WATERBIRDS OF THE VASSE-WONNERUP WETLANDS IN 1998-2000,

INCLUDING RAMSAR STATUS AND COMPARISONS WITH EARLIER DATA

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Cover photograph of Grey Teal *Anas gracilis* and other waterbirds on Malbup Creek by Roger Paine of Busselton.

Grey Teal were the most abundant birds on Vasse-Wonnerup during 1998-2000, with numbers peaking at 9,500 in December 1998. This species is widely distributed in Australia, travelling long distances in response to rainfall and wetland flooding.

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SUMMARY

Waterbird surveys in the mid 1980s showed that the Vasse-Wonnerup wetland system, 190 km south of Perth, Western Australia, regularly supported in excess of 20,000 birds and, for two species, more than 1% of their Australia-centred populations. On this basis Vasse-Wonnerup was listed in June 1990 as a Wetland of International Importance under the Ramsar Convention.

Human-induced changes in the hydrological regime of the Vasse estuary in the late 1980s and 1990s led to death of fringing vegetation, damage to pastures and possible impacts on use of the wetlands by waterbirds. Technical review in 1997 of these and other issues resulted in a number of recommendations including that surveys be conducted to assess current use by waterbirds. These surveys were conducted over two years (1998-2000) and were aimed principally at determining whether Vasse-Wonnerup continued to meet waterbird-related Ramsar criteria for international importance. This report presents the results of those surveys, discusses current Ramsar status and provides comparisons with earlier data.

The 1998-2000 data show that, nearly a decade after initial Ramsar listing and despite changes in the hydrological regime of the Vasse estuary, Vasse-Wonnerup remained one of the most important waterbird habitats in Western Australia. Waterbird numbers peaked at 37,500 in December 1998 and at least 43,400 birds made use of the site during that 'waterbird year' (1998-99). This is almost as high as the number that made use of Peel-Harvey Estuary in the same year, and is all the more noteworthy given that Peel-Harvey, which on a regular basis supports greater numbers of waterbirds than any other estuary in south-western Australia, is nineteen times the area of Vasse-Wonnerup.

It is also noteworthy that the maximum count of 37,500 waterbirds on Vasse-Wonnerup in December 1998 exceeded the numbers counted in all twelve 'substantially complete' surveys of 1984-90, the five highest of which were 30,000 (Jan 1988), 29,000 (Dec 1987), 28,300 (Dec 1986), 26,500 (Jan 1989) and 17,500 (Dec 1987) and a January 1986 count of 33,000 birds, this being the highest of all previous counts.

The mean number of waterbirds counted on Vasse-Wonnerup in the main part of the current study (Feb 1998 - May 1999) was 12% higher than the mean of previous (1982-90) surveys. This change comprised a 26% decrease in the mean number on Vasse estuary and a 255% increase on Wonnerup estuary. Aspects of methodology, coverage and timing differed between the two survey periods and waterbird abundance is highly variable naturally. The apparent shift in distribution of birds within the Vasse-Wonnerup system should therefore be regarded as possibly indicative of change in habitat availability or suitability, rather than as clear evidence that change has occurred. Nonetheless, given the changes in Vasse estuary hydrology that have occurred since 1988, further investigation is warranted.

Inter-period comparison of highest counts, second highest counts, etc., of individual species suggests that further, more-detailed consideration of a number of species is warranted. In most cases what is required is a closer examination of historical data to determine the precise locations where birds of these species were found in 1981-90 and whether these locations were adequately surveyed in 1998-2000. Follow-up surveys incorporating at least the most significant of these locations are recommended. Wood Sandpiper, Long-toed Stint and Sharp-tailed Sandpiper warrant particular survey attention.

Lower numbers of Great Egret. Blue-billed Duck, Great Cormorant and Curlew Sandpiper in 1998-2000 add to concerns that these four species are in local or wider decline. Action is needed to determine their current status, the threats they face and remedial actions required.

Concerning Ramsar status of Vasse-Wonnerup, it is clear from the 1998-2000 data that, at that time, Vasse Wonnerup continued to meet the two Ramsar Criteria under which it was nominated and listed in 1990. Thus Criterion 5 (regularly supports 20,000 or more waterbirds) continued to be met, by at least 43,400 waterbirds making use of Vasse-Wonnerup at some time during 1998-99, with 37,500 counted in December 1998 and 20,400 in January 1999. Criterion 6 (regularly supports 1% of the individuals in a population of one species or subspecies of waterbird) continued to be met, by four species, Australian Shelduck, Australasian Shoveler, Black-winged Stilt and Red-necked Avocet, each exceeding 1% of their population size. These four include the two species, Black-winged Stilt and Red-necked Avocet, identified in 1990 as meeting the 1% criterion.

1. INTRODUCTION

Surveys in the mid 1980s indicated that the Vasse-Wonnerup wetland system 190 km south of Perth, Western Australia, supported more than 30,000 waterbirds of 60 species each year (Lane 1990). On this basis Vasse-Wonnerup was listed in June 1990 as a Wetland of International Importance under the Ramsar Convention (Government of Western Australia 1990; Wetlands International 2002).

Prior to 1908, Vasse-Wonnerup was estuarine, with a narrow and almost permanent connection to the sea. In 1908 floodgates were installed to prevent the entry of seawater. The passive operation of these structures changed the hydrological regime of Vasse-Wonnerup from estuarine (tidal and fresh-brackish-saline) to non-tidal and predominantly fresh-brackish. Between 1988 and 1997, seawater was allowed back into the Vasse estuary during summer-autumn each year in attempts to prevent occasional mass fish deaths. Excessive inputs of seawater to artificially high levels led to death of fringing vegetation, damage to pastures and possibly adverse impacts on use of the estuary by waterbirds (Lane *et al.* 1997).

A Technical Working Group established in March 1997 to investigate the above issues recommended *inter alia* that surveys be conducted to assess recent use of Vasse estuary by waterbirds during summer-autumn (Lane *et al.* 1997). In March 1998 funding was obtained from the Western Australian Department of Conservation and Land Management (now Department of Environment and Conservation) to enable this work to proceed.

2. PROJECT AIM

The principal aim of the 1998-2000 surveys was to assess current usage of Vasse-Wonnerup wetlands by waterbirds, in order to determine whether the Vasse-Wonnerup Ramsar Site continued to meet the Ramsar Criteria under which it was nominated and listed in 1990 as a 'Wetland of International Importance'.

3. STUDY AREA

The main study area (Figure 1) comprised the Vasse estuary, Wonnerup estuary and Wonnerup Inlet (all of which are within the Vasse-Wonnerup Ramsar Site); plus Malbup Creek (part of which was added to the Ramsar Site in 2000) and the Deadwater (not part of the Site, but hydrologically and ecologically connected). Two locations on the adjoining Lower Vasse River Wetlands which have potential for addition to the Site were also surveyed. 'Swan Lake', at the northern end of the Site, was not included as it is usually dry for most of summer, when bird numbers peak on Vasse and Wonnerup estuaries. The Vasse-Wonnerup wetlands system is located on the eastern side of the coastal town of Busselton, a popular and rapidly growing holiday and tourist destination. In 1996, the Shire of Busselton, which also includes the nearby towns of Vasse and Dunsborough, had a resident population of c. 26,000 people.

4. METHODOLOGY

4.1 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). Several bird species not commonly regarded as waterbirds also 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, an approach that was consistent with suggestions of Rose & Scott (1997, p4) and largely consistent with the approach taken by Jaensch *et al.* (1988) in their survey of Vasse-Wonnerup and other wetlands of south-western Australia (though they did not include the Whistling Kite or White-fronted Chat).

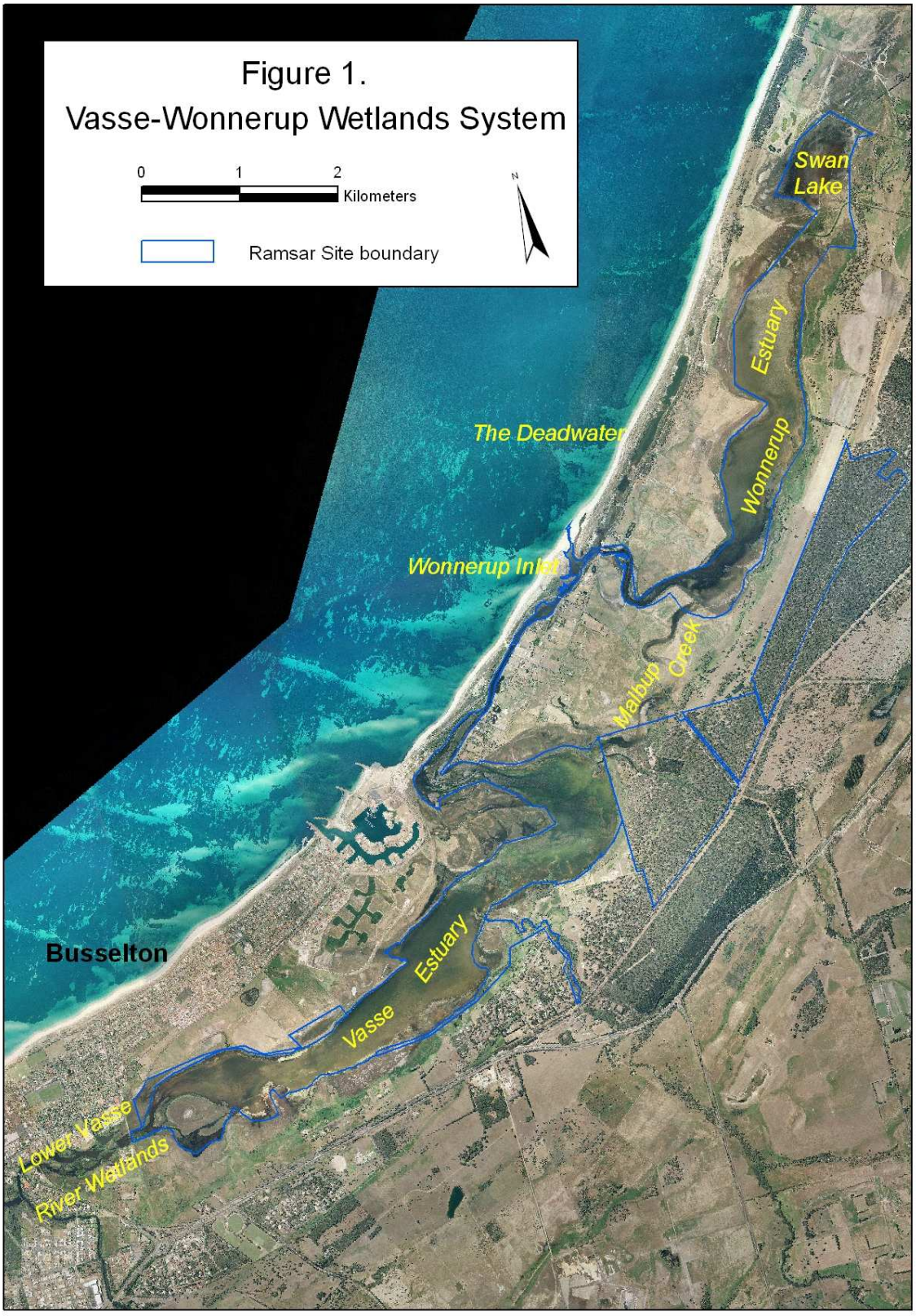
Figure 1.
Vasse-Wonnerup Wetlands System
0
1
2
Kilometers
N
Ramsar Site boundary
Swan Lake
Estuary
Wonnerup
The Deadwater
Wonnerup Inlet
Malbup Creek
Busselton
Estuary
Vasse
Lower Vasse River Wetlands

4.2 Survey Program

Ideally, all species of waterbirds would have been surveyed simultaneously. However, previous experience on Vasse-Wonnerup indicated that it would not be possible to identify and count all of the smaller shorebirds (stint, sandpiper and plover-sized birds) without excessively disturbing - and thus preventing accurate counting of - other waterbird species, several of which have been shown to be particularly sensitive to human intrusion while at this location (Bamford & Bamford 1995). On this basis it was decided that the survey work would be undertaken in two phases; the first phase (1997-98 and 1998-99) being to survey all waterbird species – but with limited attention being given to the smaller shorebirds - and the second phase (1999-2000) being to survey only shorebirds.

The first phase (all species) surveys were conducted at monthly intervals from February 1998 to April 1998 (the '1997-98' surveys) and December 1998 to May 1999 (the '1998-99' surveys). It would have been preferable for the 1997-98 surveys to have begun in December 1997, however the necessary funding did not become available until several months later. Past surveys have shown waterbirds to be most abundant on Vasse-Wonnerup between December and May, with the main peak occurring December to February (Lane 1990). Jaensch *et al.* (1988) found that species that were 'consistently recorded at Vasse [estuary] in greater numbers in certain seasons than in other seasons' were most abundant in summer (14 species) or summer-autumn (3 species).

The second phase (shorebirds only) surveys were conducted at monthly intervals from November 1999 to March 2000 (the '1999-2000' surveys). This period (November to March) was chosen to coincide with the expected main period of occurrence of migratory shorebirds at the site.

The precise survey dates and other survey details are provided in Appendix 4.

Survey methods were varied in order to suit conditions, principally estuary water levels, at the time of each survey. Because the Vasse and Wonnerup estuaries are separated from the ocean by floodgates and are therefore no longer tidal, their water levels steadily decline from spring to autumn and by late summer large areas are dry or only centimetres deep. This has a big effect on shoreline exposure and accessibility for observers, suitability for survey by various types of watercraft or on foot, the extent of the water area to be surveyed and waterbird numbers, distribution and visibility. Variations in Vasse and Wonnerup estuaries' water levels throughout the period of this project are shown in Figure 2. Timing of the bird surveys is also indicated.

Most of the surveys were conducted by A. Clarke, either by touring kayak, on foot, or a combination of the two. J. Lane and G. Pearson conducted the December 1998 survey, walking roughly abreast along or close to the estuaries' north and south shores respectively, in a generally NE-SW direction, maintaining contact by means of two-way radios. Other waterbodies were surveyed by foot and vehicle. The January 1999, February 2000 and March 2000 surveys were conducted by AC and JL in similar fashion, but communicating by means of mobile phones, which proved to be more reliable and more versatile than the radios.

The 1997-98 surveys were of the two estuaries, Vasse and Wonnerup. The 1998-99 and 1999-2000 surveys were extended to also include Malbup Creek, Wonnerup Inlet, the Deadwater and two sites (Ford Road and Peel Cove) in the Lower Vasse River Wetlands.

Most of the monthly surveys were conducted over two days because usually it was physically impossible to adequately survey the study area in one day. The March 1998 survey was accomplished in one day. The January 2000 survey was a two-day effort over three days. A few incidental observations were made one day after the waterbird surveys, during salinity / depth / temperature profiling work to be reported separately. In March 2000, the shorebird survey of Wonnerup Inlet (only one shorebird was recorded) was delayed by four days.

Binoculars and/or telescopes with tripods were used by each of the surveyors to search for, identify and count the waterbirds. Field notebooks were used for recording all data. When two observers were counting birds from opposite sides of the same waterbody, handheld two-way radios or mobile phones were used to avoid double-counting or missing birds.

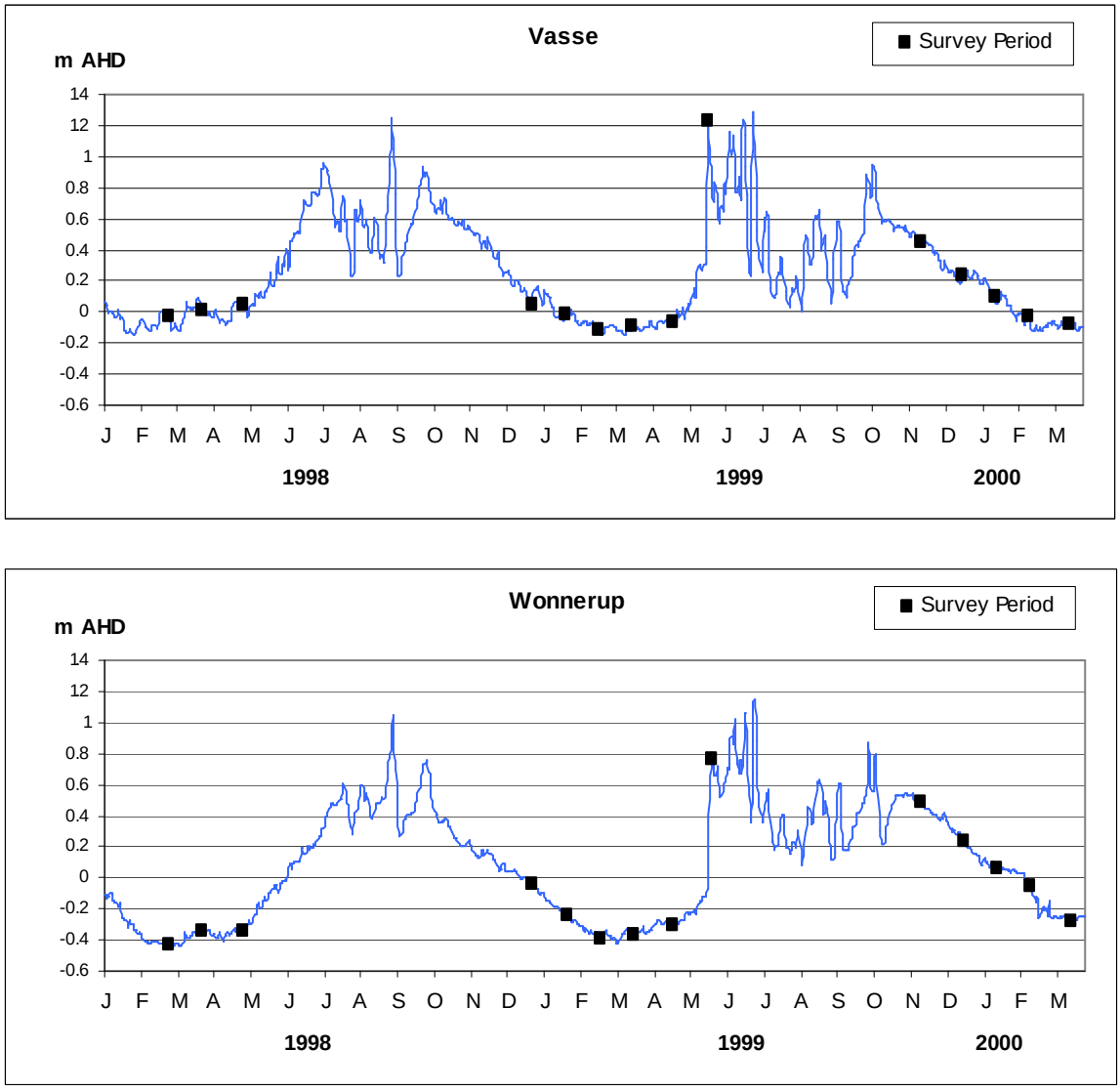

Figure 2. Water levels[1] and survey periods of the Vasse and Wonnerup estuaries during 1998-2000.

In order to facilitate comparison of the authors' 1998-2000 survey results with the 1981-90 results of R.P. Jaensch and volunteers of the Royal Australasian Ornithologists Union (RAOU; now Birds Australia) as reported by Bamford & Bamford (1992), the Vasse-Wonnerup waterbodies were divided into the ten survey sectors ('a' to 'j') reported by Jaensch. Then, in order to facilitate the conduct of the 1998-2000 surveys, several of these sectors were divided into subsectors. These sectors and subsectors are shown in Figures 3a and 3b.

The two 1998-2000 survey sites in the Lower Vasse River Wetlands - Ford Road and Peel Cove - are not within the above survey sectors. Results for these sites are presented in Appendix 1, but are not included elsewhere in this report.

[1] In metres AHD (Australian Height Datum), where 0.00 mAHD is approximately mean sea level.

Figure 3a. Survey sectors and subsectors of Vasse estuary (a, b, d, e, f(S), f(W), f(N1)) and western Malbup Creek (g(W)) in 1998-2000. Sector 'c' was not surveyed.

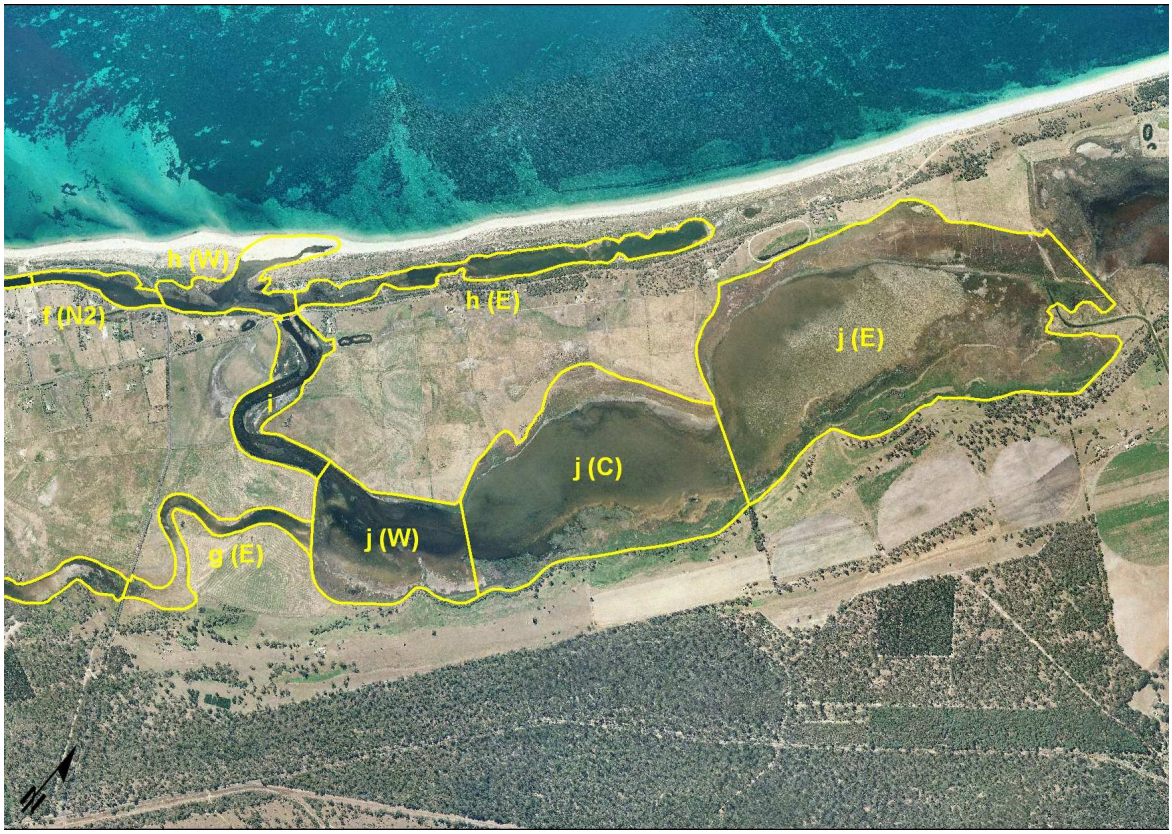

Figure 3b. Survey sectors and subsectors of Wonnerup estuary (j(E), j(C), j(W), i), the Deadwater (h(E)), Wonnerup Inlet (f(N2), h(W)) and eastern Malbup Creek (g(E)) in 1998-2000.

