	2822	**4944**
Sharp-tailed Sandpiper		654	40	15		192				421	**1322**		241			14	1				16	**272**
Curlew Sandpiper			1			1				564	**566**										336	**336**
Pied Oystercatcher		3	3	4	4	1				5	**20**	3	2	2	4				4			**15**
Black-winged Stilt		218	93	21		949				42	**1323**		434		19	46	752	1			148	**1400**
Banded Stilt			3			12					**15**		176				10					**186**
Red-necked Avocet			561		125	329				384	**1399**			1								**1**
Pacific Golden Plover										29	**29**										22	**22**
Grey Plover	4	20	2	1	3			3	2	13	**48**	4	33	5	9	8	1			2	19	**81**
Red-capped Plover	1	110	40	5		1500			2	96	**1754**		72	46	1		673		4	8	250	**1054**
Greater Sand Plover		2			1						**3**									2		**2**
Silver Gull	416	628	136	139	343	1145	12	12	196	356	**3383**	542	590	79	138	8	446	6	7	201	263	**2280**
Caspian Tern		43	20	8	10	8	4	2	14	31	**140**		96	27	22	17	28	2	20	27	59	**298**
Crested Tern	4	12		1		13	1	1	47		**79**	5	18	5	8		52	3		14	16	**121**
Fairy Tern	52	32	26			36			21		**167**										50	**50**
Whiskered Tern						305					**305**						70					**70**
White-fronted Chat		3				3					**6**		2									**2**
Little Grassbird		19				1					**20**		16		1							17
Sub Total	558	3590	1215	506	608	20324	221	247	531	13702	**41502**	640	3112	292	662	566	6208	451	339	539	5679	**18488**

APPENDIX 3. Continued.

	December 1998											February 1999										
Species / Sectors	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
Unidentified ducks											**0**						38					**38**
Unidentified knots										28	**28**					1						**1**
Unidentified waders		63								50	**113**						193		2		200	**395**
Unidentified terns											**0**								3	7		**10**
Sub Total	0	63	0	0	0	0	0	0	0	78	**141**	0	0	0	0	1	231	0	5	7	200	**444**
GRAND TOTAL	558	3653	1215	506	608	20324	221	247	531	13780	41643	640	3112	292	662	567	6439	451	344	546	5879	18932
TOTAL N° OF SPECIES	14	36	22	24	18	32	11	14	17	32	45	11	33	15	26	20	30	13	16	19	35	48

NOTES

1. In this Appendix, a blank in a sector cell indicates that the sector was surveyed for waterbirds in that month, but no birds of that species were found.

APPENDIX 4. Species and numbers of DUCKS (including unidentified ducks) counted in all survey sectors of Peel-Harvey Estuary during 1998-99.

		PEEL								HARVEY				Grand Total
Species	**Month**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**8**	**9**	**10**	**Total**	
Musk Duck	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	40	0	**40**	0	4	4	**8**	**48**
Australian Shelduck	Oct	0	297			*6*	3500		**3803**			87	**87**	**3890**
	Dec	0	342	56	22	42	3073	7	**3542**	0	2	129	**131**	**3673**
	Feb	0	140	2	49	24	277	31	**523**	0	10	123	**133**	**656**
Australian Wood Duck	Oct	0	0				0		**0**			4	**4**	**4**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
Pacific Black Duck	Oct	0	155				450		**605**			88	**88**	**693**
	Dec	2	7	17	0	0	224	2	**252**	0	12	100	**112**	**364**
	Feb	9	15	0	95	4	71	2	**196**	0	40	226	**266**	**462**
Australasian Shoveler	Oct	0	0				100		**100**			0	**0**	**100**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
Grey Teal	Oct	0	51				100		**151**			53	**53**	**204**
	Dec	0	28	10	3	0	4165	3	**4209**	3	19	350	**372**	**4581**
	Feb	0	4	0	10	0	372	2	**388**	0	0	300	**300**	**688**
Pink-eared Duck	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	0	0	2	**2**	**2**
Unidentified ducks	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	38	0	**38**	0	0	0	**0**	**38**
TOTAL N° OF DUCKS	**Oct**	0	503			*6*	4150		**4659**			232	**232**	**4891**
	Dec	2	377	83	25	42	7462	12	**8003**	3	33	579	**615**	**8618**
	Feb	9	159	2	154	28	798	35	**1185**	0	54	655	**709**	**1894**

APPENDIX 4. Cont.