Sector ‘c’ (the lowest reaches of the Sabina River) was not included in the 1998-2000 surveys due to its minor significance for most species, the amount of time that would be required to properly survey it and its lack of direct relevance to the project’s principal aim (prior to December 2000 it was not within the boundaries of the Vasse-Wonnerup Ramsar Site).

Sector ‘d’ (an area of seasonally-inundated marshes and pools on the north side of Vasse estuary) was apparently (Bamford & Bamford 1992) not counted during the 1981-90 RAOU surveys, though there is some uncertainty about this. At the time it was private land, whereas now it is crown (government) land and destined to become nature reserve. In any case, sector ‘d’ is dry for much of summer-autumn in most years.

4.3 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 (e.g. 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 and then multiplied by the number of parts. Where practicable this process was repeated two or more times to improve the estimate.

During the 1997-98 and 1998-99 surveys of all waterbird species it was sometimes not possible to determine the identity of birds, particularly small shorebirds, because they were too far away for the observer to discern distinguishing features. On these occasions they were recorded as ‘unidentified small shorebirds’, ‘unidentified ducks’, ‘unidentified black and white cormorants’, etc. Some flocks of small shorebirds were either too far away to count or were possibly missed altogether during 1997-98 and 1998-99. This was not the case in 1999-2000 when the survey effort was focussed solely on shorebirds.

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

Some movement of birds, usually from one part to another of the particular waterbody being surveyed, was observed during each day of counts. Allowance was made for this where possible. A record or mental note was kept of birds seen passing the observer, either ahead or behind, and count data were adjusted accordingly. Any ‘day one to day two’ movements between the various waterbodies (most surveys were conducted over two days) were more problematic as no measure of these was possible, at least during these surveys. Ideally the counting would have been conducted simultaneously over all component waterbodies. This would have required, however, a larger team of skilled bird surveyors than was available for the 1998-2000 counts.

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 bird 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 by Rose & Scott (1997) and Wetlands International (2006).

The survey methodology was not well suited to detecting secretive species of waterbirds such as crakes and rails. 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 and release techniques can be used. These methods were not employed due to time constraints. It is therefore highly likely that more birds of these species were present than were recorded. However, this is often a limitation in waterbird surveys of large wetlands and is not expected to impact significantly on the total number of waterbirds counted.

No specific searches were conducted for evidence (nests, eggs, flightless young) of breeding by waterbirds. Some incidental observations were made, however not all were recorded, due to priority being given to the counting of birds. Breeding observations that were recorded are presented in Section 5.6 and Appendix 3.

5. RESULTS

5.1 Species

Sixty-one species of waterbirds, as defined in Section 4.1, were recorded during the 1998-00 Vasse-Wonnerup surveys. These represented 16 families and 44 genera (Table 1).

Table 1. Waterbird species and maximum numbers counted on the Vasse-Wonnerup wetland system during 1998-2000. Scientific and common names are those of Christidis & Boles (1994). Transequatorial migrants (all of which, in this instance, are shorebirds) are denoted by [M].

Family Name	Group and Scientific Names	Common Name	Max. Count	
ANATIDAE	**Ducks & allies**			
	Biziura lobata	Musk Duck	33	
	Cygnus atratus	Black Swan	3013	
	Tadorna tadornoides	Australian Shelduck	3378	(c. 4000)[1]
	Chenonetta jubata	Australian Wood Duck	29	
	Anas superciliosa	Pacific Black Duck	2254	(c. 4750)[1]
	Anas rhynchotis	Australasian Shoveler	355	
	Anas gracilis	Grey Teal	2395	(c. 9500)[1]
	Anas castanea	Chestnut Teal	5	
	Aythya australis	Hardhead	[3]1	
PODICIPEDIDAE	**Grebes**			
	Poliocephalus poliocephalus	Hoary-headed Grebe	317	
ANHINGIDAE	**Darters**			
	Anhinga melanogaster	Darter	21	
PHALACROCORACIDAE	**Cormorants**			
	Phalacrocorax melanoleucos	Little Pied Cormorant	296	
	Phalacrocorax varius	Pied Cormorant	71	
	Phalacrocorax sulcirostris	Little Black Cormorant	325	
	Phalacrocorax carbo	Great Cormorant	1	
PELECANIDAE	**Pelicans**			
	Pelecanus conspicillatus	Australian Pelican	354	
ARDEIDAE	**Herons, Egrets, Bitterns**			
	Egretta novaehollandiae	White-faced Heron	379	
	Egretta garzetta	Little Egret	8	
	Ardea alba	Great Egret	108	
THRESKIORNITHIDAE	**Ibises, Spoonbills**			
	Threskiornis molucca	Australian White Ibis	279	
	Threskiornis spinicollis	Straw-necked Ibis	562	
	Platalea flavipes	Yellow-billed Spoonbill	151	
ACCIPITRIDAE	**Osprey, Kite, Eagles, Harriers**			
	Pandion haliaetus	Osprey	1	
	Haliastur sphenurus	Whistling Kite	11	
	Haliaeetus leucogaster	White-bellied Sea-eagle	1	
	Circus approximans	Swamp Harrier	4	
RALLIDAE	**Rails, Crakes, Water hens, Coot**			
	Gallirallus philippensis	Buff-banded Rail	4	
	Porzana fluminea	Australian Spotted Crake	1	
	Porphyrio porphyrio	Purple Swamphen	11	
	Gallinula tenebrosa	Dusky Moorhen	4	
	Fulica atra	Eurasian Coot	3570	

Table 1 continued.

Family Name	Group and Scientific Names	Common Name	Max. Count	
SCOLOPACIDAE	**Sandpipers & allies**			
	Limosa lapponica [M]	Bar-tailed Godwit	2	
	Numenius phaeopus [M]	Whimbrel	1	
	Tringa stagnatilis [M]	Marsh Sandpiper	3	
	Tringa nebularia [M]	Common Greenshank	300	
	Tringa glareola [M]	Wood Sandpiper	7	
	Xenus cinereus [M]	Terek Sandpiper	1	
	Actitis hypoleucos [M]	Common Sandpiper	11	
	Heteroscelis brevipes [M]	Grey-tailed Tattler	2	
	Calidris tenuirostris [M]	Great Knot	[3]1	
	Calidris canutus [M]	Red Knot	[3]9	
	Calidris ruficollis [M]	Red-necked Stint	2512	
	Calidris acuminata [M]	Sharp-tailed Sandpiper	432	(c. 800) [2]
	Calidris ferruginea [M]	Curlew Sandpiper	278	
HAEMATOPODIDAE	**Oystercatchers**			
	Haematopus longirostris	Pied Oystercatcher	2	
RECURVIROSTRIDAE	**Stilts, Avocets**			
	Himantopus himantopus	Black-winged Stilt	3494	
	Cladorhynchus leucocephalus	Banded Stilt	1137	
	Recurvirostra novaehollandiae	Red-necked Avocet	2000	
CHARADRIIDAE	**Plovers, Dotterels**			
	Pluvialis fulva [M]	Pacific Golden Plover	73	
	Pluvialis squatarola [M]	Grey Plover	9	
	Charadrius ruficapillus	Red-capped Plover	998	
	Charadrius leschenaultii [M]	Greater Sand Plover	6	
	Elseyornis melanops	Black-fronted Dotterel	18	
	Erythrogonys cinctus	Red-kneed Dotterel	1	
	Vanellus tricolor	Banded Lapwing	8	
LARIDAE	**Gulls, Terns**			
	Larus novaehollandiae	Silver Gull	3058	
	Sterna caspia	Caspian Tern	13	
	Sterna bergii	Crested Tern	7	
	Chlidonias hybridus	Whiskered Tern	91	
MELIPHAGIDAE	**Honeyeaters, Australian Chats**			
	Ephthianura albifrons	White-fronted Chat	9	
SYLVIDAE	**Old World Warblers**			
	Megalurus gramineus	Little Grassbird	1	
TOTAL	**61 species**[4]			

1. More Australian Shelduck, Pacific Black Duck and Grey Teal were present than were counted to species at the time. These figures (4000, 4750 and 9500) are the estimated maximum numbers of each after taking into account species proportions of some ducks initially pooled as 'unidentified'. See Section 5.2 for further explanation.

2. c. 800 is the more-likely maximum number of Sharp-tailed Sandpiper. See Section 5.2 for explanation.

3. Note that three Hardhead and c. 30 'knot types' were recorded in 1998-2000 during additional visits that were not part of the formal survey program. See Appendix 6 for details.

4. Note that one to six individuals of an additional seven species (Blue-billed Duck, Pink-eared Duck, Nankeen Night Heron, Glossy Ibis, Eastern Curlew[M], Long-toed Stint[M], Clamorous Reed Warbler) were recorded in 1998-2000 during additional visits that were not part of the formal survey program. See Appendix 6 for details.

Twenty-four of the 61 waterbird species were shorebirds with their breeding grounds either in Australia (8 resident species) or in the northern hemisphere (16 migratory species).

The number of waterbird species recorded each survey month increased from 40 in December 1998 to 44 in January 1999 and then declined progressively to 28 in May 1999 (Table 2, last row). Somewhat lower (February and March) and higher (April) numbers of species were recorded in the 1997-98 waterbird surveys, however numbers recorded 'February to April combined' in these survey years were similar (39 species in 1997-98; 42 species in 1998-99).

Sixteen shorebird species were recorded during the December 1999 and January 2000 shorebird surveys; 14 were recorded in November 1999 and 12 in the February and March 2000 surveys (Table 2). These figures are 6, 3, 0, and 3 species greater than in the corresponding months (December, January, February, March) of the 1998-99 waterbird surveys, when not all shorebirds were counted or identified to species.

Eleven migratory shorebird species were recorded during the January 2000 shorebird surveys; 10 were recorded in November and December 1999 and 7 in February and March 2000. The 1999-2000 figures are 5, 3, -1 and 2 species greater than in corresponding months (December, January, February, March) of the 1998-99 waterbird surveys, when not all shorebirds were counted or identified to species.

Of the 54 waterbird species recorded in 1998-99, 18 were recorded in all six survey months, 5 in five months, 9 in four months, 8 in three months, 4 in two months and 10 in only one survey month (Table 2).

One non-native domestic goose (white with orange beak and legs) was observed on 29 December 1998 at the western end of Vasse estuary, in sector 'a'. This bird is not included in any of the above figures or elsewhere in this report.

5.2 Abundance

All waterbirds

The 'minimum number' of waterbirds that made use of Vasse-Wonnerup at some time during 1998-99 was 43,386 (Table 2, second last row). This is the sum of the maximum monthly count of each individual species, with some adjustments made to accommodate counts that contained birds of unidentified species.

The highest single monthly (December-May) count of all species was 37,446 in December 1998 (Table 2).

The most abundant species during the 1998-00 waterbird and shorebird surveys (10 species; each more than 1,000 individuals) were Grey Teal (c. 9,500[1]), Pacific Black Duck (c. 4,750[1]), Australian Shelduck (c. 4,000[1]), Eurasian Coot (3,570), Black-winged Stilt (3,494), Silver Gull (3,058), Black Swan (3,013) Red-necked Stint (2,512), Red-necked Avocet (2,000) and Banded Stilt (1,137) (Tables 1 and 2)[2].

Twenty-six of the 61 waterbird species recorded over the period 1998-00 had maximum counts of less than 10 individuals (Table 1).

Ducks

The 'minimum number' of ducks (including ducks not identified to species) that made use of Vasse-Wonnerup during 1998-99 was 19,683 (Table 2). The most numerous ducks (more than 1,000 individuals) identified to species *at the time of survey* in 1998-99 were *(but see below)* Australian Shelduck (3,378), Pacific Black Duck (2,254) and Grey Teal (2,030). The next most abundant duck (more than 100 individuals) was Australasian Shoveler (318). Somewhat larger numbers of identified Grey Teal (2,395) and Australasian Shoveler (355) were counted in 1997-98.

The total number of unidentified ducks (14,224) in December 1998 was so high it warrants a considered attempt to allocate to species. Of the 7,280 counted in the north-eastern part of Wonnerup estuary it was

[1] See 'Ducks' subsection for explanation of Grey Teal, Pacific Black Duck and Australian Shelduck maxima.

[2] Note that the 1998-00 surveys were predominantly in summer-autumn, the seasons during which species were likely to be in greatest numbers on Vasse-Wonnerup (Jaensch *et al.* 1988).

Table 2. Species and numbers of waterbirds counted on Vasse-Wonnerup each survey in 1997-98, 1998-99 and 1999-00.

	1997-98				1998-99							1999-00 (Waders only)						All Years
Species	**02/98**	**03/98**	**04/98**	**97-98 Max**	**12/98**	**01/99**	**02/99**	**03/99**	**04/99**	**05/99**	**98-99 Max**	**11/99**	**12/99**	**01/00**	**02/00**	**03/00**	**99-00 Max**	**Max**
Musk Duck	12	24	11	24	15	16	14	17	19	33	33	-	-	-	-	-	-	33
Black Swan	2	86	368	368	3013	149	5	29	44	459	3013	-	-	-	-	-	-	3013
Australian Shelduck	1047	532	484	1047	1107	3378	1987	1265	1568	557	3378	-	-	-	-	-	-	3378
Australian Wood Duck		10	1	10	8	16	4	1		29	29	-	-	-	-	-	-	29
Pacific Black Duck	243	164	266	266	2254	752	482	687	672	1770	2254	-	-	-	-	-	-	2254
Australasian Shoveler	24	72	355	355	126	318	3			4	318	-	-	-	-	-	-	355
Grey Teal	1348	2395	1401	2395	1946	2030	548	940	1229	182	2030	-	-	-	-	-	-	2395
Chestnut Teal	5	3	4	5	2	2	4	5	4		5	-	-	-	-	-	-	5
Hardhead					1						1	-	-	-	-	-	-	1
Unidentified Ducks					14224	1034			550	882	14224	-	-	-	-	-	-	14224
Total Ducks	*2679*	*3200*	*2522*	*[1]4102*	*19683*	*7546*	*3042*	*2915*	*4042*	*3457*	*[2]19683*	-	-	-	-	-	-	-
Hoary-headed Grebe	20	205	123	205	317	60				1	317	-	-	-	-	-	-	317
Darter			5	5	21	9	4	8	14	5	21	-	-	-	-	-	-	21
Little Pied Cormorant	139	60	9	139	296	173	91	73	111	21	296	-	-	-	-	-	-	296
Pied Cormorant	1		1	1	64	71	38	1			71	-	-	-	-	-	-	71
Uid B&W Cormorants					76		10			1	76	-	-	-	-	-	-	76
Total B&W Cormorants	*140*	*60*	*10*	*[1]140*	*436*	*244*	*139*	*74*	*111*	*22*	*[2]436*	-	-	-	-	-	-	-
Little Black Cormorant			14	14	325	310	92	25	45	41	325	-	-	-	-	-	-	325
Great Cormorant	1			1				1	1	1	1	-	-	-	-	-	-	1
Total Cormorants	*141*	*60*	*24*	*[1]155*	*761*	*554*	*231*	*100*	*157*	64	*[1]762*	-	-	-	-	-	-	-
Australian Pelican		1		1	281	354	182	10	6	5	354	-	-	-	-	-	-	354
White-faced Heron	46	36	27	46	220	379	146	34	53	106	379	-	-	-	-	-	-	379
Little Egret	1	3		3	8	7	1	2			8	-	-	-	-	-	-	8
Great Egret		2	2	2	86	108	13	4	11	2	108	-	-	-	-	-	-	108
Unidentified Egrets					5		3				5	-	-	-	-	-	-	5
Total Egrets	*1*	*5*	*2*	*[1]5*	*99*	*115*	*17*	*6*	*11*	*2*	*[3]116*	-	-	-	-	-	-	-
Australian White Ibis	11	6	2	11	88	18	15	13	14	279	279	-	-	-	-	-	-	279
Straw-necked Ibis	12		77	77	562	10		42		286	562	-	-	-	-	-	-	562
Yellow-billed Spoonbill	1	20	14	20	151	18	1	7	14	29	151	-	-	-	-	-	-	151
Osprey						1			1		1	-	-	-	-	-	-	1
Whistling Kite					11	2	2	2	3	1	11	-	-	-	-	-	-	11
White-bellied Sea-Eagle	1		1	1				1			1	-	-	-	-	-	-	1
Swamp Harrier					4				1	1	4	-	-	-	-	-	-	4
Buff-banded Rail					4	2					4	-	-	-	-	-	-	4
Australian Spotted Crake						1					1	-	-	-	-	-	-	1
Purple Swamphen	11	2	5	11	2	5	6	6	3	3	6	-	-	-	-	-	-	11
Dusky Moorhen						4	1	2			4	-	-	-	-	-	-	4
Eurasian Coot	1		5	5	3570	29		1	2		3570	-	-	-	-	-	-	3570
Bar-tailed Godwit[M]																2	2	2
Whimbrel[M]			1	1								1					1	1
Marsh Sandpiper[M]													3				3	3
Common Greenshank[M]	34	18	9	34	94	300	176	92	14	4	300	67	89	102	123	33	123	300

Table 2 continued.

	1997-98				1998-99							1999-00 (Waders only)						All Years
Species	**02/98**	**03/98**	**04/98**	**97-98 Max**	**12/98**	**01/99**	**02/99**	**03/99**	**04/99**	**05/99**	**98-99 Max**	**11/99**	**12/99**	**01/00**	**02/00**	**03/00**	**99-00 Max**	**Max**
Wood Sandpiper[M]					5	2					5			7	4		7	7
Terek Sandpiper[M]						1					1							1
Common Sandpiper[M]	1		2	2	8	3	6				8	11	4	4	4	2	11	11
Grey-tailed Tattler[M]			1	1								2	1	1			2	2
Great Knot[M]													1	1			1	1
Red Knot[M]		2	9	9									5				5	9
Red-necked Stint[M]	1064	758	166	1064	14	447	2512	746	238		2512	23	50	935	2118	1506	2118	2512
Sharp-tailed Sandpiper[M]	170			170	112	372	391	2	2		391	340	432	331	281		432	432
Curlew Sandpiper[M]		278		278		13	153	6			153	1	27	96	42	30	96	278
Pied Oystercatcher												1	2				2	2
Black-winged Stilt	536	433	533	536	3371	2177	966	800	858	74	3371	515	3403	3494	2597	1072	3494	3494
Banded Stilt	1137	1034	197	1137	287	1124	887	155			1124		25	15	8	2	24	1137
Red-necked Avocet	36	1296	956	1296	2000	1013	735	18			2000	68	1220	1166	431	13	1220	2000
Pacific Golden Plover[M]						71	39	14			71	23	73	11		19	73	73
Grey Plover[M]							1				1	3		5	9	1	9	9
Red-capped Plover	763	698	259	763	157	493	998	315	335		998	70	152	599	574	447	599	998
Greater Sand Plover[M]							6				6	1		1			1	6
Black-fronted Dotterel		6	5	6	1				18	1	18			6	15	11	15	18
Red-kneed Dotterel						1					1		1				1	1
Banded Lapwing										8	8							8
Unidentified Shorebirds						1944	570		413		1944							1944
Total Shorebirds	*3741*	*4523*	*2138*	*[1]5297*	*6049*	*7961*	*7440*	*2148*	*1878*	*87*	*[3]10968*	*1126*	*5488*	*6774*	*6206*	*3138*	*[1]8239*	-
Shorebird Species	*8*	*9*	*11*	*13*	*10*	*13*	*12*	*9*	*6*	*4*	*17*	*14*	*16*	*16*	*12*	*12*	*22*	*[6]24 spp.*
Total Migr. Shorebirds[M]	*1269*	*1056*	*188*	*[1]1559*	*233*	*1209*	*3284*	*860*	*254*	*4*	*[3]3448*	*472*	*685*	*1494*	*2581*	*1593*	*[1]2884*	-
Migr. Shorebird Species[M]	*4*	*4*	*6*	*8*	*5*	*8*	*8*	*5*	*3*	*1*	*10*	*10*	*10*	*11*	*7*	*7*	*15*	*[6]16 spp.*
Silver Gull	8	13	2	13	2564	3058	265	484	136	249	3058	-	-	-	-	-		3058
Caspian Tern							13	3	1	4	13	-	-	-	-	-		13
Crested Tern	1	3	2	3		7					7	-	-	-	-	-		7
Whiskered Tern					40	91					91	-	-	-	-	-		91
Unidentified Terns			15	15								-	-	-	-	-	-	15
Total Terns	*1*	*3*	*17*	*[1]18*	*40*	*98*	*13*	*3*	*1*	*4*	*[1]111*	-	-	-	-	-	-	-
White-fronted Chat					5	2			1	9	9	-	-	-	-	-	-	9
Little Grassbird					1						1	-	-	-	-	-	-	1
Total Birds	**6676**	**8160**	**5332**	**[1]10340**	**37446**	**20375**	**11370**	**5811**	**6381**	**5047**	**[4]43386**	**1126**	**5488**	**6774**	**6206**	**3138**	**[1]8239**	-
Total Species	**29**	**28**	**34**	**39**	**40**	**44**	**35**	**35**	**29**	**28**	**54**	**14**	**16**	**16**	**12**	**12**	**22**	**[6]61 spp.**

1. Sum of annual maxima of each species. This is the standard and preferred method of calculating group (e.g. Total Ducks) totals.
2. Maximum single (simultaneous) count of all birds (including unidentified) of that group (e.g. Total Ducks). This method has been used where the presence of unidentified birds precludes use of method '1' and where this figure is greater than the sum of annual maxima of identified (only) species of the group.
3. Sum of annual maxima of identified species only, where this exceeds the maximum single (simultaneous) count including unidentified birds of the group (i.e. method '2').
4. This 'Total Birds' figure has been calculated using the totals of each 'totalled' group (e.g. Total Ducks) rather than the individual species maxima of these groups, because methods '2' and '3' above (rather than '1') needed to be applied to the totalled groups.
5. Transequatorial migrants (all of which, in this instance, are shorebirds) are denoted by [M].
6. These are the total numbers of species recorded in each group (shorebirds, migratory shorebirds, all waterbirds including shorebirds) in 1998-2000.

noted at the time that the 'great majority … are Grey Teal, then Australian Shelduck and Pacific Black Duck, then Australasian Shoveler'. The 5,440 unidentified ducks in sector 'e' of Vasse estuary were counted from two vantage points, thus: 2,530 'Australian Shelduck, Pacific Black Duck and Grey Teal in that order (descending)' from near the mouth of the Abba River, and 2,910 'mainly Australian Shelduck, Grey Teal and Pacific Black Duck' from the Rushleigh Rd. access point. The 630 unidentified duck in the western part of Malbup Creek were noted as being 'Pacific Black Duck and Grey Teal'. No comments were recorded concerning the species composition of the remaining 874 unidentified ducks counted in December 1998.

If the unidentified ducks (except the 874) are apportioned to species on the basis of the above comments, the December 1998 totals for Grey Teal, Australian Shelduck, Pacific Black Duck and Australasian Shoveler can reasonably be increased by 7,600, 3,000, 2,500 and 200 respectively. This raises the December 1998 totals to c. 9,500 Grey Teal, c. 4,000 Australian Shelduck, c. 4,750 Pacific Black Duck and c. 325 Australasian Shoveler. The 1998-00 maxima for three of these species are also raised, from 2,395 to c. 9,500 for Grey Teal, from 2,254 to c. 4,750 for Pacific Black Duck and from 3,378 to c. 4,000 for Australian Shelduck.

Based on the above, the most numerous ducks (more than 1,000 individuals) identified to species in 1998-99 were Grey Teal (c. 9,500), Pacific Black Duck (c. 4,750) and Australian Shelduck (c. 4,000). Note that while the Pacific Black Duck total exceeds all previous counts (by 550), the teal and shelduck totals are less than historical maxima, which are 14,000 and 4,536 respectively (see Table 11).

Swans, Cormorants and Terns

The maximum number of Black Swan counted in 1998-99 was 3,013 (in December 1998).

The 'minimum number' of cormorants that made use of Vasse-Wonnerup during 1998-99 was 762 (Table 2). The most numerous (more than 100 individuals) were Little Black Cormorant (325) and Little Pied Cormorant (296). Great Cormorants were scarce (maximum of one individual).

The 'minimum number' of terns that made use of Vasse-Wonnerup during 1998-99 was 111 (Table 2). The most abundant species was Whiskered Tern (91).

Shorebirds

The 'minimum number' of shorebirds that made use of Vasse-Wonnerup during 1998-99 was 10,968 (Table 2). The most numerous (more than 1,000 individuals) of these were Black-winged Stilt (3,371), Red-necked Stint (2,512), Red-necked Avocet (2,000) and Banded Stilt (1,124). The next most abundant (more than 100 individuals) were Red-capped Plover (998), Sharp-tailed Sandpiper (391, *but see paragraphs below concerning unidentified shorebirds*), Common Greenshank (300) and Curlew Sandpiper (153). Larger numbers of Banded Stilt (1,137) and Curlew Sandpiper (278) were counted in 1997-98 and larger numbers of Black-winged Stilt (3,494) and Sharp-tailed Sandpiper (432) were counted in 1999-00.

The 'minimum number' of migratory shorebirds that made use of Vasse-Wonnerup during 1998-99 was 3,448 (Table 2). The most numerous (more than 1,000 individuals) of these was Red-necked Stint (2,512). The next most abundant (more than 100 individuals) were Sharp-tailed Sandpiper (391, *but see paragraphs below*), Common Greenshank (300) and Curlew Sandpiper (153). Larger numbers of Curlew Sandpiper (278) and Sharp-tailed Sandpiper (432) were counted in 1997-98 and 1999-00 respectively.

A large number of unidentified shorebirds (1,660 of the survey total of 1,944 unidentified shorebirds) were recorded at the north-eastern end of Wonnerup estuary in January 1999. Of these, 660 were recorded as 'small shorebirds', indicating they were stint, Red-capped Plover and (possibly) sandpiper size. Another 1,000 birds were recorded as mixed 'stint and Red-capped Plover'. These birds cannot be apportioned with confidence to most-likely species so this has not been done. In any case, while apportioning would increase the January 1999 totals of stint, plover and possibly sandpiper, it would nonetheless not substantially affect their 1998-00 maxima.

The 570 unidentified shorebirds recorded in Wonnerup estuary (mainly in the central part) in February 1999 are of greater interest. Most (420) were thought to have been, and were most likely, Sharp-tailed Sandpiper, while the remainder (150) were mixed stint and Red-capped Plover. If the figure of 420 is added to the

number of birds (391) positively identified as Sharp-tailed Sandpiper in that survey, the total (c. 800 birds) is significantly higher than the maximum recorded (432) in the 'shorebird survey year' (1999-00) and throughout the entire 1998-00 study period. Note that this does not, however, alter the composition or sequence of species within the lists (above) of most numerous shorebirds and migratory shorebirds and that c. 800 is substantially exceeded by the historical maxima of 1,230 and 2,300 Sharp-tailed Sandpiper (see Table 11).

South-west comparisons

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. Only one species (Common Greenshank) had a maximum 1998-00 Vasse-Wonnerup count (300 birds) equal to or greater than that reported by Jaensch, Merrifield & Raines (213 birds at 'Peel Inlet east and south').

5.3 Seasonality in Abundance and Species Occurrence

5.3.1 All Species

All waterbirds

During 1998-99 (Dec-May), total waterbird numbers were highest (37,446) in December and steadily declined until March (5,811), with relatively little change in April and May (Figure 4). The number of waterbird species peaked at 44 in January and declined to a minimum of 28 species in May (Figure 5).

Migratory shorebirds

During 1999-00 (Nov-Mar), migratory shorebird numbers were lowest (472) in November and highest (2,581) in February (Figure 4). The number of species 'peaked' at 11 in January and was at a minimum of 7 in February and March (Figure 5).

5.3.2 Individual Species

Waterbirds other than shorebirds

In 1998-99 (Dec-May), 34 (of thirty-seven recorded in this period) waterbird species other than shorebirds were more abundant in one month than in all others (Table 2). Of these, 19 were most abundant in December, 8 in January, 1 in February, 2 in March and 4 in May.

Some of the species that showed marked 'seasonality'[1] in abundance are:

- Black Swan (3,013 in Dec98; only 5 in Feb99)
- Australian Shelduck (c. 4,000[2] in Dec98; 557 in May99)
- Grey Teal (c. 9,500[2] in Dec98; only 182 in May99)
- Australian Pelican (354 in Jan99; only 5 in May99)
- White-faced Heron (379 in Jan99; only 34 in May99)
- Great Egret (108 in Jan99; only 2 in May99)
- Silver Gull (3,058 in Jan99; only 136 in Apr99)

Hoary-headed Grebe (tens to hundreds until January 1999, zero to one February - May 1999) showed a marked episodic[1] change in numbers. This species is well known for occasionally appearing in large numbers on other south-western Australian estuaries (Serventy & Whittell 1976).

It is unclear whether the marked change in numbers of Eurasian Coot (3,570 in December 1998, 29 in January 1999 and fewer in subsequent months) was seasonal or episodic.

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[1] The distinction between seasonality and episodicity is made partly on the basis of the data of the year concerned and partly on other data of this and/or other reports and publications and involves some judgement.

[2] See section 5.2 Ducks for these figures.

Australian resident shorebirds

All seven Australian resident shorebird species recorded in 1999-00 (Nov-Mar) were more abundant in one month than in all others. Of these, 4 were most abundant in December, 2 in January and 1 in February.

Two Australian resident shorebird species showing marked seasonality in abundance (1998-99 and 1999-00 data) were:

- Black-winged Stilt (peaks of 3,371 in Dec98 and 3,494 in Jan00; only 74 in May99)
- Red-necked Avocet (1,296 in Mar98 and peaks of 2,000 in Dec98 and 1,220 in Dec99; zero in Apr-May99)

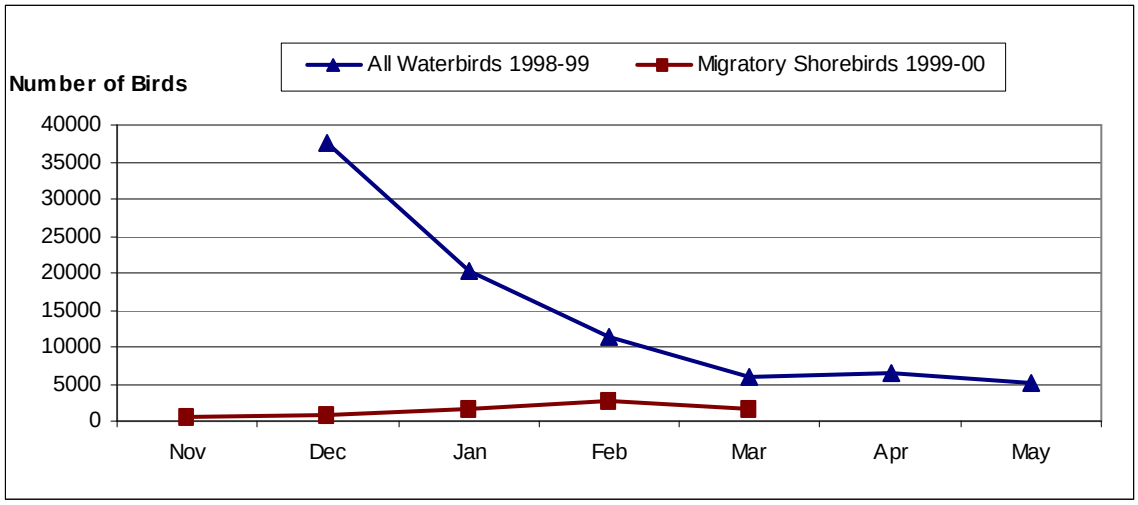

Figure 4. Seasonal variation in number of waterbirds (1998-99) and migratory shorebirds (1999-2000) on Vasse-Wonnerup.

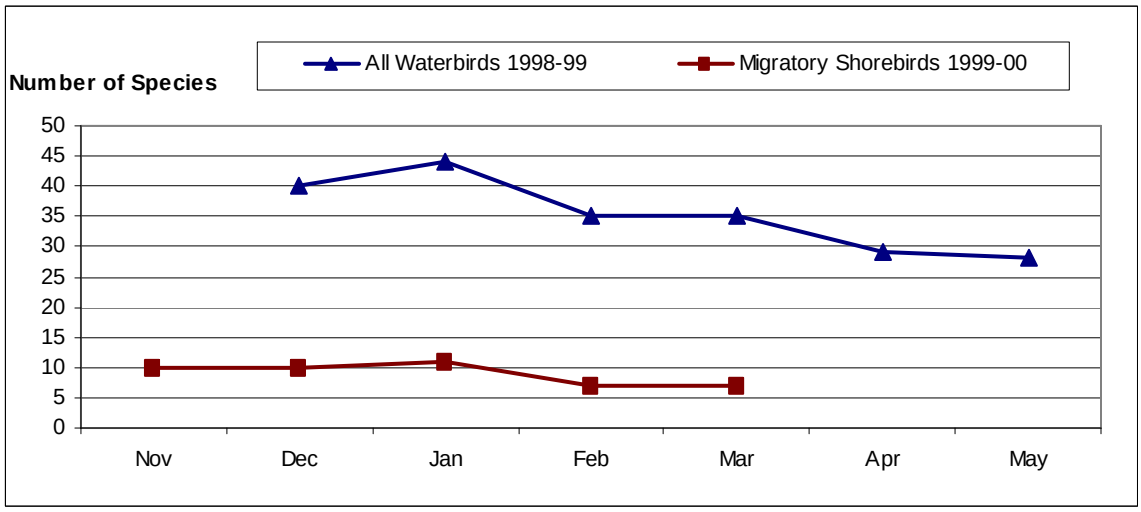

Figure 5. Seasonal variation in number of species of waterbirds (1998-99) and migratory shorebirds (1999-2000) on Vasse-Wonnerup.

Banded Stilt (peaks of 1,137 in 1997-98 and 1,124 in 1998-99 compared with 24 in 1999-00) showed a marked episodic change in numbers. This species frequently undertakes large scale and erratic movements, with populations remaining on coastal and near-coastal wetlands when the arid interior is dry, and returning to the interior to breed when inland wetlands are filled by episodic rains (Marchant & Higgins 1993).

Migratory shorebirds

Thirteen (of 15 recorded in 1999-00) migratory shorebird species were more abundant in one month than in all others. Of these, 3 were most abundant in November, 4 in December, 2 in January, 3 in February and 1 in March.

The five most abundant migratory shorebird species peaked as follows (1998-99 and 1999-00 data):

- Red-necked Stint (2512 in Feb99, 2118 in Feb00)
- Sharp-tailed Sandpiper (391 counted, but probably c. 800 in Feb99; 432 in Dec99)
- Common Greenshank (300 in Jan99; 123 in Feb00)
- Curlew Sandpiper (153 in Feb99, 96 in Jan00)
- Pacific Golden Plover (71 in Jan99, 73 in Dec99)

5.4 Distribution

It is useful for management and other purposes to know the distribution of birds and species within Vasse-Wonnerup. Summary data concerning distribution is therefore presented below and in Section 5.5. Detailed distributional data for each species may be found in Appendices 1 and 2.

All waterbirds

In 1998-99 (Dec-May), Vasse estuary and Wonnerup estuary, which are by far the largest components of the Vasse-Wonnerup wetland system, supported many more birds and species than Malbup Creek, Wonnerup Inlet and the Deadwater (Table 3). Vasse estuary supported more birds (up to 22,106) and usually more species (up to 37) than Wonnerup estuary. Malbup Creek supported substantially more birds, but not species, than Wonnerup Inlet and the Deadwater. Within this period (Dec-May) there was substantial variation in the number of birds and species on each component except Wonnerup Inlet.

Table 3. Number of waterbirds and waterbird species (in italics) on the five major components of Vasse-Wonnerup in 1998-99 (Dec-May). Months of species maxima, means and minima are shown only where they differ from months of bird numbers maxima, means and minima.

Dec 98 – May 99	**Vasse estuary**	**Wonnerup estuary**	**Malbup Creek**	**Wonnerup Inlet**	**Deadwater**	**Vasse-Wonnerup**
Maximum	22106 (Dec) *37(Jan)*	14065 (Dec) *30*	1232 (Dec) *15*	45 (Apr) *7 (Feb)*	84 (Mar) *15*	37446 (Dec) *44 (Jan)*
Mean	7833 *28*	6163 *24*	335 *7*	25 *6*	49 *10*	14405 *35*
Minimum	2512 (May) *19*	1433 (Mar) ***19***	0 (Apr) *0*	12 (May) *5 (Mar)*	8 (May) *4*	5047 (May) *28*

Within Vasse estuary, sector 'e' supported the most birds (up to 12,416), followed by sectors 'b', 'a' and 'f(W)' (Table 4). Sector 'e' also supported the highest number of species (up to 25), while sector 'd' supported the lowest number of birds and species. There was substantial variation in the number of birds and species in each sector.

Table 4. Number of waterbirds and waterbird species (italics) on sectors of Vasse estuary in 1998-99 (Dec-May).

Dec 98 – May 99	**a**	**b**	**d**	**e**	**f(S)**	**f(W)**	**f(N1)**	**Vasse estuary**
Maximum	3924 (Dec) *21*	4378 (Dec) *20*	291 (Dec) *11*	12416 (Dec) *25*	633 (Dec) ***23***	1259 (Jan) *20*	190 (Dec) *13 (Feb)*	22106 (Dec) *37 (Jan)*
Mean	1024 *8*	2093 *11*	66 *3*	3745 *19*	223 *10*	577 *15*	105 *10*	7833 *28*
Minimum	0 (Mar-Apr) *0*	150 (May) *5 (Mar)*	0 (Jan-Apr) *0*	1129 (May) *15*	0 (May) *0*	60 (May) *5*	47 (Apr) *6 (May)*	2512 (May) *19*

Within Wonnerup estuary, sector 'j(E)' generally supported the most birds (up to 10,312), while sector 'i' supported the fewest (Table 5). Species numbers were similar across the sectors. There was substantial variation in the number of birds and species in each sector.

Table 5. Number of waterbirds and waterbird species (italics) on sectors of Wonnerup estuary in 1998-99 (Dec-May). Results for sectors 'j(C)' and 'j(W)' have been pooled because they were not separated in the December 1998 survey. See Appendix 1 for separate 'j(C)' and 'j(W)' results in the other survey months.

Dec 98 – May 99	j(E)	j(C)+j(W)	i	Wonnerup estuary
Maximum	10312 (Dec) *24 (Dec-Jan)*	4769 (Jan) *21 (Dec)*	955 (Feb) *24*	14065 (Dec) *30*
Mean	3261 *14*	2484 *15*	418 *16*	6163 *24*
Minimum	396 (Mar) *7*	895 (Apr) *9 (Mar)*	101 (Mar) *9 (May)*	1443 (Mar) *19*

Within Malbup Creek, sector 'g(W)' supported the most birds (up to 987) and species (up to 14) (Table 6). There was substantial variation in the number of birds and species in both sectors. Note that it is unclear whether or not Malbup Creek was dry at the time of the (late) April 1999 waterbird surveys, when zero birds were counted within it.

Table 6. Number of waterbirds and waterbird species (italics) on sectors of Malbup Creek in 1998-99 (Dec-May).

Dec 98 – May 99	g(W)	g(E)	Malbup Creek
Maximum	987 (Dec) *14*	384 (May) *9*	1232 (Dec) *15*
Mean	225 *5*	110 *3*	335 *7*
Minimum	0 (Apr) *0*	0 (Feb-Apr) *0*	0 (Apr) *0*

Migratory shorebirds

In 1999-00 (Nov-Mar), Vasse estuary and Wonnerup estuary supported many more migratory shorebirds and more migratory shorebird species than Malbup Creek, Wonnerup Inlet and the Deadwater (Table 7). Vasse estuary supported more birds (up to 1,390) and more species (up to 9) than Wonnerup estuary. Very few migrants (up to 3 birds and 1 species) used the Deadwater. Within this period (Nov-Mar) there was substantial variation in the number of birds and species using most components.

Table 7. Number of migratory shorebirds and migratory shorebird species (italics) on the five major components of Vasse-Wonnerup in 1999-2000 (Nov-Mar).

Nov 99 – Mar 00	Vasse estuary	Wonnerup estuary	Malbup Creek	Wonnerup Inlet	Deadwater	Vasse-Wonnerup
Maximum	1390 (Feb) *9 (Jan)*	1178 (Feb) *6 (Jan, Mar)*	12 (Feb) *2 (Jan, Feb)*	31 (Nov) *5*	3 (Nov) *1*	2581 (Feb) *11 (Jan)*
Mean	891 *6*	462 *5*	5 *1*	7 *2*	<1 *<1*	1365 *9*
Minimum	396 (Nov) *4 (Mar)*	42 (Nov) *3*	0 (Nov) *0*	1 (Feb-Mar) *1 (D,F,M)*	0 (Dec-Mar) *0*	472 (Nov) *7 (Feb, Mar)*

Within Vasse estuary, sectors 'a', 'b' and 'e' supported the most migratory shorebirds (maxima 532 - 744), while the other sectors supported very few (maxima 3 - 6) (Table 8). Sectors 'a', 'b' and 'e' also supported the highest number of migratory shorebird species. There was substantial variation in the number of birds and species using components.

Table 8. Number of migratory shorebirds and migratory shorebird species (italics) on sectors of Vasse estuary in 1999-2000 (Nov-Mar).

Nov 99 – Mar 00	a	b	d	e	f(S)	f(W)	f(N1)	Vasse estuary
Maximum	744 (Feb) *5 (Dec)*	532 (Jan) *5*	3 (Dec-Jan) *2*	681 (Mar) *6 (Jan)*	2 (Feb) *1 (Feb, Mar)*	6 (Feb) *2 (Mar)*	3 (N, J-F) *1 (N-F)*	1390 (Feb) *9 (Jan)*
Mean	284 *3*	327 *3*	1 *<1*	274 *3*	<1 *<1*	2 *<1*	2 *<1*	891 *6*
Minimum	0 (Mar) *0*	0 (Nov) *0*	0 (N, F-M) *0*	4 (Dec) *1 (Nov-Dec)*	0 (Nov-Jan) *0*	0 (Nov-Dec) *0*	0 (Mar) *0*	396 (Nov) *4 (Mar)*

Within Wonnerup estuary, sector 'j(C)' supported the most migratory shorebirds (up to 812), while sector 'j(W)' supported the fewest (up to 171) (Table 9). Species numbers were similar across all sectors. There was substantial variation in the number of birds and species using each sector.

Table 9. Number of migratory shorebirds and migratory shorebird species (italics) on sectors of Wonnerup estuary in 1999-2000 (Nov-Mar).

Nov 99 – Mar 00	j(E)	j(C)	j(W)	i	Wonnerup estuary
Maximum	340 (Feb) *4*	812 (Feb) *4*	171 (Mar) *5*	509 (Jan) *5*	1178 (Feb) *6 (J,M)*
Mean	103 *2*	200 *2*	49 *2*	109 *2*	462 *5*
Minimum	1 (Nov) *1 (Nov-Jan)*	22 (Dec) *1 (Nov)*	4 (Nov) *1 (Feb)*	1 (Feb) *1 (Nov)*	42 (Nov) *3*

Within Malbup Creek, sector 'g(W)' supported more migratory shorebirds (up to 11) than sector 'g(E)', however numbers of individuals and species were very low in both sectors (Table 10).

Table 10. Number of migratory shorebirds and migratory shorebird species (italics) on sectors of Malbup Creek in 1999-2000 (Nov-Mar).

Nov 99 – Mar 00	g(W)	g(E)	Malbup Creek
Maximum	11 (Feb) *2 (Jan-Feb)*	1 (Feb) *1*	12 (Feb) *2 (Jan-Feb)*
Mean	4 *1*	<1 *<1*	5 *1*
Minimum	0 (Nov) *0*	0 (N-J, M) *0*	0 (Nov) *0*

5.5 Seasonality in Distribution

All waterbirds

Total waterbird numbers on the three non-tidal components of Vasse-Wonnerup (22,106 birds on Vasse estuary, 14,065 on Wonnerup estuary and 1,232 on Malbup Creek) were highest in the first survey month (December) of 1998-99 (Figure 6). Numbers were lowest (2512, 1433 and zero) in these components in

May, March and April respectively. R.P. Jaensch has recalled (pers. comm., 10 Oct 07) that in the late 1980s there was sometimes a seasonal shift in distribution with bird numbers increasing on Wonnerup estuary after they had peaked on the Vasse estuary. This shift, he recalls, was probably due to earlier drying / shallowing of Vasse estuary than Wonnerup estuary (R.P. Jaensch pers., comm., 25 Jan 08)[1]. At least at the 'all waterbirds' level, this was not the case in 1998-99 (Dec-May).

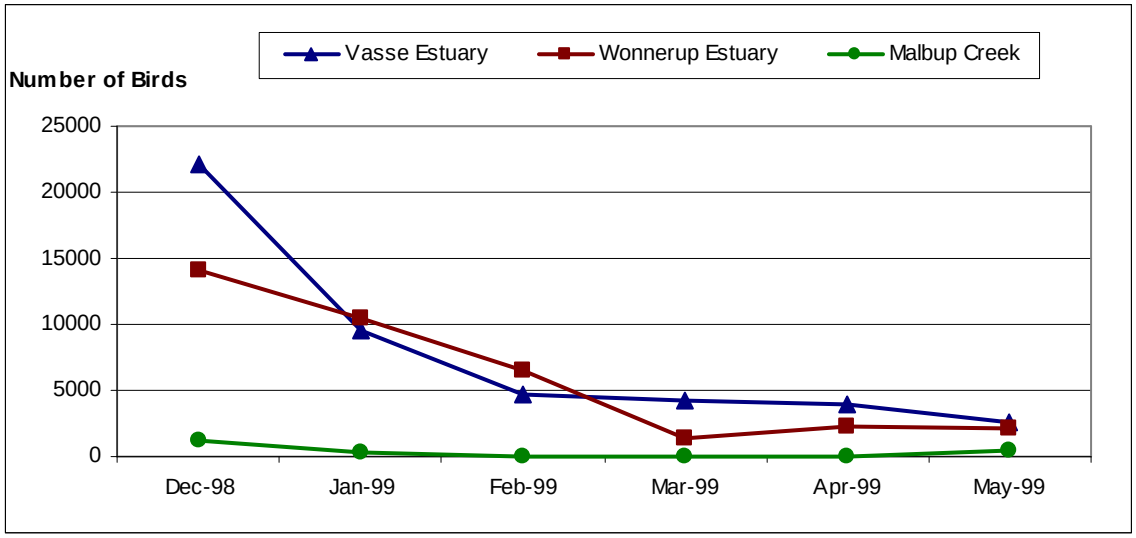

Figure 6. Seasonal variation in number of waterbirds on Vasse estuary, Wonnerup estuary and Malbup Creek in 1998-99 (Dec-May).