		PEEL								HARVEY				Grand Total
	Month	1	2	3	4	5	6	7	Total	8	9	10	Total	
N° OF IDENTIFIED SPECIES	Oct	0	3			*1*	4		4			4	4	5
	Dec	1	3	3	2	1	3	3	3	1	3	3	3	3
	Feb	1	3	1	3	2	4	3	4	0	3	5	5	5

NOTES

1. In this Appendix, a blank in a sector cell indicates that the sector was not surveyed for birds of that species in that month.
2. In this Appendix, a zero in a sector cell indicates that the sector was surveyed in that month, but no birds of that species were found.
3. Some numbers in this Appendix appear in italics and small font. This indicates that, while some birds were counted, the relevant sector was not surveyed for all birds of that species (or, if a subtotal or total, for all individuals of all duck species) in that month.

APPENDIX 5. Species and numbers of CORMORANTS (including unidentified cormorants) counted in all survey sectors of Peel-Harvey during 1998-99.

		PEEL								HARVEY				Grand Total
Species	**Month**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**8**	**9**	**10**	**Total**	
Little Pied Cormorant	Oct	27	25			*1*	187		**240**			25	**25**	**265**
	Dec	31	143	0	140	0	203	165	**682**	107	128	15	**250**	**932**
	Feb	33	323	0	195	1	486	261	**1299**	175	154	65	**394**	**1693**
Pied Cormorant	Oct	34	36				310		**380**			2	**2**	**382**
	Dec	20	84	0	5	0	491	13	**613**	82	29	3	**114**	**727**
	Feb	30	58	0	5	0	54	40	**187**	58	15	11	**84**	**271**
Little Black Cormorant	Oct	1	300				8		**309**			5	**5**	**314**
	Dec	2	604	0	4	0	2011	0	**2621**	0	5	10	**15**	**2636**
	Feb	6	34	0	3	180	610	3	**836**	6	2	531	**539**	**1375**
Great Cormorant	Oct	0	1		*1*		10		**12**			2	**2**	**14**
	Dec	0	12	0	0	5	9	0	**26**	2	0	2	**4**	**30**
	Feb	0	6	0	1	6	1	1	**15**	0	0	7	**7**	**22**
Unidentified cormorants	Oct	0	0				2		**2**			0	**0**	**2**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
TOTAL N° OF CORMORANTS	**Oct**	62	362		*1*	*1*	517		**943**			34	**34**	**977**
	Dec	53	843	0	149	5	2714	178	**3942**	191	162	30	**383**	**4325**
	Feb	69	421	0	204	187	1151	305	**2337**	239	171	614	**1024**	**3361**
N°. OF IDENTIFIED SPECIES	**Oct**	3	3		*1*	*1*	4		**4**			4	**4**	**4**
	Dec	3	3	0	3	1	4	2	**4**	3	3	4	**4**	**4**
	Feb	3	3	0	4	3	4	4	**4**	3	3	4	**4**	**4**

NOTES

1. In this Appendix, a blank in a sector cell indicates that the sector was not surveyed for birds of that species in that month.
2. In this Appendix, a zero in a sector cell indicates that the sector was surveyed in that month, but no birds of that species were found.
3. Some numbers in this Appendix appear in italics and small font. This indicates that, while some birds were counted, the relevant sector was not surveyed for all birds of that species (or, if a subtotal or total, for all individuals of all cormorant species) in that month.

APPENDIX 6. Species and numbers of KNOTS (including unidentified knots) counted in all survey sectors of Peel-Harvey Estuary during 1998-99.