Bird numbers were highest on the two tidal[2] components (84 birds on the Deadwater and 45 on Wonnerup Inlet) in March and April respectively and lowest (8 and 12 respectively) in May (Figure 7).

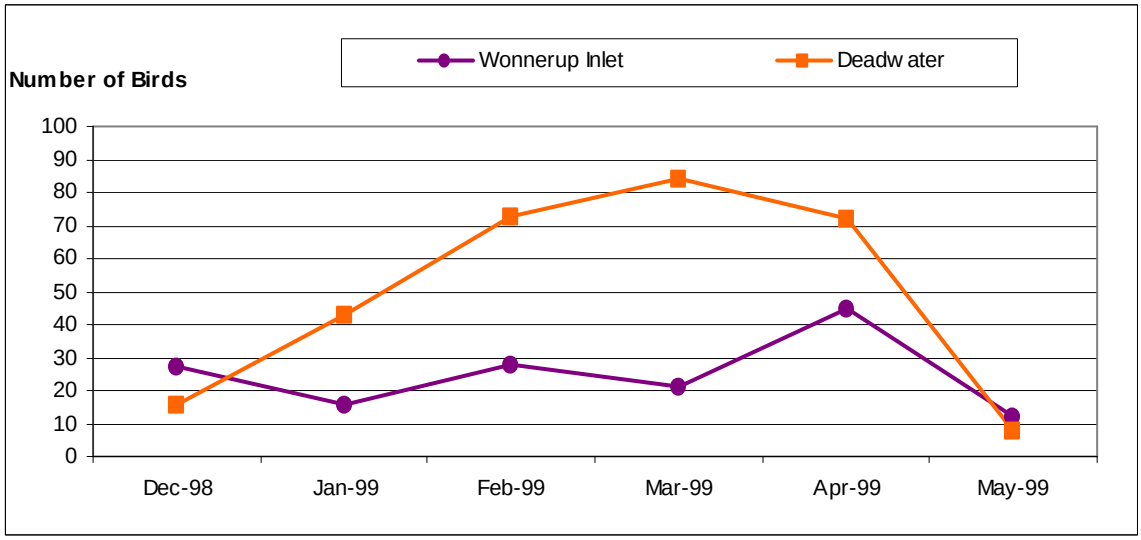

Figure 7. Seasonal variation in number of waterbirds on Wonnerup Inlet and the Deadwater in 1998-99 (Dec-May).

[1] This is a potentially important recollection in the context of hydrological change in Vasse estuary and its effects on waterbird usage of the Vasse-Wonnerup wetland system. It warrants further investigation.

[2] Except when the sandbar at the mouth of Wonnerup Inlet is closed

Numbers of waterbird species on Vasse estuary (37 species), Wonnerup estuary (30) and Malbup Creek (15) were highest in the months of December and January and subsequently declined (Figure 8). Numbers of species were lowest on these three waterbodies in May (19 species), March (19) and April (zero) respectively.

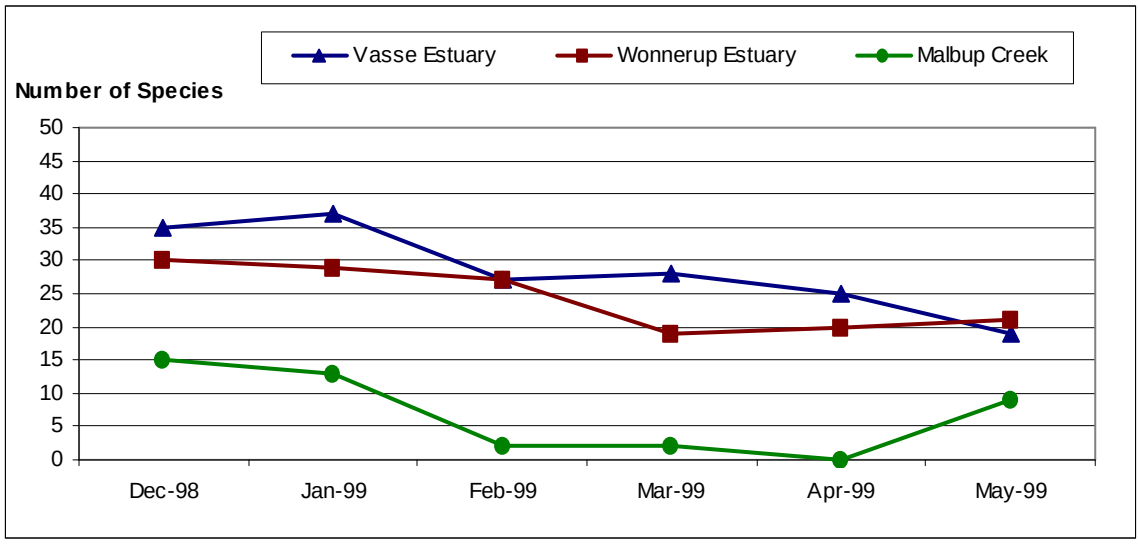

Figure 8. Seasonal variation in number of species of waterbirds on Vasse estuary, Wonnerup estuary and Malbup Creek in 1998-99 (Dec-May).

Numbers of species were highest on Wonnerup Inlet (8 species) and the Deadwater (15) in December and March respectively and lowest (5 and 4) in March and May respectively (Figure 9). Note that, of all components, Wonnerup Inlet had the least variation in number of species.

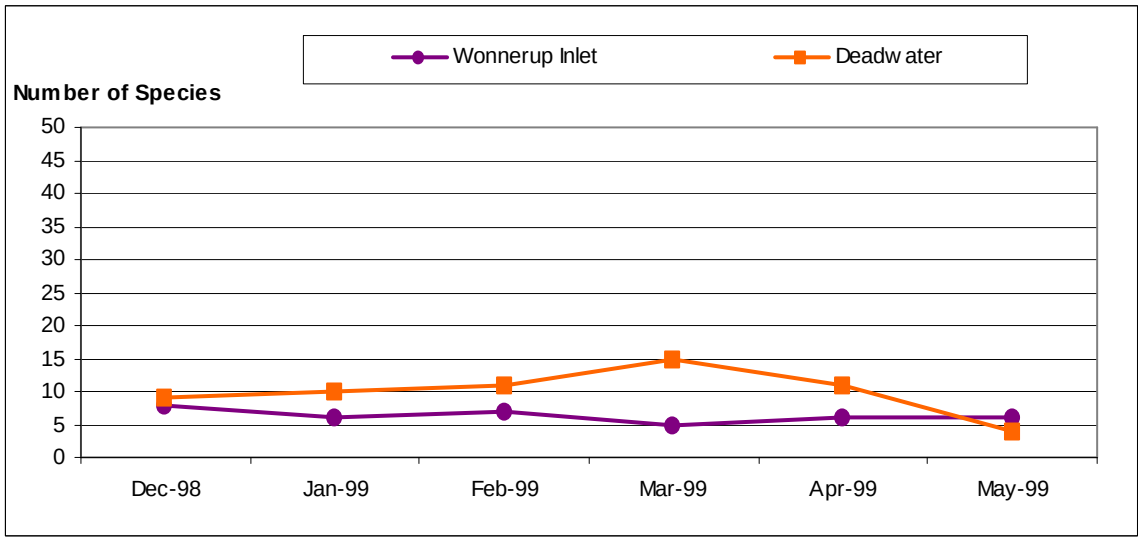

Figure 9. Seasonal variation in number of species of waterbirds on Wonnerup Inlet and the Deadwater in 1998-99 (Dec-May).

Migratory shorebirds

Migratory shorebird numbers peaked on Vasse estuary (1,390 birds), Wonnerup estuary (1,178) and Malbup Creek (12) in the same month (February) of 1999-00 (Figure 10). Numbers were lowest (396, 42 and zero respectively) on these three waterbodies in November of 1999-00. February was also the peak month for migratory shorebirds on Vasse and Wonnerup estuaries in 1998-99, when 1,356 were on Vasse and 1,927 on Wonnerup, while none were recorded in that month on Malbup Creek.

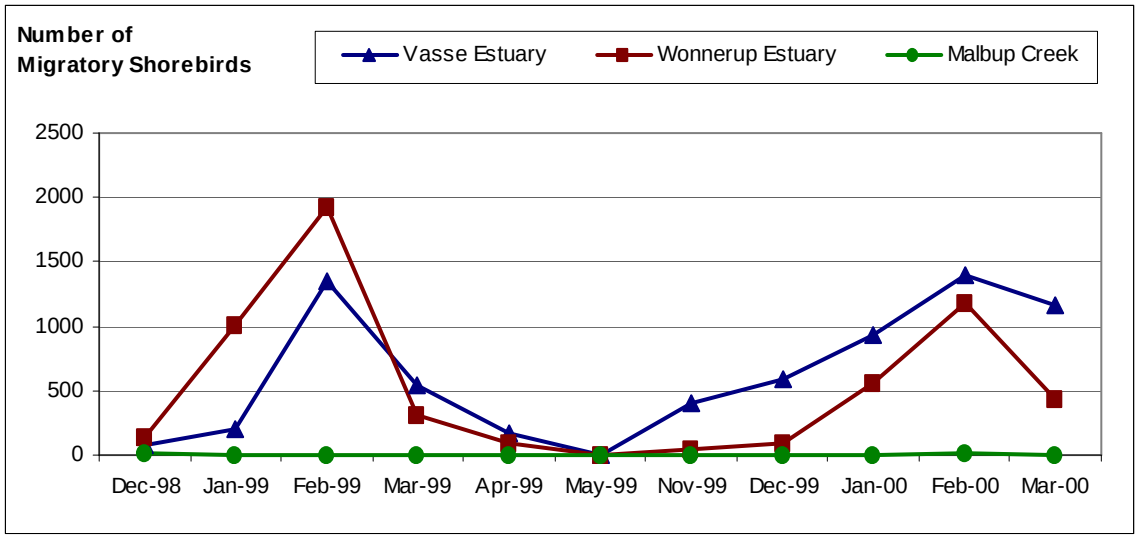

Figure 10. Seasonal variation in number of migratory shorebirds on Vasse estuary, Wonnerup estuary and Malbup Creek from December 1998 to March 2000. Note that small shorebirds were under-counted on at least the larger waterbodies (Vasse and Wonnerup estuaries) in some, possibly all, survey months of 1998-99 (Dec-May) (See sections 4.2 and 4.3).

Migratory shorebird numbers 'peaked' on Wonnerup Inlet (31 birds) and the Deadwater (3 birds) in November of 1999-00 (Figure 11).

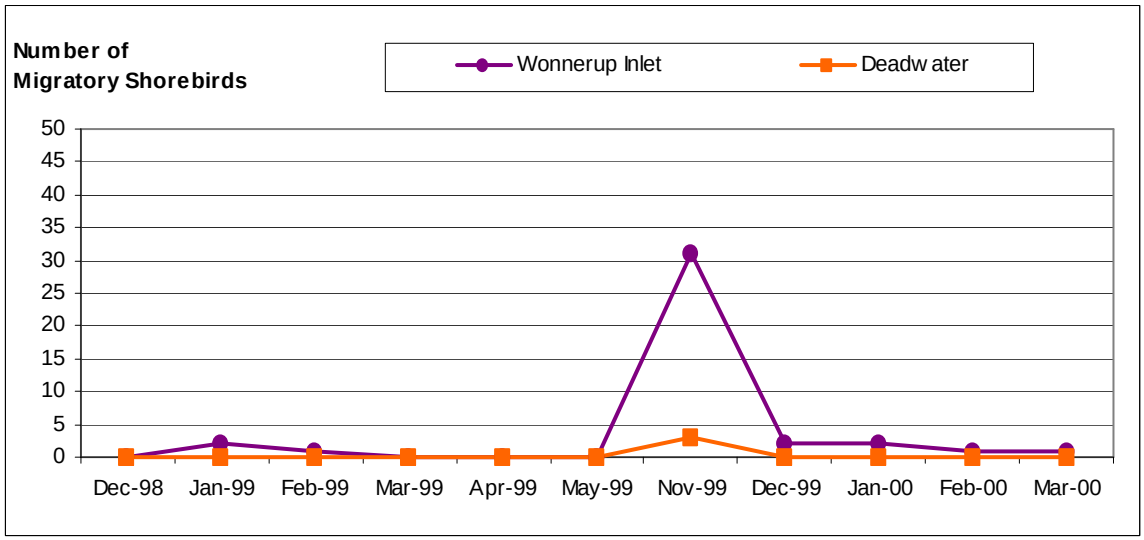

Figure 11. Seasonal variation in number of migratory shorebirds on Wonnerup Inlet and the Deadwater from December 1998 to March 2000.

During 1999-00, the number of migratory shorebird species peaked on Vasse estuary (9 species) in January, on Wonnerup estuary (6 species) in January and March, and on Malbup Creek in January - February (Figure 12). Numbers of species were lowest on Vasse estuary (4 species), Wonnerup estuary (3 species) and Malbup Creek (zero species) in March, November and November respectively of 1999-00.

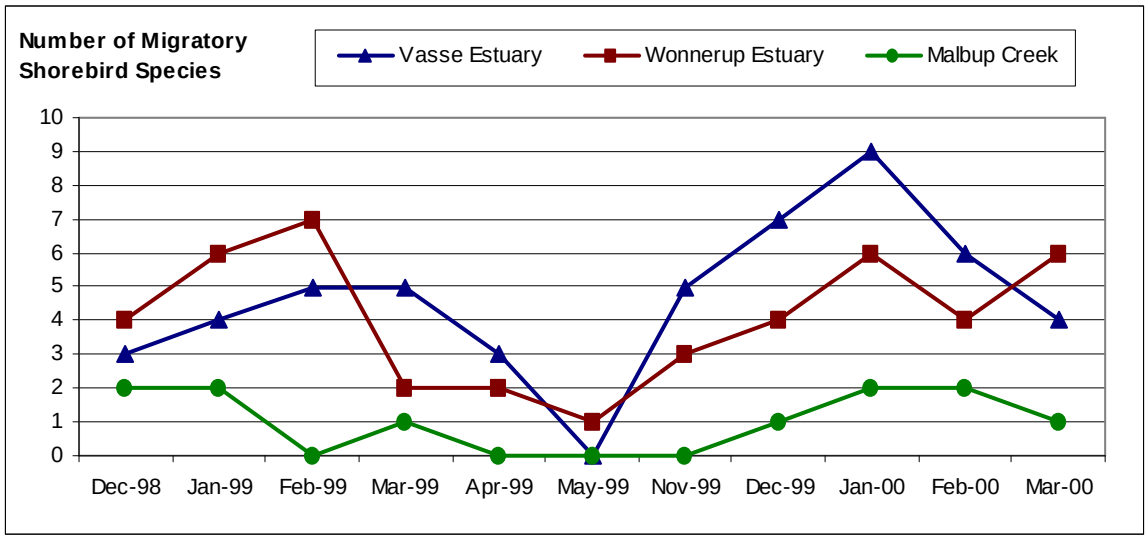

Figure 12. Seasonal variation in number of species of migratory shorebirds on Vasse estuary, Wonnerup estuary and Malbup Creek from December 1998 to March 2000. Note that, at least in the larger waterbodies (Vasse and Wonnerup estuaries), not all small shorebirds were identified to species in at least some survey months of 1998-99 (Dec-May) (See sections 4.2 and 4.3).

The 1999-00 'peaks' on Wonnerup Inlet (5 species) and the Deadwater (1 species) were in November (Figure 13).

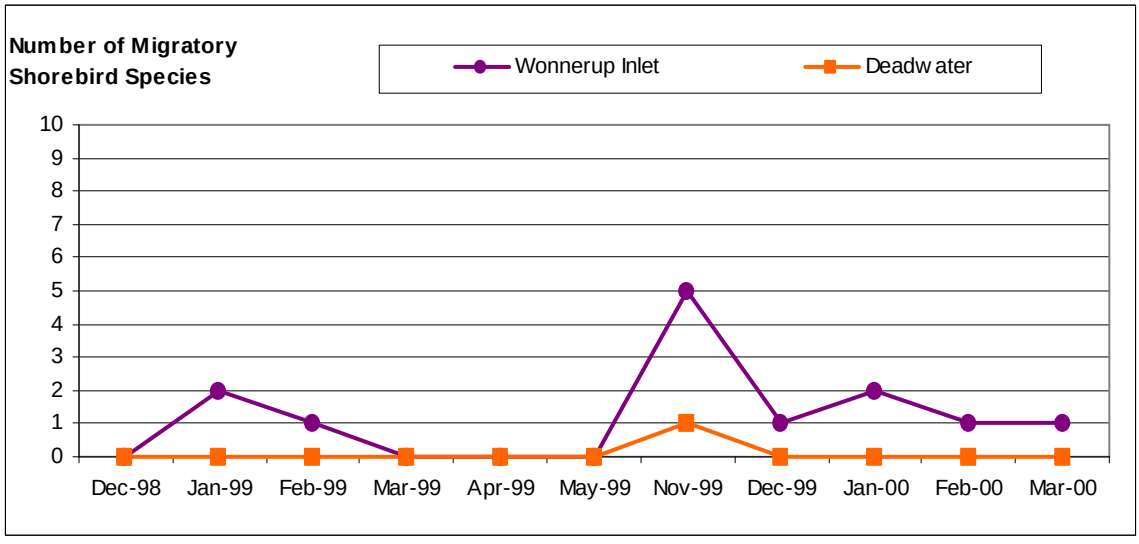

Figure 13. Seasonal variation in number of species of migratory shorebirds on Wonnerup Inlet and the Deadwater from December 1998 to March 2000.

5.6 Breeding

Six species of waterbirds were recorded breeding during the 1998-2000 surveys. These were Black Swan, Pacific Black Duck, Grey Teal, Hardhead, Red-capped Plover and Black-fronted Dotterel. Summary information is presented below. See Appendix 3 for details.

Some downy Black Swan cygnets were seen in eastern / north-eastern parts of the Vasse and Wonnerup estuaries in December 1998. In the same survey month there were also single broods of five downy and six older cygnets in the western part of Malbup Creek. The main swan breeding area of Vasse-Wonnerup ('Swan Lake', to the north-east of Wonnerup estuary) was not included in the 1998-00 survey program (see Section 3).

Ten small (downy) Pacific Black Duck ducklings (a brood of nine and a single duckling) were seen in the Vasse estuary exit channel in late December 1998.

Fourteen small and medium-sized Grey Teal ducklings (broods of six and eight respectively) were also seen in the Vasse estuary exit channel in late December 1998.

Two small Hardhead ducklings and an adult bird were seen repeatedly diving beneath the water surface in Vasse estuary in late December 1998.

There were two downy Red-capped Plover chicks in Malbup Creek in late December 1999.

A Black-fronted Dotterel nest with one egg was found at the water's edge in Vasse estuary in late April 1999.

Some additional breeding observations, including of Purple Swamphen, were made during visits in 1998-2000 that were not part of the formal survey program. These may be found in Appendix 6.

It is also considered useful to present here two extracts from Jaensch (1987) and Jaensch (1988) as these references are not widely available, yet contain important information regarding waterbird breeding at Vasse-Wonnerup.

> 'The largest known [at that time] aggregation of breeding Black Swans in Western Australia occurs at Vasse-Wonnerup Estuary where about 200 pairs have been recorded. In addition, many pairs of Pacific Black Duck and Grey Teal breed in the low rushland and samphire marsh which fringes the estuary. In particular, the importance of the outflow marshes of the Sabina and Abba rivers and the marshy area adjacent to the eastern limits of the project area (Proposed Conservation Island) [Port Geographe], has not been recognised until the last two years' (Jaensch 1988).

> 'In addition, the Vasse-Wonnerup Estuary has a vital role as the area from which [presumably] Yellow-billed Spoonbills, Great Egrets[1] and Sacred Ibises obtain food for their young which are in the breeding colony at nearby McCarley's [Ludlow] swamp' (Jaensch 1987).

5.7 Feeding Frenzies

In December-January of 1998-99, large numbers of pelicans, egrets, herons, ibis, cormorants, spoonbills, gulls and ducks congregated on some mornings in the lowest reaches of the Vasse and Wonnerup estuaries to feed on fish and their fry. Descriptions of several of these impressive events, which appear to occur at about this time of every year, may be found in Appendix 6.

[1] R.P Jaensch has recently advised (pers. comm., 12 Oct 07) that '… on at least several occasions we observed small numbers of this species with the soft part colours (blue-green face, pink legs; and plumes) characteristic of current breeding activity, in the marshes around Ford Road. In at least two years, we confirmed breeding by this species in McCarley's Swamp and/or Australind Swamp at the same time.

5.8 Comparisons with 1981-90 Count Data[1]

5.8.1 Comparisons of Abundance

Species with higher maximum counts in 1998-2000

Twenty nine of the 61 waterbird species recorded in the 1998-00 surveys had highest counts that were greater than (28 species) or equal to (one species) the highest counts made during both the 12 'substantially complete' 1984-90 RAOU surveys reported by Bamford & Bamford (1992) and the 74 substantially complete or partial 1981-87 RAOU surveys reported by Jaensch (1987) (Table 11).

The largest (>100 birds) increases numerically were (in order of numerical magnitude of increase) Silver Gull (1531 to 3058), Banded Stilt (226 to 1137), Pacific Black Duck (4200 to c. 4750), Red-necked Stint (2000 to 2512), Black Swan (2750 to 3013), Red-capped Plover (785 to 998), Australian White Ibis (79 to 279), White-faced Heron (250 to 379) and Little Black Cormorant (203 to 325).

The largest (>50%) increases in percentage terms were (in order of percentage magnitude of increase) Whimbrel (0 to 1), Terek Sandpiper (0 to 1), Common Sandpiper (4[2] to 11), Banded Stilt (226 to 1137), Chestnut Teal (1 to 5), Pacific Golden Plover (15 to 73), Little Egret (2 to 8), Australian White Ibis (79 to 279), Black-fronted Dotterel (6 to 18), Darter (10 to 21), Grey-Tailed Tattler (1 to 2), Pied Oystercatcher (1 to 2), Silver Gull (1531 to 3058), Little Black Cormorant (203 to 325), Banded Lapwing (5 to 8) and White-faced Heron (250 to 379).

Species common to both of the above categories (increased in numbers by >100 and in percentage by >50%) were (in taxonomic order) Little Black Cormorant (203 to 325), White-faced Heron (250 to 379), Australian White Ibis (79 to 279), Banded Stilt (226 to 1137) and Silver Gull (1531 to 3058).

Species with lower maximum counts in 1998-2000

Forty-five species were each recorded during each of the 1981-85, 1985-87 and 1981-90 surveys (i.e. 45 species were common to all three survey periods) reported by Jaensch (1987) and Bamford & Bamford (1992). In the 1998-00 surveys, the highest counts of 10 of these same 45 species were less than (three were zero) the highest counts made in all three of the former survey periods.

The largest (>100 birds) decreases numerically were (in order of numerical magnitude of decrease, from the lowest maximum of the three early survey periods to the 1998-00 maximum) Curlew Sandpiper (395 to 278) and Great Egret (220 to 108).

The largest (>50%) decreases in percentage terms were (in order of percentage magnitude of decrease, from the lowest maximum of the three early survey periods to the 1998-00 maximum) Nankeen Night Heron (10 to zero), Australasian Grebe (6 to zero), White-necked Heron (1 to zero), Hardhead (50 to 1), Crested Tern (20 to 7), Pied Cormorant (130 to 71), Australian Wood Duck (61 to 29) and Great Egret (220 to 108).

The tenth species, Australian Pelican (447 to 354) decreased by less than 100 birds and less than 50%.

Five of the 61 waterbird species recorded in the 1998-00 surveys had highest counts exceeded by six or more (maximum seven) of the counts made during the 12 'substantially complete' 1984-90 RAOU surveys reported by Bamford & Bamford (1992). These were Australian Wood Duck, Hardhead, Pied Cormorant, Great Egret and Nankeen Night Heron.

Consideration of individual species with lower maximum counts in 1998-2000

From a wildlife conservation perspective, decreases in numbers are generally considered to be potentially of concern whereas increases (except, for example, of 'pest' species) are generally not of concern. Species showing decreases in maximum numbers counted are therefore considered in more detail as follows.

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[1] Note that in this section, the maximum number estimates of c. 4,000 Australian Shelduck, c. 4,750 Pacific Black Duck, c. 9,500 Grey Teal and c. 800 Sharp-tailed Sandpiper are used. See section 5.2 for explanation

[2] This assumes that the count of 132 Common Sandpiper in March 1990 reported in Bamford & Bamford (1992) is erroneous.

Seventy-nine species in total were recorded during the 1981-85, 1985-87 and 1984-90 surveys reported by Jaensch (1987) and Bamford & Bamford (1992) (Table 11). In the 1998-00 surveys, the highest counts of 52 species were less than the highest counts made during one or more of the earlier surveys[1]. These 52 species are listed below[2], together with comments relating to the possible significance of the count data. It will be seen from these comments that the authors consider that some species warrant specific follow-up action (in most cases, a more-detailed examination of count data) whereas most do not. Species of particular interest and, in some cases, concern, either locally (Vasse-Wonnerup) or more-generally, are underlined. Recommendations regarding future surveys are made for a number of species.

1) ***Blue-billed Duck*** *(6, 0, 0, **0**[3])*: Closer examination of Vasse-Wonnerup data is warranted to determine where the Blue-billed Ducks counted in 1981-85 were located and whether this location(s) was adequately surveyed in subsequent years. Table 2 of Bamford & Bamford (1992) (data reproduced in Appendix 2 of this report) indicates that, in the period 1982-90, Blue-billed Ducks were only recorded in survey sector 'g' (Malbup Creek). Note that one bird of this species was recorded (see Appendix 6) in Malbup Creek on 22 February 2000 during a visit that was not part of the 1998-00 waterbird survey program. Also, one individual was recorded on the Lower Vasse River Wetlands (Peel Cove) on 30 October 1998 (additional visit) and in May 1999 (survey program). There is evidence of a decline in numbers of Blue-billed Duck elsewhere in south-western Australia, for example on the 'Jandakot lakes' and North Lake near Perth (M.J. Bamford, pers. comm., 10 Oct 07).

2) ***Musk Duck*** *(80, 30, 42, **33**)*: The 1998-00 maximum is within the range of previous maxima and exceeds the second-highest 1984-90 count (32 birds).

3) ***Australian Shelduck*** *(1873, 2565, 4536, **c. 4000**)*: The maximum number counted in 1998-00 was 3,378. This, however, is considered to be an 'under-count' and c. 4,000 is considered a better estimate (see Section 5.2 for explanation). This figure is within the range of previous maxima and exceeds the second-highest 1984-90 count (2959 birds).

4) ***Australian Wood Duck*** *(90, 61, 123, **29**)*: The 1998-00 maximum is also exceeded by six of the twelve 1984-90 counts. Most 1982-90 birds were located in sector 'c' (lower reaches of Sabina River) and very few were recorded elsewhere (Appendix 2). Sector 'c' was not surveyed during 1998-00.

5) ***Australasian Shoveler*** *(50, 500, 716, **355**)*: The 1998-00 maximum is within the range of previous maxima and is exceeded *by* only one of the twelve 1984-90 counts.

6) ***Grey Teal*** *(3970, 9650, 14000, **c. 9500**)*: The maximum number counted in 1998-00 was 2,395. This, however, is considered to be an 'under-count' and c. 9,500 is considered a better estimate (see Section 5.2 for explanation). This figure is within the range of previous maxima but is exceeded by three of the twelve 1984-90 counts.

7) ***Pink-eared Duck*** *(0, 66, 10, **0**)*: The 1998-00 maximum (zero) is within the range of previous maxima but is exceeded by five of the twelve 1984 counts. Closer examination of Vasse-Wonnerup data is warranted to determine where the Pink-eared Ducks counted in 1985-87 and 1984-90 were located and whether this location(s) was adequately surveyed in other periods. Note that this irruptive species was recorded (see Appendix 6) in Malbup Creek on 22 February 2000 during a visit that was not part of the 1998-00 waterbird survey program. Also, this species was recorded (1-15 birds) on the Lower Vasse River Wetlands (Peel Cove) on three occasions during the survey program of 1998-00 and on one additional visit (06 May 1998).

8) ***Hardhead*** *(200, 100, 50, **1**)*: The 1998-00 maximum is also exceeded by seven of the twelve 1984-90 counts. However, this is not necessarily indicative of a long term change as the Hardhead is a 'dispersive and irruptive' species (Marchant & Higgins 1990b) and 'at times can be abundant in recently inundated wetlands in the arid and northern savanna regions of Australia, implying abandonment of southern refuges' (R.P. Jaensch, pers. comm., 29 Jan 08). Note that Hardheads were recorded (see Appendix 6) in slightly higher numbers (3 birds) on Vasse estuary on 28 November 1998 and on Malbup Creek (3 birds) on 22 February 2000 during visits that were not part of the 1998-00 waterbird survey program.

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[1] Also, the highest counts of 20 species were less than the highest counts made during two or more of the earlier survey periods and the highest counts of 11 species were less than in all three of the earlier survey periods.

[2] Species are listed in taxonomic order, with migrant names (all are waders except White-winged Black Tern) followed by [M].

[3] The highest counts in 1981-85, 1985-87, 1984-90 and 1998-00 appear in brackets after each species name, with the highest count of 1998-00 shown in **bold**. Note that there is some overlap between the three early data sets and in some cases the maximum counts from two surveys periods could refer to the same count (e.g. Australian Pelican 447).

Table 11. Highest 1998-2000 counts of waterbirds on Vasse-Wonnerup compared with highest, second highest, etc., 1984-90 RAOU counts as reported by Bamford & Bamford (1992) and highest 1981-85 & 1985-87 RAOU counts as reported by Jaensch (1987). Counts that exceed the highest 1998-00 counts are shaded tan. Names are those of Christidis & Boles (1994), except Australian Painted Snipe *Rostratula australis* (Baker *et al.* 2007).

* In 1998-00, fourteen surveys were conducted. Nine surveys were of all species, but with limited attention given to small shorebirds, and five were of shorebirds only.

** Twelve 'substantially complete' 1984-90 RAOU surveys are reported by Bamford & Bamford (1992). For comparative purposes only the eight (or fewer) highest counts need be shown in this Table.

*** For each species, only the first 1984-90 count that is less than or equal to the highest 1998-00 count is shown in this Table.

Data Source	**This Paper**	**Bamford & Bamford 1992**									**Jaensch 1987**	
Period of Survey	**98-00**	**1984-90**									**81-85**	**85-87**
No. of Surveys	**9(5)***	**12 'substantially complete'**									**61**	**13**
Count Ranking	**1st**	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	****8th**		**1st**	**1st**
Blue-billed Duck	[2]0	0									6	0
Musk Duck	33	42	***32								80	30
Black Swan	3013	2750									1244	1371
Australian Shelduck	c. 4000	4536	2959								1873	2565
Australian Wood Duck	29	123	113	93	60	55	30	24			90	61
Pacific Black Duck	c. 4750	4200									2768	4000
Australasian Shoveler	355	716	350								50	500
Grey Teal	c. 9500	14000	11942	9650	8600						3970	9650
Chestnut Teal	5	1									1	1
Pink-eared Duck	[2]0	10	10	7	5	2	0				0	66
Hardhead	[5]1	50	30	22	12	7	2	2	1		200	100
Australasian Grebe	0	6	5	4	3	0					[1]350	27
Hoary-headed Grebe	317	150	30								150	40
Darter	21	7									10	10
Little Pied Cormorant	296	260									74	130
Pied Cormorant	71	200	150	141	130	110	90	82	17		130	212
Little Black Cormorant	325	203									90	122
Great Cormorant	1	24	1								60	1
Australian Pelican	354	447	423	120							447	750
White-faced Heron	379	250									227	250
Little Egret	8	1									2	0
Eastern Reef Egret	0	0									0	1
White-necked Heron	0	1	1	1	0						4	4
Great Egret	108	237	163	159	149	125	115	106			237	220
Nankeen Night Heron	[2]0	17	7	5	5	2	2	1	0		10	10
Australasian Bittern	0	0									0	1
Glossy Ibis	[2]0	14	13	1	0						0	1
Australian White Ibis	279	59									44	79
Straw-necked Ibis	562	500									200	500
Royal Spoonbill	0	0									0	1
Yellow-billed Spoonbill	151	130									22	120
Osprey	1	2	2	1							2	1
Whistling Kite	11	-									-	-
White-bellied Sea-Eagle	1	1									1	1
Swamp Harrier	4	4									3	5
Buff-banded Rail	4	0									0	3
Baillon's Crake	0	0									0	1
Australian Spotted Crake	1	0									0	5
Spotless Crake	0	0									2	0
Purple Swamphen	11	25	5								10	15
Dusky Moorhen	4	8	3								0	14
Black-tailed Native-hen	0	0									4	1

Table 11 continued.

Data Source	This Paper	Bamford & Bamford 1992									Jaensch 1987	
Period of Survey	**98-00**	**1984-90**									**81-85**	**85-87**
No. of Surveys	**9(5)**	**12 'substantially complete'**									**61**	**13**
Count Ranking	**1st**	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**		**1st**	**1st**
Eurasian Coot	3570	2500									1061	4000
Pin-tailed Snipe[3]	0	0									0	1
Black-tailed Godwit	0	8	8	1	0						0	18
Bar-tailed Godwit	2	14	5	5	2						0	5
Whimbrel	1	0									0	0
Marsh Sandpiper	3	3	3	2							3	8
Common Greenshank	300	155									14	200
Wood Sandpiper	7	72	57	50	47	44	4				0	61
Terek Sandpiper	1	0									0	0
Common Sandpiper	11	[4]132									4	3
Grey-tailed Tattler	2	1									0	1
Great Knot	[5]1	12	12	3	3	0					0	12
Red Knot	[5]9	2									0	8
Red-necked Stint	2512	1035									1035	2000
Long-toed Stint	[2]0	24	21	19	13	12	0				0	44
Pectoral Sandpiper	0	7	1	0							0	3
Sharp-tailed Sandpiper	c. 800	1230	626								626	2300
Curlew Sandpiper	278	2500	1121	734	395	120					395	1200
Ruff	0	0									0	1
Australian Painted Snipe	0	0									0	1
Pied Oystercatcher	2	0									0	1
Black-winged Stilt	3494	4000	3600	2854							2750	5000
Banded Stilt	1137	125									226	100
Red-necked Avocet	2000	2000									740	4000
Pacific Golden Plover	73	15									0	6
Grey Plover	9	4									1	14
Red-capped Plover	998	785									785	400
Greater Sand Plover	6	4									0	0
Black-fronted Dotterel	18	4									4	6
Red-kneed Dotterel	1	0									0	2
Banded Lapwing	8	1									0	5
Silver Gull	3058	1531									1531	1383
Gull-billed Tern	0	1	0								0	0
Caspian Tern	13	15	8	2							8	15
Crested Tern	7	23	3								20	25
Fairy Tern	0	1	0								2	0
Whiskered Tern	91	4									180	4
White-winged Black Tern	0	70	1	1	0						0	16
White-fronted Chat	9	-									-	-
Clamorous Reed-Warbler	[2]0	0									0	1
Little Grassbird	1	6	2	2	1						0	5
No. of Species	**[2]61**	**64**									**50**	**73**

1. Historical count of 350 Aust'asian Grebe is considered erroneous. They were probably Hoary-headed Grebe. See Section 5.8.1.
2. Note that one Blue-billed Duck, six Pink-eared Duck, three Nankeen Night Heron, four Glossy Ibis, one Eastern Curlew[M], at least one Long-toed Stint[M] and at least one Clamorous Reed Warbler were recorded during additional visits in 1998-2000 that were not part of the formal survey program. See Appendix 6 for further detail.
3. This is a probable, rather than definite record of this species of *Gallinago* snipe (R.P. Jaensch, pers. comm., 10 Oct 07).
4. The historical count of 132 Common Sandpiper is considered erroneous (they were more-likely Common Greenshank).
5. Note that three Hardhead and c. 30 'knot types' were recorded in 1998-2000 during additional visits that were not part of the formal survey program. See Appendix 6 for further details.

9) ***Australasian Grebe*** *(350, 27, 6,* ***0****)*: The maximum count of 350 in 1981-85 is probably erroneous because, except at a few locations such as Lakes Chittering and Wannamal, north of Perth (Jaensch *et al.* 1988), this species is not known to flock in such large numbers in south-western Australia (Serventy & Whittell 1976; Marchant & Higgins 1990a). The birds that were seen were more likely to have been Hoary-headed Grebe, a species known to flock in large numbers, including on south-west estuaries (Serventy & Whittell 1976). A careful re-examination of all previous Vasse-Wonnerup records of Australasian Grebes is warranted.

10) ***Pied Cormorant*** *(130, 212, 200,* ***71****)*: The 1998-00 maximum is also exceeded by seven of the twelve 1984-90 counts. Even if all (and this is likely to be a substantial over-estimate) of the 76 unidentified black & white cormorants of the December 1998 survey are added to the number (64) of Pied Cormorants counted in that survey, the total (and new maximum, 140), while within the range of previous maxima, is exceeded by two of them and also by three of the twelve 1984-90 counts. Future surveys should aim at more accurate counts of this species. R.P. Jaensch has advised (pers. comm., 29 Jan 08) that 'Our counts of 100+ Pied Cormorant primarily were of birds perched on fence posts running across Wonnerup estuary'.

11) ***Great Cormorant*** *(60, 1, 24,* ***1****)*: Closer examination of Vasse-Wonnerup data is warranted to determine where the Great Cormorants counted in 1981-85 and 1984-90 were located and whether this location(s) was adequately surveyed in 1985-87 and 1998-00. The authors are concerned about the regional status of this species, due to a decline in numbers counted (and encountered) elsewhere, for example on Peel-Harvey Estuary (Lane & Pearson 2002; Lane *et al.* 2002a,b).

12) ***Australian Pelican*** *(447, 750, 447,* ***354****)*: While the 1998-00 maximum is less than the maxima of previous survey periods, it is exceeded by only one of the twelve 1984-90 counts.

13) ***Eastern Reef Egret*** *(0, 1, 0,* ***0****)*: The 1998-00 maximum (zero) is within the range of previous maxima. This is a species of the sea coast, rarely venturing into south-western Australian estuaries.

14) ***White-necked Heron*** *(4, 4, 1,* ***0****)*: In most years this species is recorded in south-western Australia in low numbers, but occasionally there is an influx from the north of the State (Serventy & Whittell 1976, Marchant & Higgins 1990a). The count data are consistent with this general pattern.

15) ***Great Egret*** *(237, 220, 237,* ***108****)*: The 1998-00 maximum is also exceeded by six of the twelve 1984-90 counts. Concern has been expressed in the past about the level of threats to known breeding colonies in south-western Australia and the impact this might have on numbers (Jaensch & Vervest 1989). The Vasse-Wonnerup data might reflect a regional trend. They might also indicate a recent decline in breeding activity and/or success at nearby breeding sites, in particular McCarley's (Ludlow) Swamp. Investigation is warranted

16) ***Nankeen Night Heron*** *(10, 10, 17,* ***0****)*: The 1998-00 maximum is also exceeded by seven of the twelve 1984-90 counts. Most 1982-90 birds were located in sector 'c' (lower reaches of Sabina River) (Appendix 2), which was not surveyed during 1998-00. Some birds were located in other sectors in 1982-90 and it would be useful to examine those early records in detail to determine exactly where and when the birds were seen. R.P. Jaensch has advised (pers. comm., 12 Oct 07) that '5 were in tall thickets of *Melaleuca hamulosa* in the "New River Marshes" (west of Ford Rd?) on 4 December 1987'. Note that 1-3 birds of this species were recorded (see Appendix 6) at or near the Vasse estuary and Wonnerup estuary floodgates on 27-28 December 1998 and 09 January 1999 respectively during visits that were not part of the 1998-00 waterbird survey program.

17) ***Australasian Bittern*** *(0, 1, 0,* ***0****)*: This species occurs in very low numbers (estimated 500 individuals) in south-western Australia (Wetlands International 2006). There is only one record from Vasse-Wonnerup; a single bird observed by R.P. Jaensch on 22 November 1986 (pers. comm., 10 & 12 Oct 07) in 'extensive low sedgeland (*Bolboschoenus*) at the Vasse River deltaic marshes' (sector 'a') (ANCA 1996; see also the 'Baillon's Crake' entry, five paragraphs below, for further description of these marshes). It would be logical to search this location, especially during spring, in any future Vasse-Wonnerup survey intended to include this species.

18) ***Glossy Ibis*** *(0, 1, 14,* ***0****)*: The 1984-90 counts of 14 and 13 birds were exceptional; all other counts being one or zero. This is not a common species in south-western Australia; its main distribution being northern and eastern Australia. Note that this species was recorded (see Appendix 6) on Wonnerup estuary on 23 February 2000 during a visit that was not part of the 1998-00 waterbird survey program. Also, this species was recorded (1-5 birds) on the Lower Vasse River Wetlands on several occasions during 1998-00.

19) ***Royal Spoonbill*** *(0, 1, 0, **0**)*: This species is infrequently recorded, in very low numbers (usually single birds), in south-western Australia. It is reasonably abundant in northern and eastern Australia.

20) ***Osprey*** *(2, 1, 2, **1**)*: The 1998-00 maximum is within the range of previous maxima and is exceeded by only two of the twelve 1984-00 counts.

21) ***Swamp Harrier*** *(3, 5, 4, **4**)*: The 1998-00 maximum is within the range of previous maxima.

22) ***Baillon's Crake*** *(0,1,0,**0**)*: This secretive and 'normally freshwater' (R.P.Jaensch, pers. comm., 29 Jan 08) species is easily overlooked. Concerning the single 1985-87 record, R.P. Jaensch has advised (pers. comm., 29 Jan 08) that 'A single Baillon's Crake was flushed from marsh in the Vasse River floodout just east of Ford Road on 30/10/87. This area, and connected similar habitat occupying a larger area to the south-east (map attached), also supported Australian Spotted Crakes and Buff-banded Rails in spring and crake/rail footprints were plentiful in the mud. Vegetation was dominated by samphire with abundant sedge *Bolboschoenus caldwellii* and water buttons *Cotula* sp.; similar habitat was scarce or localised in the Vasse Wonnerup system east of this area, eg. along the southern side of the western basin of Vasse Estuary and on parts of the Port Geographe development site. We found eight empty nests of crakes in the habitat near Ford Road in December 1987; remarkably, although I assumed that these were nests of Australian Spotted Crake, which seems to be the most numerous crake in this type of swamp, the only nest with eggshell fragments was of a Spotless Crake (egg shells were more than one layer deep, suggesting multiple-year usage)'. Note that during 1982-90, unidentified crakes were recorded in sector 'f' (lowest reaches of Vasse estuary / part Wonnerup Inlet).

23) ***Australian Spotted Crake*** *(0, 5, 0, **1**)*: This secretive species, whose presence is 'likely to be strongly influenced by inland wetland availability' (R.P. Jaensch, pers. comm., 10 Oct 07), is easily overlooked. It would be useful to examine past records to determine when and where it has been recorded in order to ensure that these sites are adequately searched in future surveys intended to include this species. During 1982-90 it was recorded in sector 'a' (the western end of Vasse estuary; see also the 'Baillon's Crake' entry, one paragraph above). Note that unidentified crakes were recorded in sector 'f' (lowest reaches of Vasse estuary / part Wonnerup Inlet) in 1982-90.

24) ***Spotless Crake*** *(2, 0, 0, **0**)*: This species, which is 'more secretive than other crakes' (R.P. Jaensch, pers. comm., 10 Oct 07), is easily overlooked. It would be useful to examine past records to determine when and where it has been recorded in order to ensure that these sites are adequately searched in future surveys intended to include this species. During 1982-90 it was recorded in sectors 'c' (lower reaches of Sabina River) and 'a' (western end of Vasse estuary; see also the 'Baillon's Crake' entry, two paragraphs above, including discovery of a Spotless Crake nest). Note that unidentified crakes were recorded in sector 'f' (lowest reaches of Vasse estuary / part Wonnerup Inlet) in 1982-90.

25) ***Purple Swamphen*** *(10, 15, 25, **11**)*: The 1998-00 maximum is within the range of previous maxima and is exceeded by only one of the twelve 1984-00 counts. Note that this species was regularly recorded in numbers (24-65 birds) on the Lower Vasse River Wetlands (mainly at Ford Road) during 1998-00.

26) ***Dusky Moorhen*** *(0, 14, 8, **4**)*: The 1998-00 maximum is within the range of previous maxima and was exceeded by only one of the twelve 1984-00 counts.

27) ***Black-tailed Native-hen*** *(4, 1, 0, **0**)*: This species occasionally irrupts into south-western Australia from inland breeding grounds.

28) ***Eurasian Coot*** *(1061, 4000, 2500, **3750**)*: The 1998-00 maximum is within the range of previous maxima.

29) ***Pin-tailed Snipe**[M]* *(0, 1, 0, **0**)*: This species is a rare vagrant to south-western Australia. There is only one probable record from Vasse-Wonnerup: 'A *Gallinago* Snipe, probably *G. stenura* [Pin-tailed Snipe] was seen [by R.P. Jaensch (pers. comm., 10 Oct 07)] in this area ['marshy margins and wet samphire of central Vasse Estuary'] in January 1986' (ANCA 1996). It would be logical to search this location (which is within survey sector 'b') in any future Vasse-Wonnerup survey aimed at this species. Note that there 'were widespread records of snipe on the Swan Coastal Plain in the second half of the 1980s …' (R.P. Jaensch , pers. comm., 29 Jan 08).