		PEEL								HARVEY				Grand Total
Species	**Month**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**8**	**9**	**10**	**Total**	
Great Knot	Oct	0	37				0		**37**			0	**0**	**37**
	Dec	0	2	1	0	1	0	0	**4**	0	0	19	**19**	**23**
	Feb	0	0	0	0	0	0	0	**0**	0	0	1	**1**	**1**
Red Knot	Oct	0	33				1		**34**			0	**0**	**34**
	Dec	0	11	0	0	0	0	0	**11**	0	0	2	**2**	**13**
	Feb	0	24	0	0	0	0	0	**24**	2	0	1	**3**	**27**
Unidentified knots	Oct	0	27				0		**27**			0	**0**	**27**
	Dec	0	0	0	0	0	0	0	**0**	0	0	28	**28**	**28**
	Feb	0	0	0	0	1	0	0	**1**	0	0	0	**0**	**1**
TOTAL N° OF "KNOTS"	**Oct**	0	97				1		**98**			0	**0**	**98**
	Dec	0	13	1	0	1	0	0	**15**	0	0	49	**49**	**64**
	Feb	0	24	0	0	1	0	0	**25**	2	0	2	**4**	**29**
N° OF IDENTIFIED SPECIES	**Oct**	0	2				1		**2**			0	**0**	**2**
	Dec	0	2	1	0	1	0	0	**2**	0	0	2	**2**	**2**
	Feb	0	1	0	0	0	0	0	**1**	1	0	2	**2**	**2**

NOTES

1. In this Appendix, a blank in a sector cell indicates that the sector was not surveyed for birds of that species in that month.
2. In this Appendix, a zero in a sector cell indicates that the sector was surveyed in that month, but no birds of that species were found.

APPENDIX 7. Species and numbers of STINT & SANDPIPER SIZED WADERS (including unidentified species) counted in all survey sectors of Peel-Harvey Estuary during 1998-99.

		PEEL								HARVEY				Grand Total
Species	**Month**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**8**	**9**	**10**	**Total**	
Red-necked Stint	Oct	0	1290				3592		**4882**			6	**6**	**4888**
	Dec	0	318	170	62	0	4881	0	**5431**	0	0	11005	**11005**	**16436**
	Feb	0	419	63	2	65	1562	0	**2111**	1	10	2822	**2833**	**4944**
Sharp-tailed Sandpiper	Oct	0	41				156		**197**			1	**1**	**198**
	Dec	0	654	40	15	0	192	0	**901**	0	0	421	**421**	**1322**
	Feb	0	241	0	0	14	1	0	**256**	0	0	16	**16**	**272**
Curlew Sandpiper	Oct	0	60				175		**235**			0	**0**	**235**
	Dec	0	0	1	0	0	1	0	**2**	0	0	564	**564**	**566**
	Feb	0	0	0	0	0	0	0	**0**	0	0	336	**336**	**336**
Red-capped Plover	Oct	0	85				575		**660**			8	**8**	**668**
	Dec	1	110	40	5	0	1500	0	**1656**	0	2	96	**98**	**1754**
	Feb	0	72	46	1	0	673	0	**792**	4	8	250	**262**	**1054**
Greater Sand Plover	Oct	0	0				3		**3**			0	**0**	**3**
	Dec	0	2	0	0	1	0	0	**3**	0	0	0	**0**	**3**
	Feb	0	0	0	0	0	0	0	**0**	0	2	0	**2**	**2**
Unidentified waders (stint/sandpiper size)	Oct	0	4				60		**64**			40	**40**	**104**
	Dec	0	63	0	0	0	0	0	**63**	0	0	50	**50**	**113**
	Feb	0	0	0	0	0	193	0	**193**	2	0	200	**202**	**395**
TOTAL N° OF STINT/SANDPIPER SIZED WADERS	**Oct**	0	1480				4561		**6041**			55	**55**	**6096**
	Dec	1	1147	251	82	1	6574	0	**8056**	0	2	12136	**12138**	**20194**
	Feb	0	732	109	3	79	2429	0	**3352**	7	20	3624	**3651**	**7003**

NOTES

1. In this Appendix, a blank in a sector cell indicates that the sector was not surveyed for birds of that species in that month.
2. In this Appendix, a zero in a sector cell indicates that the sector was surveyed in that month, but no birds of that species were found.

APPENDIX 8. Species and numbers of TERNS (including unidentified terns) counted in all survey sectors of Peel-Harvey Estuary during 1998-99.