30) ***Black-tailed Godwit**[M]* *(0, 18, 8, **0**)*: The 1998-00 maximum (zero) is within the range of previous maxima but is exceeded by three of the twelve 1984-90 counts. This species is irregularly recorded in south-western Australia, in low numbers.

31) ***Bar-tailed Godwit**[M]* *(0, 5, 14, **2**)*: The 1998-00 maximum is within the range of previous maxima but is exceeded by three of the twelve 1984-90 counts. All counts, however, are low, indicating that Vasse-Wonnerup is not an important site for this migratory species, which is more abundant at some other sites in the south-west of Western Australia (e.g. Jaensch *et al.* 1993; Lane & Pearson 2002) and very

abundant in northern parts of the State (Higgins & Davies 1996).

32) ***Marsh Sandpiper**[M]* *(3, 8, 3, **3**)*: The 1998-00 maximum is within the range of previous maxima.

33) ***Wood Sandpiper**[M]* *(0, 61, 72, **7**)*: The 1998-00 maximum is within the range of previous maxima, however the 1985-87 and 1984-90 maxima were substantially higher and the 1998-00 maximum is also substantially exceeded by five of the twelve 1984-90 counts. Past records should be examined to determine exactly where and when this species has previously been recorded on Vasse-Wonnerup and to ensure that at least the most significant of these locations are always included in future surveys involving this species[1]. R.P. Jaensch's recollection (pers. comm., 10 Oct 07, 29 Jan 08) is that, in the 1980s, Wood Sandpiper were, like Long-toed Stint, 'principally in an area of samphire and couch near where the Sabina River flows out, mainly on the few days/weeks when water levels were just right' and that this species 'normally does not inhabit saline waters'. Additional information concerning preferred Vasse-Wonnerup habitats of Wood Sandpipers and two other shorebird species is presented under 'Pectoral Sandpiper', two paragraphs below. Further surveys aimed specifically at this species are warranted.

34) ***Great Knot**[M]* *(0, 12, 12, **1**)*: The 1998-00 maximum is within the range of previous maxima but is exceeded by three of the twelve 1984-90 counts. All counts, however, are low, indicating that Vasse-Wonnerup is not an important site for this migratory species, which is very abundant in northern parts of Western Australia (Higgins & Davies 1996). Note that a single group of c. 30 'knot types' was recorded in 1998-2000 during an additional visit that was not part of the formal survey program. Some or all of these could have been Great Knots. See Appendix 6 for further detail.

35) ***Long-toed Stint**[M]* *(0, 24, 24, **0**)*: The 1998-00 maximum (zero) is within the range of previous maxima, however the 1985-87 and 1984-90 maxima were substantially higher and the 1998-00 maximum is also exceeded by five of the twelve 1984-90 counts. Past records should be examined to determine exactly where and when this species has previously been recorded on Vasse-Wonnerup and to ensure that at least the most significant of these locations are always included in future surveys intended to include this species. Note that this species was recorded (see Appendix 6) near the Malbup Creek bird hide on 06 February 1999 during a visit that was not part of the 1998-00 waterbird survey program. R.P. Jaensch's recollection (pers. comm., 10 Oct 07, 29 Jan 08) after reviewing original notebooks is that, in the 1980s, Long-toed Stint were, like Wood Sandpiper, 'principally in an area of samphire and couch near where the Sabina River flows out, mainly on the few days/weeks when water levels were just right' and 'sometimes in small outliers of this habitat' Also, 'the far north-east of the Wonnerup system seemed suitable for this species when muddy short grass occurred on the dry wetland bed'. Jaensch has formed the view that this species also 'normally is more prevalent in freshwater than saline habitats'. Additional information concerning preferred Vasse-Wonnerup habitats of Long-toed Stints and two other shorebird species is presented under 'Pectoral Sandpiper' below. Further surveys aimed specifically at this species are warranted.

36) ***Pectoral Sandpiper**[M]* *(0, 3, 7, **0**)*: The 1998-00 maximum (zero) is within the range of previous maxima. This species is regularly recorded in south-western Australia, in very low numbers. Following a check of field notebooks, R.P. Jaensch has advised (pers. comm., 12 Oct 07) that, on Vasse-Wonnerup, 'Wood Sandpiper, Long-toed Stint and Pectoral Sandpiper were principally recorded in low sparse samphire, in muddy condition, to the immediate west and east of that small peninsula where the Sabina River flows into Vasse Estuary (map attached). In some notebooks I coined the name 'Sabina Marshes" for this area, particularly the eastern part which was categorised also by a reasonably extensive area of couch grass in the form of low mounds separated by mud/drying shallows. Often these habitats provided a loafing area and possibly also feeding opportunities for a wide range of migratory shorebirds. On at least one occasion (21/1/89), this suite of birds was found in drying arms of Malbup Creek: 67 Wood Sandpipers were flushed from couch grass and slush with pieces of flat limestone. Small numbers of some of these birds were on the marshes on "Giles Point" (near the [Port Geographe] development site) on 28/12/87. Generally, you need to flush these three species to find them all, and knowing their call (as they speed away) therefore is an advantage'.

37) ***Sharp-tailed Sandpiper**[M]* *(626, 2300, 1230, **c. 800**)*: The maximum number counted in 1998-00 was 432. This, however, is considered to be an 'under-count' and c. 800 is a better estimate (see Section 5.2 for explanation). Due to its small size, colouration and markings, this species can easily be overlooked when in samphire and couch marshes. It would be useful to examine past records to determine exactly

[1] Note that in a 12 Oct 07 personal communication concerning this and several other species, R.P. Jaensch made the general comment that 'Many of these observations relate to spatially small parts of the VW system, underlining the importance of comprehensive coverage and knowing the habitat preferences of particular (uncommon) species'.

where and when this species was previously recorded in large numbers on Vasse-Wonnerup and to ensure that these and similar habitats are thoroughly searched in future surveys. Further surveys aimed specifically at this species are warranted.

***38) <u>Curlew Sandpiper</u>**[M] *(395, 1200, 2500, **278**)*: The 1998-00 maximum is also exceeded by four of the 1984-90 counts. There is strong evidence that Curlew Sandpiper have declined in numbers elsewhere in Australia over the past two decades (Minton *et al.* 2003). The low maximum count in 1998-00 reflects this downward trend. The 2,500 recorded in January 1989 were 'mostly in the central basin of Vasse estuary' (R.P. Jaensch, pers. comm., 12 Oct 07).

***39) Ruff**[M] *(0, 1, 0, **0**)*: This is a near-regular visitor to south-western Australia, in very low numbers.

***40) Australian Painted Snipe**[1] *(0, 1, 0, **0**)*: This 'exceptionally secretive and cryptic bird' (R.P. Jaensch, pers. comm., 10 Oct 07) is a breeding resident-nomad of eastern and northern Australia and a rare vagrant to the south-west. There is only one[2] record from Vasse-Wonnerup. This was a single bird in sector 'a' (the western end of Vasse estuary) in early February 1986 (Jaensch 1986; Jaensch *et al.* 1988). Jaensch (1988) has written: 'further surveys may prove that it occurs regularly and perhaps breeds in the areas of samphire, low rush and sedge fringing the [Vasse-Wonnerup] Estuary. These birds have been observed breeding in areas [presumably in eastern Australia] subject to disturbance by stock animals similar to those found in the Southern Conservation Area and Proposed Conservation Island [north side of Vasse estuary, adjacent to Port Geographe canals development]'.

***41) Black-winged Stilt** *(2750, 5000, 4000, **3494**)*: The 1998-00 maximum is within the range of previous maxima and is exceeded by only two of the twelve 1984-90 counts.

***42) Red-necked Avocet** *(740, 4000, 2000, **2000**)*: The 1998-00 maximum is within the range of previous maxima.

***43) Grey Plover**[M] *(1, 14, 4, **9**)*: The 1998-00 maximum is within the range of previous maxima.

***44) Red-kneed Dotterel** *(0, 2, 0, **1**)*: The 1998-00 maximum is within the range of previous maxima. This species' presence on Vasse-Wonnerup is 'likely to be strongly influenced by inland wetland availability' (R.P. Jaensch, pers. comm., 10 Oct 07),

***45) Gull-billed Tern** *(0, 0, 1, **0**)*: The 1998-00 maximum (zero) is within the range of previous maxima. This species is irregularly recorded in south-western Australia, in low numbers.

***46) Caspian Tern** *(8, 15, 15, **13**)*: The 1998-00 maximum is within the range of previous maxima and is exceeded by only one of the twelve 1984-90 counts.

***47) Crested Tern** *(20, 25, 23, **7**)*: While the 1998-00 maximum is less than the maxima of previous survey periods, it is exceeded by only one of the twelve 1984-90 counts.

***48) Fairy Tern** *(2, 0, 1, **0**)*: The 1998-00 maximum (zero) is within the range of previous maxima and is exceeded by only one of the twelve 1984-90 counts.

***49) Whiskered Tern** *(180, 4, 4, **91**)*: The 1998-00 maximum is within the range of previous maxima.

***50) White-winged Black Tern**[M] *(0, 16, 70, **0**)*: The 1998-00 maximum (zero) is within the range of previous maxima and is substantially exceeded by only one of the twelve 1984-90 counts. This species, which breeds in the northern hemisphere, is an annual visitor to parts of northern Australia and occasionally invades the south-west in association with gales or cyclones (Serventy & Whittell 1976; Higgins & Davies 1996).

***51) Clamorous Reed-Warbler** *(0, 1, 0, **0**)*: The 1998-00 maximum is within the range of previous maxima. In south-western Australia, this species is generally confined to rushbeds, particularly of *Baumea articulata* and *Typha* spp. It would be useful to examine past records to determine when and where it has been recorded in order to ensure that these sites are adequately searched in future surveys intended to include this species. Note that this species was recorded (see Appendix 6) in a stand of bulrush *Typha orientalis* at the far western end of Vasse estuary (Ford Rd) on 30 October 1998 during a visit that was not part of the 1998-00 waterbird survey program.

***52) Little Grassbird** *(0, 5, 6, **2**)*: The 1998-00 maximum is within the range of previous maxima. Few birds of this species have been recorded on Vasse-Wonnerup as it typically frequents thick saltmarsh (*Halosarcia*) vegetation and is easily overlooked. It would be useful to examine past records to

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[1] *Rostratula australis* (Baker *et al.* 2007)

[2] The date of the record of a single bird 'seen nearby in samphire and sedgeland in January 1986 (ANCA 1996) is incorrect. This should be February 1986 as this was the same bird as reported by Jaensch (1986) and Jaensch *et al.* (1988).

determine when and where it has been recorded in order to ensure that these sites are adequately searched in future surveys intended to include this species.

5.8.2 Comparisons of Distribution

Bamford & Bamford (1992) analysed data collected by members and staff of the RAOU (now Birds Australia) between January 1982 and March 1990 in an effort to identify the distribution of each waterbird species within the Vasse-Wonnerup wetland system over that period. They presented that data in tabular format, showing the 'mean number [of birds] of each species observed per visit to each section of the Vasse-Wonnerup Estuary [sic]'. While doing so, they recognised a number of significant limitations to the data set. For example:

> 'Counts were made as often as once a month in the early 1980s but were made only once or twice a year late in the decade. Total counts were carried out in most summers but counts in autumn/winter were generally infrequent and incomplete'. … '[The data were not] collected as systematically as would have been desirable for detailed analysis[1]. For example, not all sections were surveyed on all counts, data from different sections were pooled on some counts and complete identification of all birds was not always possible[2]'. … 'Although data were collected over a nine year period, only one section was surveyed in every calendar month. For six of the 10 sections, counts were made in five or more calendar months …'

R.P. Jaensch has also advised (pers. comm., 10 Oct 07) that '… the emphasis 1981-85 was on the [Sabina River] nature reserve [which at that time comprised the lowest reaches of the Sabina River, plus an adjacent portion of Vasse estuary]. Post 1985 we started looking at whole systems and non-reserve areas. Hence we explored Wonnerup [estuary]. Often we did not have time to cover all of Wonnerup, which on certain weeks of the year/cycle was overflowing with waterbirds'. In a separate communication to the authors (12 Oct 07), R.P. Jaensch has added '…whereas access to the Vasse wetlands was possible through several "public access" points, this was not the case for the majority of the Wonnerup system and often birds were observed at great distance using telescopes. Hence, we rarely achieved comprehensive coverage of the Wonnerup system, nor the identification of all species, whereas that was often possible for the Vasse system'.

Despite these limitations, and those of the 1998-00 surveys, it is tempting to compare means derived from some of our 1998-00 data with the means of the 1982-90 data. This we do in Appendix 2 and Tables 12 and 13 below. Note that sectors 'c' and 'd' have been omitted as each was surveyed in one, but not both, of the 1998-00 and 1982-90 survey periods.

<u>All waterbirds</u>

The mean numbers of waterbirds counted on Vasse-Wonnerup in 1982-90 (6-25 surveys per sector) and from February 1998 to May 1999 (6-9 surveys per sector) were similar (10,657 and 11,927 birds respectively - an increase of just 12%) (Table 12). There was a 28-29% 'shift' in bird numbers from Vasse estuary to Wonnerup estuary, in that Vasse estuary bird numbers changed from 83% to 55% of the total and Wonnerup estuary numbers changed from 13% to 42% of the total. There was little change in Malbup Creek and part Wonnerup Inlet + Deadwater numbers. Most of the decrease in Vasse estuary numbers was in sectors 'a' (29% to 6%) and 'b' (32% to 16%). There was a rise in numbers in sector 'e' (13% to 26%) of Vasse estuary and in both sectors ('i' from 1% to 5%; 'j' from 12% to 37%) of Wonnerup estuary. These differences - and similarities - should be regarded as 'possibly indicative' rather than definitive, given Bamford & Bamford's (1992) and R.P. Jaensch's cautionary words above (Section 5.8.2) about 1982-90 data.

Fewer waterbird species were recorded on Vasse-Wonnerup from February 1998 to May 1999 (55 species) than in 1982-90 (61 species) (Table 13).

There were larger changes in the number of species on each estuary between the two periods. In 1982-90, 59 species (97% of the total) were recorded in Vasse estuary, whereas in 1998-99 the figure was down to 47

[1] It should be noted that the RAOU surveys of 1981-90 were aimed principally at determining the numbers and species of waterbirds making use of Vasse-Wonnerup, rather than detecting changes in use. For this reason, much of the survey work was necessarily exploratory, rather than systematic, in nature.

[2] As was also the case (incomplete identification) in 1998-2000.

species (85%). Change was even more pronounced on Wonnerup estuary, where only 32 species (52% of the total) were recorded in 1982-90 and 43 species (78%) were recorded in 1998-99.

Table 12. Comparison of mean number and percentage of waterbirds observed in each sector January 1982 – March 1990 (from Bamford & Bamford 1992) and February 1998 – May 1999 (this study) [1].

		Vasse estuary					Malb. Creek	Wonn. Inlet* + D'water	Wonnerup estuary			V-W
	Periods	**a**	**b**	**e**	**f***	**Total**	**g**	**h***	**i**	**j**	**Total**	**Total**
No. of surveys	1982-90	6	13	21	25	-	19	7	16	6	-	-
	1998-99	9	9	9	9	-	6	6	9	9	-	-
Mean No. of Birds	**1982-90**	3110	3406	1424	925	**8865**	351	29	139	1273	**1412**	**10657**
	1998-99	753	1898	3130	740	**6521**	335	64	650	4357	**5007**	**11927**
Mean % of Birds	***1982-90***	*29*	*32*	*13*	*9*	***83***	*3*	*0.3*	*1*	*12*	***13***	***100***
	1998-99	*6*	*16*	*26*	*6*	***55***	*3*	*0.5*	*5*	*37*	***42***	***100***

* Sector 'f' is principally the lowest reaches of the Vasse estuary (where birds are numerous), but also includes a small part (Vasse estuary floodgates to Layman Road bridge) of Wonnerup Inlet (where birds are not numerous). Sector 'h' is the Deadwater plus that part of Wonnerup Inlet that is not in sector 'f'.

Table 13. Comparison of total number and percentage of waterbird species observed in each sector Jan 1982 – Mar 1990 and Feb 1998 – May 1999[2].

		Vasse estuary					Malb. Creek	Wonn. Inlet* & D'water	Wonnerup estuary			V-W
	Period	**a**	**b**	**e**	**f***	**Total**	**g**	**h***	**i**	**j**	**Total**	**Total**
No. of surveys	1982-90	6	13	21	25	-	19	7	16	6	-	-
	1998-99	9	9	9	9	-	6	6	9	9	-	-
No. of Species	**1982-90**	43	28	37	41	**59**	34	17	30	18	**32**	**61**
	1998-99	26	26	37	39	**47**	19	20	36	37	**43**	**55**
% of Species	***1982-90***	*70*	*46*	*61*	*67*	***97***	*56*	*28*	*49*	*30*	***52***	***100***
	1998-99	*47*	*47*	*67*	*71*	***85***	*35*	*36*	*65*	*67*	***78***	***100***

* Sector 'f' is principally the lowest reaches of the Vasse estuary (where birds are numerous), but also includes a small part (Vasse estuary floodgates to Layman Road bridge) of Wonnerup Inlet (where birds are not numerous). Sector 'h' is the Deadwater plus that part of Wonnerup Inlet that is not in sector 'f'.

[1] Adjusted by very small amounts (0-2 birds and 0% in each sector) by removal of Whistling Kite and White-fronted Chat from 1998-99 data as these species were not included in 1982-90 surveys.

[2] Adjusted by small amounts (0-2 species and 0-2% in each sector) by removal of Whistling Kite and White-fronted Chat from 1998-99 data as these species were not included in 1982-90 surveys.

Within Vasse estuary, the only marked change was in sector 'a', with the total number of recorded species decreasing from 43 to 26. This is somewhat surprising given that fewer surveys of this sector were made in 1982-90 (six surveys) than in 1998-99 (nine surveys). It is clear, however, from R.P. Jaensch's personal communications of 10 & 12 October 2007, that he undertook a number of exhaustive surveys of this sector within the 1982-90 period and these may have contributed to the high total (adding, for example, Australasian Bittern, Australian Spotted Crake, Spotless Crake and Long-toed Stint). It also appears from his communications (12 Oct 07; see 'Nankeen Night Heron' entry in Section 5.8.1 above) that at least one survey of sector 'a' extended to the west of Ford Road (i.e. outside the formal boundary of sector 'a') and into different habitat and potentially adding more species (e.g. Musk Duck, Australasian Grebe and Nankeen Night Heron).

The largest change, in both numerical and percentage terms, was an increase in the number of species recorded in 'j' sector of Wonnerup estuary, from 18 to 37 species.

There was a large decrease in the number of species recorded on Malbup Creek (34 to 19). More surveys of this sector were undertaken in 1982-90 (19 surveys) than in 1998-00 (6 surveys) but, perhaps more importantly (given that other sectors were also surveyed more often in 1982-90 than 1998-00), 'timing [of surveys of Malbup Creek] is critical' (R.P. Jaensch, pers. comm., 10 Oct 07). In his experience, species' presence on this waterbody could change very rapidly within a season.

As with mean bird numbers (above), these differences, and similarities, should be regarded as 'possibly indicative' rather than definitive.

Individual species

Several 'waterbird species other than shorebirds' showed (Appendix 2) some similarities in distribution between Jan 1982 – Mar 1990 and Feb 1998 – May 1999, for example:

- Musk Duck: most birds were found in sectors 'e' and 'f' (lower reaches of Vasse estuary / part Wonnerup Inlet) in both survey periods (1982-90 and 1998-99).
- Black Swan: most birds were in sectors 'a', 'b', 'e' (broad expanses of Vasse estuary) and 'j' (broad expanses of Wonnerup estuary) in both periods.
- Darter: most birds were in sectors 'f' and 'h' (lowest reaches of Vasse estuary / Wonnerup Inlet / Deadwater) in both periods.
- Pied Cormorant: were not recorded at any time in sectors 'a' and 'b' (the broad upper and middle reaches of Vasse estuary) in either survey period (nor were 'unidentified black & white cormorants' - a grouping that could potentially contain Pied Cormorants).
- Great Cormorant: were not recorded at any time in sectors 'a', 'b' and 'e' (broad upper, middle and lower reaches of Vasse estuary) in either survey period
- Australian Pelican: most birds were in sectors 'e', 'f (lower reaches of Vasse estuary / part Wonnerup Inlet)', 'i' and 'j' (Wonnerup estuary) in both periods.
- Great Egret: widely scattered throughout Vasse-Wonnerup in both survey periods.
- Australian White Ibis: widely scattered; more birds in sector 'a' (west end of Vasse estuary) than in other sectors in both periods.
- Osprey: only recorded in sectors 'f' (lowest reaches of Vasse estuary / part Wonnerup Inlet) and 'i' (exit channel of Wonnerup estuary) in both periods.
- Purple Swamphen: not recorded in Wonnerup estuary, Malbup Creek or sector 'h' (part Wonnerup Inlet / Deadwater) in both periods.
- Dusky Moorhen: not recorded in Wonnerup estuary or sector 'h' (part Wonnerup Inlet / Deadwater)[1] in both periods.
- Eurasian Coot: largest numbers recorded in sector 'e' (lower broad expanse of Vasse estuary) in both survey periods (but note also the dissimilarity in that large numbers of coots were also recorded in sector 'f' (lowest reaches of Vasse estuary / part Wonnerup Inlet) in 1982-90 and (instead) in 'j' (broad expanses of Wonnerup estuary) in 1998-99.

[1] Note that numerous species of waterbirds, including waders, were not recorded, i.e. apparently not present, in sector 'h' (part Wonnerup Inlet and entire Deadwater) during the 1982-90 and 1998-00 surveys.

- Silver Gull: widely distributed throughout the Vasse estuary and Wonnerup estuary in both survey periods.

Some 'waterbird species other than shorebirds' showed very dissimilar distributions between the survey periods, for example:

- Australian Shelduck: While there was a large increase (287 to 625) in the mean numbers counted in sector 'e' (lower broad expanse of Vasse estuary) from 1982-90 to 1998-99, there was an even larger increase (92 to 599) in sector 'j' (broad expanses of Wonnerup estuary). In percentage terms, these increases greatly exceed the concomitant increase in mean total numbers of Australian Shelduck on Vasse-Wonnerup (995 to 1,657).
- Grey Teal: While there was a large increase (150 to 559) in the mean numbers counted in sector 'e' (lower broad expanse of Vasse estuary) from 1982-90 to 1998-99, there was an even larger increase (85 to 866) in sector 'j' (broad expanses of Wonnerup estuary). In percentage terms, these increases greatly exceed the concomitant increase in mean total numbers of Grey Teal on Vasse-Wonnerup (1,268 to 2,179).
- Little Egret: recorded in sectors 'a', 'b' (the broad upper and middle reaches of Vasse estuary), 'f', 'h' (lowest reaches of Vasse estuary / Wonnerup Inlet / Deadwater) and 'i' (Wonnerup estuary exit channel) in 1998-99 but only in sector 'g' (Malbup Creek) in 1982-90. This apparent expansion in distribution is coincident with a sizeable increase in Little Egret numbers on Vasse-Wonnerup – and more generally in south-western Australia - between the two survey periods.

Several shorebird species showed some similarities in distribution between Jan 1982 – Mar 1990 and the Feb 1998 – May 1999 and Nov 1999 – May 2000 surveys, for example:

- Common Sandpiper: never recorded in sectors 'a' to 'e' (broad expanses of Vasse estuary) or 'g' (Malbup Creek); recorded in sectors 'f' and 'h' (lowest reaches of Vasse estuary / Wonnerup Inlet / Deadwater) and 'i' (Wonnerup estuary exit channel) in all three survey periods; recorded in sector 'j' (broad expanses of Wonnerup estuary) in 1982-90 and 1998-99.
- Red-necked Stint: when the probability that many of the unidentified shorebirds were stint is taken into account, distributions in the three survey periods are fairly similar, with most birds in the broad expanses of the two estuaries and fewest in Malbup Creek and Wonnerup Inlet / Deadwater. Most abundant in sectors 'j' (broad expanses of Wonnerup estuary) and 'b' (middle broad expanse of Vasse estuary) in all three survey periods.
- Black-winged Stilt: widely distributed in all three survey periods – except sector 'h' (part Wonnerup Inlet / Deadwater) where this species has rarely been recorded.
- Banded Stilt: never recorded in sectors 'g' (Malbup Creek) and 'h' (part Wonnerup Inlet / Deadwater).
- Red-capped Plover: when the probability that many unidentified shorebirds were Red-capped Plover is taken into account, distributions in the three survey periods show some similarities, with most birds being found in the broad expanses of the two estuaries.

Some shorebird species showed very dissimilar distributions between the survey periods, for example:

- Common Greenshank: widely distributed in all three survey periods, but very many more recorded in sectors 'i' and 'j' (Wonnerup estuary) in both 1998-99 and 1999-00 than in 1982-90.
- Wood Sandpiper: only recorded in sector 'b' (middle broad expanse of Vasse estuary)[1] in 1982-90; only recorded in sectors 'e' (lower broad expanse of Vasse estuary) and 'g' (Malbup Creek) in both 1998-99 and 1999-00.

It must be stressed that many of the similarities and differences described above might be largely or entirely artefacts of differences in methodologies, timing and coverage between recent and historical survey periods, rather than reflective of real differences in mean distributions of waterbirds between the two periods. Nonetheless the comparisons are useful in indicating possibilities and informing the design of future Vasse-Wonnerup waterbird survey and monitoring programs.

[1] R.P. Jaensch's recollection (pers. comm., 10 Oct 07) is that the Wood Sandpipers in sector 'b' were '… principally in an area of samphire and couch near where the Sabina River flows out, and only on the few days/weeks when water levels were just right'.

6. DISCUSSION

6.1 Waterbirds on Vasse-Wonnerup from 1981-1990 to 1998-2000

It is apparent from the 1998-2000 data that, a decade or more on from the RAOU surveys of 1981-90, as reported in Bamford & Bamford (1992) and Jaensch (1987), Vasse-Wonnerup remained one of the most important waterbird habitats in Western Australia. Only four other wetlands in south-western Australia have maximum counts higher than the 37,446 recorded on Vasse-Wonnerup in December 1998. These are Peel-Harvey Estuary (150,525 waterbirds in 1976-77, Lane & Pearson 2002), Lake Muir (51,613 in March 1989, Halse *et al.* 1990), Culham Inlet (an estimate of 44,000 Banded Stilt in October 1986, ANCA 1996) and Dumbleyung Lake (40,440 in March 1987, Jaensch & Vervest 1988).

The 'minimum number'[1] (43,386) of waterbirds that made use of Vasse-Wonnerup at some time during 1998-99 is also comparable with the minimum number (44,939) that made use of Peel-Harvey Estuary in the same year (Lane *et al.* 2002a), though it is somewhat to substantially lower than the corresponding Peel-Harvey figures of 60,562 in 1996-97 (Lane *et al.* 2002b) and 176,244 in 1976-77 (Lane & Pearson 2002). In making these comparisons it is worth noting that Peel-Harvey Estuary, c. 110 km to the north, is c. 19 times the area of Vasse-Wonnerup (12,500 ha versus c. 650 ha; ANCA 1996).

The mean number of waterbirds counted on Vasse-Wonnerup in the current study (Feb 1998 - May 1999) was somewhat (12%) higher than the mean of previous (1982-90) Vasse-Wonnerup surveys. This change comprised a modest (26%) decrease in the mean number on Vasse estuary and a large (255%) increase on Wonnerup estuary. Because of substantial differences in methodologies, coverage and timing of surveys between the two periods, these differences in mean numbers counted might, to some extent at least, be statistical artefacts and not truly reflective of real differences (if any exist) in waterbird numbers and, in particular, distributions on Vasse-Wonnerup. Also, the 1998-99 survey period was relatively short, so any real differences, if they exist, might simply be reflective of normal year-to-year variations rather than longer term change. The apparent shift in distribution of birds within Vasse-Wonnerup should therefore be regarded as possibly indicative of changes in habitat availability and or suitability, rather than as clear evidence that such change has occurred. However, given the changes that have occurred to Vasse estuary water flow management since 1988, further more-detailed investigation of distributional data is warranted, with this issue as a principal focus.

The number of waterbird species (61) recorded on Vasse-Wonnerup during 1998-00 is less than numbers previously reported by Bamford & Bamford (1992), Jaensch (1987), ANCA (1996) and Lane (1997a) (68, 77, 78 and 84 species respectively). That the 1998-00 number is lower is to be expected as waterbirds are highly mobile and lists for individual wetlands typically grow as more survey effort is expended[2]. Some of those previously reported are vagrant, irruptive or secretive species that have only been recorded as a result of chance events or considerable survey effort.

6.2 Species warranting further attention

Comparison of highest counts, second highest counts, etc., of individual species suggests that further, more-detailed consideration and or investigation of a number of waterbird species is warranted, as follows.

- Closer examination of historical Vasse-Wonnerup data is warranted to determine the precise locations where Blue-billed Duck *Oxyura australis*, Pink-eared Duck *Malacorhynchus membranaceus*, Great Cormorant *Phalacrocorax carbo* and Nankeen Night Heron *Nycticorax caledonicus* were found in earlier survey periods and whether these locations were adequately surveyed in other periods, including 1998-99.
- Careful re-examination of all historical records of Australasian Grebes *Tachybaptus novaehollandiae* on Vasse-Wonnerup is warranted as previous high counts are probably erroneous.

[1] The 'minimum number' is the sum of the maximum count of each species in the given time period. It exceeds the highest number of waterbirds (all species) counted in any single survey, because different species peak in numbers at different times of the year.

[2] As evidenced by the fact that an additional seven waterbird species were recorded during visits to Vasse-Wonnerup during the 1998-2000 survey period that were not part of the formal survey program (see Appendix 6 for details).

- Many 'unidentified black & white cormorants', perhaps including Pied Cormorants, were counted in 1998-99. The 1998-99 counts of Pied Cormorants *Phalacrocorax varius* were exceeded by many historical counts. Future surveys should therefore aim at identifying all black & white cormorants to species, so that more-accurate counts of Pied Cormorants are achieved.
- The Great Egret *Ardea alba* is a conspicuous, easily surveyed species of waterbird. The 1998-99 count data indicates a sizeable decrease in numbers since earlier surveys. Concern has been expressed in the past about the level of threats to egret breeding colonies in south-western Australia, including nearby McCarley's (Ludlow) Swamp. The current status of this species in south-western Australia warrants investigation. Current threats and necessary remedial actions need to be identified.
- The lower numbers of Blue-billed Duck *Oxyura australis*, Great Cormorant *Phalacrocorax carbo* and Curlew Sandpiper *Calidris ferruginea* that were counted in 1998-2000 add weight to concerns that these three species are also in local or wider decline. They also warrant action to determine their current status, the specific threats they face and remedial actions needed.
- Single individuals of Australasian Bittern *Botaurus poiciloptilus* (a rare breeding species in south-western Australia), *Gallinago* Snipe (probably Pin-tailed Snipe *Gallinago stenura*, a rare vagrant to Australia with breeding grounds in Russia) and Australian Painted Snipe *Rostratula australis* (rare in south-western Australia, uncommon breeding species in northern and eastern Australia) were recorded, each on one occasion only, all in western and central Vasse estuary, and only during the 1985-87 survey period. None were recorded in 1998-00. The precise locations where these birds were found, and other similar habitats in sectors 'a' and 'b' at least, should be thoroughly searched in future surveys aimed at these species.
- Baillon's Crake *Porzana pusilla*, Australian Spotted Crake *P. fluminea* and Spotless Crake *P. tabuensis* are secretive species, easily overlooked. Zero, one and zero respectively were recorded on Vasse-Wonnerup in 1998-99. Although numbers previously recorded have also been low (one, five and two respectively), past records should be examined to determine precisely where and when these birds were found. These and perhaps other prospective sites should be thoroughly searched in future surveys aimed at these species. Similar comments apply to the Clamorous Reed-Warbler *Acrocephalus stentoreus* and Little Grassbird *Megalurus gramineus*, two species which, unless calling, can also be easily missed in generalised waterbird surveys.
- Substantially fewer Wood Sandpiper *Tringa glareola* (seven) and Long-toed Stint *Calidris subminuta* (zero[1]), and somewhat fewer Sharp-tailed Sandpiper *Calidris acuminata* (c. 800), were counted in 1998-00 than in previous surveys. Past records should be examined to determine exactly where and when these migrant shorebirds have previously been recorded on Vasse-Wonnerup. The most significant of these locations should always be included in future surveys aimed at these species. Further surveys aimed specifically at these species are warranted.

6.3 Ramsar Status of Vasse-Wonnerup

In 1990, the Vasse-Wonnerup wetlands system was listed as a Wetland of International Importance under the Ramsar Convention. At that time, Vasse-Wonnerup met the following two Ramsar Criteria (note that a site need only meet one Ramsar Criterion to be eligible for listing).

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 (Ramsar Convention Secretariat 2007) of the above Criteria are as follows.

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.

[1] Though note that this species was recorded on Malbup Creek in February 1999 during a visit to Vasse-Wonnerup that was not part of the formal 1998-2000 survey program (see Appendix 6 for details).

Of interest in the context of this report is whether or not Vasse-Wonnerup continued to meet Ramsar Criteria 5 and 6 in 1998-2000. 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 Convention Bureau (2000) 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 & Watkins (1999) took the following approach.

> 'In regard to criterion [5], 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 [5] 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. 100,000)'.
>
> 'In testing against [criterion 6], 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 taken by Jaensch & Watkins (1999) and have applied this to Vasse-Wonnerup as follows.

Ramsar Criterion 5 ('More than 20,000 waterbirds')

It is clear from the results of the surveys reported above that Vasse-Wonnerup supported more than 20,000 waterbirds in 1998-99. At least 43,386 waterbirds made use of Vasse-Wonnerup at some time during 1998-99, 37,446 waterbirds were counted in December 1998 and 20,375 were counted in January 1999.

The maximum (1998-00) count of 37,446 waterbirds in December 1998 exceeded all twelve, 'substantially complete', 1984-1990, RAOU counts reported by Bamford & Bamford (1992), the five highest of which were 29,957 (Jan 1988), 28,977 (Dec 1987), 28,347 (Dec 1986), 26,457 (Jan 1989) and 17,482 (Dec 1987), and the January 1986 count of c. 33,000 birds (Jaensch 1987) which is the highest of all previous counts.

On this basis it is concluded that, in 1998-99, Vasse-Wonnerup continued to meet Ramsar Criterion 5 (formerly 3a) for inclusion in the List of Wetlands of International Importance.

Ramsar Criterion 6 ('More than 1% of population of a species')

'One percent of population' levels have been published (Wetlands International 2006[1]) for 44 of the 61 waterbird species recorded on Vasse-Wonnerup during 1998-00. These species are listed in Appendix 5, together with their respective maximum 1998-00 counts and 1% levels.

Five species, Australian Shelduck, Australasian Shoveler, Black-winged Stilt, Red-necked Avocet and Red-capped Plover, had maximum 1998-00 Vasse-Wonnerup counts that were greater than their respective 1% levels (Table 14).

The respective 1% levels of four of the five species of Table 14 have also been exceeded by three or more counts from the periods 1984-90 (Bamford & Bamford 1992), 1981-85 and 1985-87 (Jaensch 1987) (Table

[1] In order to ensure international comparability, Contracting Parties to the Ramsar Convention have been urged (see Ramsar 'Strategic Framework for the List of Wetlands of International Importance, edition 2006') to use the international population estimates and 1% thresholds published and updated every three years by Wetlands International as the basis for evaluating sites against the 1% Criterion.

15). However, the 1% level of the fifth species, Red-capped Plover, has not been exceeded by any previous counts and was only marginally exceeded by the 1998-00 maximum count. Note also that while the 1% levels (1,600 and 1,800 birds respectively) for Sharp-tailed and Curlew Sandpiper have previously been exceeded (highest counts of 2,300 and 2,500 birds respectively; see Table 11) these counts have not previously been recognised as a basis for listing of the Site and these species' 1% levels were not exceeded in the 1998-00 surveys.

Table 14. Species with maximum 1998-2000 Vasse-Wonnerup counts exceeding '1% of population' levels.

Species	Maximum Vasse-Wonnerup count in 1998-00	One Percent Level of relevant population	Distribution of relevant population (Wetlands International 2006)
Australian Shelduck	c. 4000 (Dec 1998)	2400	SW Australia
Australasian Shoveler	355 (Apr 1998)	120	SW Australia
Black-winged Stilt	3494 (Jan 2000)	3000	SE Asia – Australasia
Red-necked Avocet	2000 (Dec 1998)	1100	Australia
Red-capped Plover	998 (Feb 1999)	950	Australia

Table 15. Comparison of '1% of population' levels with recent (1998-2000) and historical (1981-90) Vasse-Wonnerup count data. Counts that exceed relevant species 1% levels are shaded green.

Data Source	Wetlands International 2006	This Paper	Bamford & Bamford 1992							Jaensch 1987	
Period of Survey	Current	98-00	1984-90							81-85	85-87
Count Ranking	1% Level	1st	1st	2nd	3rd	4th	5th	6th		1st	1st
Australian Shelduck	2400	c. 4000	4536	2959	2600	2373	1873	1496		1873	2565
Australasian Shoveler	120	355	716	350	264	260	200	50		50	500
Black-winged Stilt	3000	3494	4000	3600	2854	2000	1394	1000		2750	5000
Red-necked Avocet	1100	2000	2000	1703	1300	995	950	450		740	4000
Red-capped Plover	950	998	785	560	383	324	100	35		785	400

On the basis of the above it is concluded that, at the time of most recent surveys (1998-00), Vasse-Wonnerup continued to regularly support 1% of the relevant Ramsar populations of four[1] waterbird species (Australian Shelduck, Australasian Shoveler, Black-winged Stilt and Red-necked Avocet) and therefore continued to meet Ramsar Criterion 6 for inclusion in the List of Wetlands of International Importance. At the time (1990) of initial nomination and Ramsar listing of Vasse-Wonnerup, only two species (Black-winged Stilt and Red-necked Avocet) were identified as meeting the 1% criterion (Government of Western Australia 1990). Australian Shelduck and Australasian Shoveler were not so identified due to the non-existence of relevant population estimates for those species at that time.

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[1] Note that only one species of waterbird needs to reach the 1% threshold in order for Criterion 6 to be met.

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APPENDICES

APPENDIX 1. Species and numbers of waterbirds counted, by smallest survey sector, in the 1998-2000 Vasse-Wonnerup surveys.

This Appendix (A3, 18pp) is available from the principal author on request. It includes raw data from the Lower Vasse River Wetlands, adjacent to the main study area of this report.

APPENDIX 2. Comparison by means (averages) of waterbird use of Vasse-Wonnerup survey sectors in 1982-90 and 1998-2000.

This Appendix (A4, 19pp) is also available from the principal author on request.

APPENDIX 3. Breeding waterbirds on Vasse-Wonnerup in 1998-2000.

The following evidence of waterbird breeding activity was recorded during the 1998-2000 Vasse-Wonnerup waterbird surveys.

Black Swan *Cygnus atratus*

On 29 Dec 98, JL recorded nine Class I (i.e. entirely covered with down feathers) cygnets in 2 or 3 broods (i.e. broods of 3, 3, 3 or 3, 6 cygnets – not possible to discern) in sector 'f(S)' of Vasse estuary and one brood of five Class I and one brood of six Class II (party downy, part contour-feathered) cygnets in the western part of Malbup Creek (sector 'g(W)'). JL also recorded on 29 Dec 98 low numbers (tens) of Class I cygnets in sector 'e' of Vasse estuary, from both the Abba River mouth and the Rushleigh Rd. access points. 'Some downy cygnets' were observed by JL in sector 'j(E)' of Wonnerup estuary on 30 Dec 98.

Pacific Black Duck *Anas superciliosa*

On 29 Dec 98, JL recorded one adult with one Class I duckling upstream of the Vasse estuary floodgates (i.e. in the NE part of sector 'f(N1)') and one adult with nine Class I ducklings on the Vasse estuary exit channel near Ballarat Rd (also in sector 'f(N1)').

Grey Teal *Anas gracilis*

On 29 Dec 98, JL saw two adults with six small Class I ducklings upstream of the Vasse estuary floodgates (i.e. in the NE part of sector 'f(N1)') and 2 adults with 8 Class II ducklings on the Vasse estuary exit channel near Ballarat Rd (also in sector 'f(N1)').

Hardhead *Aythya australis*

JL saw one adult with 2 small Class I ducklings ('all diving') in sector 'e' of Vasse estuary (from Rushleigh Rd. access) on 29 Dec 98.

Red-capped Plover *Charadrius ruficapillus*

Two 'juvenile downy chicks only a few days old' were seen by AC in the western part of Malbup Creek (sector 'g(W)') on 29 Dec 99.

Black-fronted Dotterel *Elseyornis melanops*

AC found on 27 Apr 99 'one nest with one egg sitting on a low rock surrounded by shallow water, 3 metres from water's edge and 4 metres from edge of samphire, 50 metres east of Vasse East water level recorder [i.e. in sector 'e' of Vasse estuary]'.

Notes

1. AC=A.G. Clarke, JL=J.A.K. Lane.
2. The numbers of cygnets and ducklings listed in this Appendix are not included in any other Appendices, Tables or Figures of this report.
3. Note that one additional species, the Purple Swamphen, was recorded breeding in sector 'a' of Vasse estuary during an additional visit that was not part of the formal survey program. See Appendix 6 for details.

APPENDIX 4. 1998-2000 Vasse-Wonnerup waterbird survey program.

AREA OF SURVEY	Feb 98	Mar 98	Apr 98	Dec 98	Jan 99	Feb 99	Mar 99	Apr 99	May 99	Nov 99	Dec 99	Jan 00	Feb 00	Mar 00
Vasse estuary														
a(W)		25 AC	28 AC	29 GP+ JL	27 JL	24 AC	24 AC	27 AC	28 AC	23 AC	29 AC+ GP	25 AC	22 AC+ JL	29 AC
a(E)				29 GP	27 AC									
b(W)	25 AC	25 AC	28 AC		27 AC	24 AC	24 AC	27 AC	28 AC	23 AC	29 AC+ GP	25 AC	22 AC+ JL (+24 AC)	29 AC+ JL
b(E)				29 GP	27 AC									
d				29 GP	27 AC	24 AC	24 AC	27 AC	28 AC	23 AC	29 AC	25 AC	22 JL	29 JL
e(W)	25 AC	25 AC	28 AC	29 JL	27 JL	24 AC	24 AC	27 AC	28 AC	23 AC	29 AC+ GP	25 AC	22 AC+ JL	29 AC
e(N)					27 JL									
f(N1)	25 AC	25 AC	28 AC	29 JL	27 JL	24 AC	24 AC	27 AC	28 AC	23 AC	29 AC	25 AC	22 AC (+24 AC)	31 AC
f(W)				29 GP	27 AC	24 AC	24 AC	27 AC	28 AC	23 AC	29 AC	25 AC	22 JL	29 JL
f(S)				29 JL	27 JL	24 AC	24 AC	27 AC	28 AC	23 AC	29 AC	25 AC	22 AC	29 AC
Wonnerup estuary														
i	26 AC	25 AC	29 AC	30 GP	28 AC	25 AC	25 AC	28 AC	29 AC	24 AC	29 AC	27 AC	23 AC	30 AC
j(C)	26 AC	25 AC	29 AC		28 AC	25 AC	25 AC	28 AC	29 AC	24 AC	29 AC	27 AC	23 AC+ JL	30 AC+ JL
j(W)			29 AC	GP 30	28 AC	25 AC	25 AC	28 AC	29 AC	24 AC	29 AC	27 AC	23 AC+ JL	30 AC+ JL
j(E)			29 AC	JL+ GP 30	28 JL	25 AC	25 AC	28 AC	29 AC	24 AC	29 AC	27 AC	23 AC+ JL	30 AC+ JL
Malbup Creek														
g(W)				29 JL	27 JL	25 AC	24 AC	27 AC	28 AC	24 AC	AC	25 AC	22 JL	29 JL
g(E)				30 JL	28 JL	25 AC	24 AC	28 AC	29 AC	24 AC	29 AC	27 AC	23 JL	30 JL
Wonnerup Inlet														
f(N2)				30 JL	28 AC	25 AC	25 AC	28 AC	29 AC	24 AC	30 AC	27 AC	23 AC	3 Apr JL
h(W)				30 JL	28 AC	25 AC	25 AC	28 AC	29 AC	24 AC	30 AC	27 AC	23 AC	3 Apr JL
Deadwater														
h(E)				30 JL	28 JL	25 AC	25 AC	28 AC	29 AC	24 AC	30 AC	27 AC	23 AC	30 AC
Lower Vasse R. Wetlands														
Ford Rd				29 GP	27 JL	24 AC	24 AC	27 AC	28 AC		29 AC	25+28 AC	22 JL	29 AC
Peel Cove				29 JL	27 AC	24 AC	24 AC	27 AC	28 AC				22 JL	JL AC

Notes

1. Cells in the above Table contain the date on which each sector was surveyed and the initials of the personnel who conducted each survey. AC=A.G. Clarke, GP=G.B. Pearson, JL=J.A.K. Lane.

APPENDIX 5. Maximum counts, 1% levels and relevant population distributions of the 44 species of waterbirds recorded on Vasse-Wonnerup during 1998-2000 for which 1% levels (Wetlands International 2006) have been published.