		PEEL								HARVEY				Grand Total
Species	**Month**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Total**	**8**	**9**	**10**	**Total**	
Caspian Tern	Oct	1	20				16		**37**			13	**13**	**50**
	Dec	0	43	20	8	10	8	4	**93**	2	14	31	**47**	**140**
	Feb	0	96	27	22	17	28	2	**192**	20	27	59	**106**	**298**
Crested Tern	Oct	25	12				23		**60**			0	**0**	**60**
	Dec	4	12	0	1	0	13	1	**31**	1	47	0	**48**	**79**
	Feb	5	18	5	8	0	52	3	**91**	0	14	16	**30**	**121**
Fairy Tern	Oct	22	23				0		**45**			0	**0**	**45**
	Dec	52	32	26	0	0	36	0	**146**	0	21	0	**21**	**167**
	Feb	0	0	0	0	0	0	0	**0**	0	0	50	**50**	**50**
Whiskered Tern	Oct	0	0				213		**213**			124	**124**	**337**
	Dec	0	0	0	0	0	305	0	**305**	0	0	0	**0**	**305**
	Feb	0	0	0	0	0	70	0	**70**	0	0	0	**0**	**70**
Unidentified terns	Oct	0	0				0		**0**			0	**0**	**0**
	Dec	0	0	0	0	0	0	0	**0**	0	0	0	**0**	**0**
	Feb	0	0	0	0	0	0	0	**0**	3	7	0	**10**	**10**
TOTAL N° OF TERNS	**Oct**	48	55				252		**355**			137	**137**	**492**
	Dec	56	87	46	9	10	362	5	**575**	3	82	31	**116**	**691**
	Feb	5	114	32	30	17	150	5	**353**	23	48	125	**196**	**549**
N° OF IDENTIFIED SPECIES	**Oct**	3	3				3		**4**			2	**2**	**4**
	Dec	2	3	2	2	1	4	2	**4**	2	3	1	**3**	**4**
	Feb	1	2	2	2	1	3	2	**3**	1	2	3	**3**	**4**

NOTES

1. In this Appendix, a blank in a sector cell indicates that the sector was not surveyed for birds of that species in that month.
2. In this Appendix, a zero in a sector cell indicates that the sector was surveyed in that month, but no birds of that species were found.

APPENDIX 9. Breeding waterbirds of Peel-Harvey Estuary in 1998-99.

The following evidence of waterbird breeding activity was recorded during the 1998-99 Peel-Harvey Estuary waterbird surveys.

Black Swan ***Cygnus atratus***

Fourteen cygnets seen by AC in sector 6 on 12 Oct 98. Six large downy cygnets seen by JL near the mouth of the Coolup Drain (sector 6) on 15 Oct 98. Three large downy cygnets seen by JL near the western shore at the southern end of Harvey Estuary (sector 10) on 16 Oct 98.

Four large cygnets seen by JL in sector 10 on 18 Dec 98.

Two cygnets seen by AC in Sector 6 on 15 Feb 99.

Pacific Black Duck ***Anas superciliosa***

Eleven class I ducklings observed by JL at the eastern end of Creery Lagoon (sector 2a) on 13 Oct 98. Four class II-III ducklings seen by JL in the entrance channel to Yunderup Canals (sector 6) on 15 Oct 98. One class I duckling seen by JL in north-eastern distributary of Harvey River delta (sector 10) on 16 Oct 98.

Australian Pelican ***Pelecanus conspicillatus***

GP noted during 12 Oct 98 pelican air survey that "no pelican breeding recorded at either Peel Inlet or Harvey Estuary".

GP noted during 7 Dec 98 pelican air survey that "Nirimba Cay [sector 6] was exposed but there were no signs of nests. No nests were observed on Boundary [sector 2] or Boodalan [sector 6] Islands".

GP noted during 15 Feb 99 pelican air survey that "Nirimba Cay was exposed but there was no evidence of nesting. No nests were observed on Boundary or Boodalan Islands".

Additional observations will be presented in a later report on pelican nesting on Peel-Harvey.

Silver Gull ***Larus novaehollandiae***

Nests with eggs were seen by JL on Boodalan Island on 15 Oct 98.

"Some recently fledged juveniles", but no eggs, were seen by JL on Boodalan Island on 17 Dec 98

NOTES

1. AC=A.C. Clarke, GP=G.B. Pearson, JL=J.A.K. Lane.
2. The numbers of cygnets, ducklings and other flightless juvenile birds listed in this Appendix are not included in any other Appendices or Tables of this report.

APPENDIX 10. 1998-99 Peel-Harvey Estuary waterbird survey program.

TYPE/AREA OF SURVEY [3]	OCT 1998	DEC 1998	FEB 1999
Pelicans aerial	M12, GP	M 7, GP	M 15, GP
Swans aerial (Harvey only)	M12, GP	M 7, GP	M 15, GP
Swans by boat (Peel only)	M12, AC	M 7, AC	M 15, AC
Sector 1	Tu 13, JL	Tu 8, JL	Tu 16, JL
Sector 2a	Tu 13, JL	Tu 8, JL	Tu 16, JL
Sector 3	-	Tu 8, JL	Tu 16, JL
Sector 2b	Tu 13, JL	W 9, JL	W 17, JL
Sector 4	-	W 9, JL	W 17, JL
Sector 9	-	W 9, AC	W 17, AC
Inner Sector 6 (on foot)	W 14, JL	Th 10, JL	Th 18, JL
Sector 7	-	Th 10, AC	Th 18, AC
Sector 8	-	Th 10, AC	Th 18, AC
Outer Sector 6 (by boat)	Th 15, JL	Th 17, JL	F 19, JL
Sector 5	-	Th 17, JL	F 19, JL
Sector 10	F 16, JL	F 18, JL	Sa 20, JL

NOTES

1. Cells in the above table contain the day and date on which each sector was surveyed and the initials of the personnel who conducted each survey. AC=A.C. Clarke, GP=G.B. Pearson, JL=J.A.K. Lane.
2. Rows have been arranged in chronological order to show the standard sequence of survey.
3. See section 5.2 of this report for descriptions of the Types and Areas of survey.

APPENDIX 11. Maximum counts, 1% levels and relevant population distributions of the 25 species of waterbirds recorded on Peel-Harvey in 1998-99 for which 1% levels (Watkins & AWSG 1993, Rose & Scott 1997) have been published.

Species	Maximum Peel-Harvey count in 1998-99	One Percent Level of relevant population	Distribution of relevant population (Rose & Scott 1997)
Black Swan	1130	4000	Australia
Great Crested Grebe	18	65	Australia
Bar-tailed Godwit	137	3300	Alaska/E&SE Asia/Aust/NZ
Whimbrel	4	400	SE Asia/New Guinea/Aust/NZ
Eastern Curlew	24	210	E&SE Asia/Australia/NZ
Common Greenshank	319	400	E&SE Asia & Australia
Terek Sandpiper	2	360	Not presented
Common Sandpiper	18	300	Not presented
Grey-tailed Tattler	9	480	Not presented
Ruddy Turnstone	2	280	Not presented
Great Knot	37	3200	E&SE Asia/Aust/New Guinea
Red Knot	34	2000	New Guinea/Australia/NZ
Red-necked Stint	**16436**	**4700**	E Siberia/SE&E Asia/Aust/NZ
Sharp-tailed Sandpiper	1322	1700	N America/E Sib/NG/Aust/NZ
Curlew Sandpiper	566	2500	E/SE Asia & Australia
Pied Oystercatcher	20	110	Australia/S New G/Tas/Aru Is
Black-winged stilt	1400	5320	Not presented
Banded Stilt	186	2100	Southern Australia/Tasmania
Red-necked Avocet	**1399**	**1100**	Australia
Pacific Golden Plover	29	900	Not presented
Grey Plover	81	160	Not presented
Red-capped Plover	**1754**	**950**	Australia
Greater Sand Plover	3	990	Not presented
Caspian Tern	**298**	**30**	Australia/New Zealand
Fairy Tern	**167**	**60**	Western Australia

NOTES

1. The five species with maximum 1998-99 Peel-Harvey counts exceeding their respective 1% population levels are shown in **bold.**
2. "Relevant populations" are the populations to which the birds of Peel-Harvey Estuary belong. Some species of waterbirds, e.g. many species of migratory shorebirds, have two or more distinct populations with limited intermingling.