Species	Maximum Vasse-Wonnerup count in 1998-00	One Percent Level of relevant population	Distribution of relevant population[1] (Wetlands International 2006)
Musk Duck	33	250	SW Australia
Black Swan	3,013	10,000	Australia
Australian Shelduck[2]	**c. 4,000**	**2,400**	**SW Australia**
Australian Wood Duck	29	10,000	SW Australia
Pacific Black Duck	c. 4,750	10,000	Australia, New Guinea, Indonesia
Australasian Shoveler	**355**	**120**	**SW Australia**
Grey Teal	c. 9,500	20,000	Australia, New Guinea
Chestnut Teal	5	50	SW Australia
Hardhead	[3]1	10,000	Australia
Hoary-headed Grebe	317	5,000	New Zealand, Australia
Darter	21	1,000	Australia
Little Black Cormorant	325	10,000	Australia
Australian Pelican	354	10,000	Australia
Little Egret	8	1,000	Australia
Great Egret	108	1,000	Australia, S New Guinea
Australian White Ibis	279	10,000	Australia, S New Guinea
Straw-necked Ibis	562	10,000	Australia
Yellow-billed Spoonbill	151	1,000	Australia
Purple Swamphen	11	250	SW Australia
Eurasian Coot	3,570	10,000	Australia, New Zealand
Bar-tailed Godwit	2	1,700	Subspecies *menzbieri*
Whimbrel	1	550	Subspecies *variegatus*
Marsh Sandpiper	3	10,000	E, SE Asia, Oceania
Common Greenshank	300	1,000	E, SE Asia, Australia
Wood Sandpiper	7	1,000	E, SE Asia, Australia
Terek Sandpiper	1	500	E, SE Asia, Australia
Common Sandpiper	11	500	E & SE Asia to Oceania
Grey-tailed Tattler	2	400	Indon., Phillipines, New Guin., Australia
Great Knot	[3]1	3,800	SE Asia, Australia
Red Knot	[3]9	2,200	Subspecies *rogersi*
Red-necked Stint	2,512	3,200	E India, Sri Lanka, SE Asia to Aust'asia
Sharp-tailed Sandpiper	c. 800	1,600	Australia, New Guinea, Indon., China
Curlew Sandpiper	278	1,800	E, SE Asia & Australia
Pied Oystercatcher	2	110	Australia, S New Guinea, Aru Is
Black-winged Stilt	**3,494**	**3,000**	**SE Asia – Australasia**
Banded Stilt	1,137	2,100	Australia
Red-necked Avocet	**2,000**	**1,100**	**Australia**
Pacific Golden Plover	73	1,000	E,SE Asia – Australasia & Oceania
Grey Plover	9	1,300	E,SE Asia & Australia
Red-capped Plover	**998**	**950**	**Australia**
Greater Sand Plover	6	1,000	SE Asia, Australia
Black-fronted Dotterel	18	160	Australia
Caspian Tern	13	1,000	Australia
Whiskered Tern	91	10,000	Australia

NOTES

1. 'Relevant populations' are the populations to which the birds of Vasse-Wonnerup belong. Some species of waterbirds, e.g. many species of migratory shorebirds, have two or more distinct populations with limited intermingling.
2. The five species with maximum 1998-00 Vasse-Wonnerup counts exceeding their respective 1% population levels are shown in **bold.**
3. Three Hardhead and c. 30 'knot types' were recorded in 1998-2000 during additional visits that were not part of the formal survey program. See Appendix 6 for details.

APPENDIX 6. Miscellaneous waterbird records during 1998-2000.

The **MISCELLANEOUS RECORDS** below are additional to those presented in the main body of this report (i.e. they do not appear elsewhere in this report). They have been extracted from J.Lane's field notebooks and cover the period from 25 February 1998 (the beginning of the first formal survey of the 1998-2000 waterbird study) to 03 April 2000 (end of last formal survey).

Additional species
Some species listed below were recorded during additional visits to the main survey area but not during programmed 1998-00 surveys. These were **Eastern Curlew** (one bird on 14 Mar 98), **Pink-eared Duck** (six birds on 22 Feb 00), **Clamorous Reed Warbler** (species recorded on 30 Oct 98), **Nankeen Night Heron** (up to three birds on 27-28 Dec 98, 09 Jan 99), **Long-toed Stint** (species recorded on 06 Feb 99), **Blue-billed Duck** (one bird on 22 Feb 00) and **Glossy Ibis** (four birds on 23 Feb 00).

Higher numbers
Several species listed below were recorded in higher numbers during additional visits to the main survey area than during programmed 1998-00 surveys. Thus the single group of **c. 30 'knot types'** [*Calidris canutus* or *C. tenuirostris*] recorded at the mouth of Wonnerup Inlet on 11 Mar 98 was larger than the combined maximum counts (1 and 9 respectively) of these two species during programmed surveys. Also, the **3 Hardhead** on the Vasse estuary on 28 Nov 98 and on Malbup Creek on 22 Feb 00 exceeded the maximum count of one bird during programmed surveys.

Additional breeding species
One species listed below was recorded breeding during an additional visit to the main survey area but not during programmed 1998-00 surveys. Thus, two **Purple Swamphens** with small chicks were observed at the western end of Vasse estuary, on the downstream (eastern) side of Ford Road on 30 October 1998.

Lower Vasse River Wetlands
Two species listed below were not recorded in the main survey area either during programmed surveys or during additional visits. They were, however, recorded on the nearby Lower Vasse River Wetlands (not part of the main Vasse-Wonnerup survey area) during additional visits (only). These were **Freckled Duck** (one bird on 06 May 98) and **Australasian Grebe** (species recorded on 06 May 98 and 2 birds on 29 Mar 00).

Feeding frenzies
Early morning feeding frenzies involving large numbers of pelicans, egrets, herons, ibis, cormorants, spoonbills, gulls and ducks in the lowest reaches of the Vasse and Wonnerup estuaries were observed on a number of dates referred to below (01Dec98, 27Dec98, 28Dec98, 30Dec98, 02Jan99, 14Jan99, 16Jan99, 27Jan99, 28Jan99).

Tagged Birds
A Banded Stilt with a yellow 'leg flag' (stiff plastic tab loosely fitted to the leg) was seen on the Port Geographe development site (adjoining northern side of Vasse estuary) on 10 March 1998. This was one of c. 500 flightless chicks flagged by the authors at Lakes Ballard and Marmion in the Eastern Goldfields of Western Australia in 1995 (Lane 1996). One Great (probably) Egret with two yellow wing tags was seen near the Vasse estuary floodgates on 27 Dec 98.

MISCELLANEOUS RECORDS

26 Feb 1998: 'Small group (20?) of Red-necked Avocet' at Wonnerup Inlet mouth.

28 Feb 98: 0630-0830hrs. Walked along Vasse estuary shoreline from c. 100m south of Abba River mouth 'most of the way' to Sabina River mouth. 'Water's edge did not reach fringing vegetation at any point'. Recorded 'Silver Gull, Black-winged Stilt, Australian Pelican, Australian Shelduck, White-faced Heron, Great Egret, Black Swan, Grey Teal, Pacific Black Duck, Pied Cormorant, Red-capped Plover, Banded Stilt, Whistling Kite, Red Fox *Vulpes vulpes* (2), Common Greenshank, Australasian Shoveler, Hardhead (1), Red-necked Avocet (20), Curlew Sandpiper, Red-necked Stint, Chestnut Teal (1)'.

07 Mar 98: 0616hrs. 'Musk Duck feeding at base of pylon on upstream side of [Wonnerup estuary] floodgates. One Tattler [presumed Grey tailed]'.

07 Mar 98: 0650-…?[<0930]hrs. 'Vasse estuary Sabina Nature Reserve accessed from Inlet Drive'. Whistling Kite (2), Grey Teal, Black-winged Stilt, Pacific Black Duck, Australian Shelduck, Red-capped Plover (one flightless chick), Black Swan, White-faced Heron, Australasian Shoveler (3), Silver Gull'.

10 Mar 98: c. 0935-1005hrs. Port Geographe site adjoining northern side of Vasse estuary. 'One Banded Stilt (50m away with binoculars) with yellow leg flag on left leg above 'knee' (stiff yellow plastic). This bird has full dark chestnut

band and black belly patch. Dark wings. There is definitely no metal band on this bird'. 'c. 600 [Banded Stilt] … of which c. 95% have [chest] bands and 5% don't. Bands are well-defined'. 'These birds are feeding in the rain in shallow water and damp mud on south side [before realignment placed them on the north side] of Layman Road in an excavated area of Port Geographe'.

11 Mar 98: 0858hrs. Wonnerup Inlet mouth. 'Strong NW wind. Group of **c. 30 'knot' types** [*Calidris canutus* or *C. tenuirostris*] at mouth'.

14 Mar 98: 0645-0755hrs. 'Vasse estuary – pool on south side of grove of peppermints [*Agonis flexuosa*] between Layman Rd and [Vasse] estuary (near beach). '0645hrs. **Eastern Curlew (1)**, Silver Gull, Black-winged Stilt, Darter (2), Great Egret, Yellow-billed Spoonbill, Red-necked Avocet, Little Pied Cormorant, Little Black Cormorant, Pacific Black Duck, Grey Teal, Musk Duck, Pied Cormorant, Purple Swamphen, Australian White Ibis, Australian Shelduck, White-faced Heron, Common Greenshank, Common Sandpiper'.

14 Mar 98: 0800-…? Vasse estuary [next to pool surveyed 0645-0755hrs on same day and referred to above]. 'Straw-necked Ibis (32), Black Swan (3), Curlew Sandpiper (9, including one with 'coloured chest')'.

18 Mar 98: 0644hrs. 'Seven Australasian Shoveler ([including] 1 male and 3 females) roosting on slightly exposed mud bank in Wonnerup Inlet'.

30 Mar 98: c. 1045-1110hrs. 'Took 64ASA photos of [flock of] Straw-necked Ibis on Willmott's property [paddock] on Layman Rd'.

04 Apr 98: 0650hrs. 'Vasse estuary, south of palm, Avocet Bay [Vasse estuary south of Estuary View Dve, as viewed from western shore]'. 'Red-necked Avocet (c. 350 feeding in tight circle), Banded Stilt. Black-winged Stilt, Yellow-billed Spoonbill (16), Silver Gull (40), Pied Cormorant (45), Australian White Ibis (3), Australian Pelican (1), Hoary-headed Grebe (115), Little Pied Cormorant (6), Common Greenshank (3), Musk Duck (7), White-faced Heron (12), Great Egret, Grey Teal (230), White-fronted Chat (1)'.

04 Apr 98: 0755hrs. 'Vasse estuary opposite mouth of Sabina River'. 'Swamp Harrier (1), Black Swan (19), White-faced Heron (3), Black-winged Stilt, Australian Shelduck, Grey Teal, [unidentified] egret, Pacific Black Duck, Common Greenshank, Chestnut Teal (1 male), Australasian Shoveler (1 male)'. 'Unidentified tern'.

06 Apr 98: 0742hrs. Wonnerup estuary floodgates. 'Seven Little Pied Cormorant 0-1m on upstream side of [flood]gates'. 'One adult White-bellied Sea-Eagle'.

09 Apr 98: 0705hrs. 'One White-bellied Sea-Eagle flying over Wonnerup Inlet'.

11 Apr 98: 0655-0825hrs. 'Vasse estuary near Abba River mouth'. 'Black Swan, Black-winged Stilt, Great Egret, Red-necked Avocet, Silver Gull, Grey Teal, Pacific Black Duck, Australian Shelduck, White-faced Heron, Australian Pelican, Banded Stilt, Australian White Ibis, Little Pied Cormorant, Common Greenshank, Whistling Kite, Straw-necked Ibis'.

13 Apr 98: Vasse estuary floodgates. 'Some, c. 5, Hoary-headed Grebe 0-1m upstream of [flood]gates'.

18 Apr 98: 0713-…?hrs. 'Vasse estuary, Rushleigh Rd access point'. 'Black Swan, Australian Shelduck, Red-necked Avocet, Banded Stilt, Black-winged Stilt, Silver Gull, 29 Red-necked Stint (several with reddish head and neck), Black-fronted Plover, Chestnut Teal (1 male), White-faced Heron, Swamp Harrier, Yellow-billed Spoonbill, Australasian Shoveler, White-fronted Chat'.

25 Apr 98: 0715-0915hrs. 'Vasse estuary from Rushleigh Rd access point'. 'Australian Shelduck, Black Swan, Grey Teal, Pacific Black Duck, Red-necked Avocet, Black-winged Stilt, Australasian Shoveler, Little Pied Cormorant, unidentified grebe (small), Yellow-billed Spoonbill, Whistling Kite, Little Black Cormorant, Silver Gull, White-faced Heron, Chestnut Teal, Red-capped Plover, Red-necked Stint, Banded Stilt'.

02 May 98: 0700-0735hrs. Vasse estuary at Estuary View Drive. 'Grey Teal (c. 350 – counted 346), Black Swan (20), Purple Swamphen (2), Black-winged Stilt (2), Pacific Black Duck (11), Hoary-headed Grebe (6), Australasian Shoveler (1), Common Greenshank (2), Whistling Kite (heard only), White-faced Heron (2), Musk Duck (1), Swamp Harrier (1), Chestnut Teal (3 males), Little Black Cormorant (1 overhead), Silver Gull (1 overhead), Australian Shelduck (2), Australian White Ibis (1), Yellow-billed Spoonbill (1)'.

02 May 98: 0750-0807hrs. Wonnerup estuary floodgates. 'Chestnut Teal (1 pair on bank with 3 Grey Teal nearby [useful for comparison]), Grey Teal (hundreds), Pacific Black Duck, Australian Pelican (4), Little Pied Cormorant, Black Swan (5), Australian White Ibis (2), Hoary-headed Grebe (20), White-faced Heron (1)'.

06 May 98: 1605-…?hrs. Lower Vasse River Wetlands (Pioneer Cove). '**Freckled Duck** (one only; no red base to bill), Australasian Shoveler (male and female), Pink-eared Duck, Black-winged Stilt, Pacific Black Duck, Dusky Moorhen, Eurasian Coot, Black Swan, Grey Teal, Swamp Harrier, Yellow-billed Spoonbill, Australian White Ibis, Caspian Tern, Hoary-headed Grebe, Purple Swamphen, Darter, **Australasian Grebe**'.

13 May 98: 1608-…?hrs. Vasse estuary (Estuary View Drive). 'Black Swan, Musk Duck, Pied Cormorant, Yellow-billed Spoonbill, Grey Teal, Chestnut Teal (male), Little Pied Cormorant, Pacific Black Duck, Darter, Australian Shelduck, White-faced Heron'.

22 May 98: 1245-c.1330hrs. Pool (lake) on south side of grove of peppermints [*Agonis flexuosa*] between Layman Rd and Vasse estuary. 'Black Swan (12), Black-winged Stilt (4), White-fronted Chat (c. 10), Great Egret (1), Chestnut Teal (1 male), mixed Grey Teal and Pacific Black Duck (mainly Grey Teal) (450-500 based on several counts by JL and 2+ other observers)'. 'Water level in lake was low'.

30 Oct 98: 1320- c.1350hrs. Lower Vasse River Wetlands (Pioneer Cove). 'Blue-billed Duck (1 male), Grey Teal, Pacific Black Duck, Straw-necked Ibis (2), Yellow-billed Spoonbill (1), Eurasian Coot, Little Black Cormorant, Great Egret (one with black beak and green face), Silver Gull (4), Hardhead (2), Dusky Moorhen, White-faced Heron (3), Purple Swamphen (adults and one juvenile), Australian White Ibis (2), Musk Duck, Swamp Harrier (1)'.

30 Oct 98: 1400-…?hrs. Lower Vasse River Wetlands (Ford Road). 'Australian White Ibis (7), White-faced Heron (1), Pacific Black Duck (1), Little Black Cormorant, Great Egret, Grey Teal, Straw-necked Ibis, **Purple Swamphen** (one with 2 tiny downy **chicks**; one with 3 tiny downy chicks, all on downstream side of Ford Road), Little Pied Cormorant (1)'. 'From roof [of vehicle], in Vasse estuary (islands in wide expanse) Australian Pelican (4), Great Cormorant (1)'. 'Hardhead, Eurasian Coot, **Clamorous Reed Warbler** (in the bulrush), Swamp Harrier, Black Swan (and cygnets)'.

26 Nov 98: 1300hrs. Vasse estuary floodgates. 'Common Sandpiper (2), Darter (1), Little Black Cormorant (1), Great Egret (1)'. 'All on floodgate structure'.

28 Nov 98: 0650-0815hrs. Vasse estuary at Abba River 'entrance' [mouth]. 'Australian Pelican, Pacific Black Duck (one with all large Class II ducklings), Black-winged Stilt, Australian Shelduck, Little Pied Cormorant, Pied Cormorant, Black Swan (large Class II cygnet), Straw-necked Ibis, Grey Teal, Swamp Harrier, Little Black Cormorant, Silver Gull, Yellow-billed Spoonbill, White-faced Heron, unidentified grebes, **Hardhead (3),** Australasian Shoveler (1 male), Australian White Ibis, Australian Wood Duck, Musk Duck, Darter, Whiskered Tern'.

01 Dec 98: c.0530-0545hrs. Vasse estuary at Estuary View Drive. Reported to JL by Tom Moore, who saw 'a pelican feeding frenzy (c. 40 pelicans, 15 egrets and hundreds of Silver Gulls)' at this location. According to TM (who resides in Estuary View Dve) this was 'the first feeding frenzy for this summer'.

04 Dec 98: 0645-…?hrs. Vasse estuary at Rushleigh Road access point. 'Common Greenshank, Australian White Ibis, Grey Teal, Australian Shelduck, Great Egret, Black-winged Stilt (adults and juveniles), Little Pied Cormorant, Silver Gull, Black Swan (medium-large downy cygnets), Little Black Cormorant, White-faced Heron, Australian Pelican, Eurasian Coot, Caspian Tern, Swamp Harrier, Pacific Black Duck, Whiskered Tern, Musk Duck, Yellow-billed Spoonbill, Australian Wood Duck (male)'.

15 Dec 98: 0610hrs. c.200m upstream from Wonnerup estuary floodgates. There were 32 egret [most or all would have been Great Egret; some would possibly have been Little Egret], 24 Yellow-billed Spoonbill and 15 Australian Pelican.

15 Dec 98: 0625hrs. Vasse estuary exit channel at Ballarat Rd access point. 'Three broods of 7, 4 and 2 Class II (different sizes) Grey Teal ducklings'.

15 Dec 98: 0630 hrs. Vasse estuary at Webster Rd access point. 'Staggering number (10,000+?) of waterbirds, mainly upstream'.

19 Dec 98: <0915hrs. Vasse estuary at access c. 100m south of Abba River mouth. 'Black Swan, Australian Pelican, Australian Shelduck, Silver Gull, Black-winged Stilt, Pacific Black Duck, Little Black Cormorant, Grey Teal, Whistling Kite, Australasian Shoveler, Australian White Ibis, Hardhead, Great Egret, Straw-necked Ibis, Sacred Kingfisher, Eurasian Coot, Musk Duck, Red-necked Avocet, Swamp Harrier, Yellow-billed Spoonbill'.

27 Dec 98: 0522-0600hrs & 0615-0645hrs. Vasse estuary floodgates. 'Large numbers of fish-eating birds 0-200m upstream of [flood]gates – fishing. 115 Australian Pelican, c. 25 Great Egret, 3 Australian White Ibis, 2 Yellow-billed Spoonbill, c. 8 White-faced Heron, 1 **Nankeen Night Heron**, c. 50 Silver Gull. Also c. 10 Pacific Black Duck with [the] other birds. And c. 10 Little Pied Cormorant and c. 10 Little Black Cormorant. The birds are feeding on [fish] fry that have come to very near (1mm) the surface. The fry are generally c. 1.5cm long. They swim jerkily to the surface and then descend. They are separate, not in 'schools'. The largest seen (1 only) was c. 2.5cm. They come to the surface head up

and sink tail first'. 'Birds upstream [from the floodgates] are clearly feeding on the fry'. 'Back at Vasse estuary floodgates at c. 0615hrs. Bird activity unchanged. At 0630hrs c. 40 pelicans left, flying NE towards Wonnerup [estuary]. Some birds may also have left earlier. One egret has 2 yellow wing tags'. 'One Little Egret landed at edge of channel 15m upstream of floodgates (Vasse) at 0643hrs. 0645hrs - I left – birds still feeding on fry'.

28 Dec 98: 0525-0536hrs. Vasse estuary floodgates. 'Many birds feeding in the channel upstream of the [flood]gates (0-200m). Scores of Great Egret, 4+ Little Egret, scores of pelicans, scores of Silver Gull, 7 Australian White Ibis, Pacific Black Duck (5-10?), White-faced Heron (5-10?), several? **Nankeen Night Heron**, 10-20? small cormorant'. 'Situation same as yesterday morning. Birds are feeding on struggling fry – generally 1.5cm long. One was 3cm long'.

28 Dec 98: 0539-. Wonnerup estuary floodgates. 'Seven pelicans, 2 Great Egret, 1 Little Pied Cormorant all ≤80m from [flood]gates (upstream side)'.

28 Dec 98: 0601hrs. 'Stopped at vehicle access point c. 300m upstream of Vasse [estuary] floodgates. Shoals of fry coming to surface (tail down) but appear strong/healthy. Many pelicans and egrets. cc. 60 pelicans + 20+ egret + tens of [Silver] gulls in lagoon of property … 50m further upstream (south side) – feeding'.

29 Dec 98: 0920hrs. Vasse estuary floodgates. '3 Little Pied Cormorant + 1 Australian Pelican feeding 5-20m upstream of floodgates + 2 Pacific Black Duck (1 Class I duckling – small – Grey Teal?)'.

30 Dec 98: 0608hrs. Wonnerup estuary floodgates. 'Many pelicans, gulls, cormorants, egret, feeding 10-80m upstream and more flying in as I sit and watch'.

30 Dec 98: 0650hrs. Wonnerup Inlet mouth. 'Took photos of Osprey with large fish'.

30 Dec 98: 1129hrs. '38 Banded Plover [in paddock] around circular concrete water trough near (SE of) intersection of Layman Rd and Forrest Beach Road'.

31 Dec 98: 1420hrs. 'One Great Egret 20m upstream [from Vasse estuary floodgates] on SE shore is getting steady feed of (presumably) small fry. No other birds feeding upstream or downstream (except 1 Darter)'.

31 Dec 98: 1440hrs. Wonnerup estuary floodgates. 'No bird activity upstream or downstream but there are c. 70 pelicans resting on point c. 80m upstream'.

01 Jan 1999: 0645hrs. Vasse estuary floodgates. '31 pelicans, c. 100 Silver Gull, unidentified egret, Australian White Ibis, duck, cormorant all 0-50m upstream of floodgates and feeding'.

02 Jan 99: 'Tom Moore tells me that yesterday morning at c. 0730hrs there were many pelicans, egrets and gulls feeding in the bay [Vasse estuary] in front of Estuary View Drive. Also 2-3 previous incidents like this (but in the [Vasse estuary] exit channel) in the past two weeks …'.

02 Jan 99: 0643hrs. Vasse estuary floodgates. 'Two Grey Teal with 8 small Class I ducklings. 3 White Ibis. 14 Pacific Black Duck'.

02 Jan 99: 0655-0705hrs. Wonnerup estuary floodgates. '15 Great Egret, 3 Yellow-billed Spoonbill, 7 White Ibis, c. 65 pelican, tens of Little Pied Cormorant, tens of Little Black Cormorant, tens of Silver Gull'.

08 Jan 99: …hrs. Wonnerup estuary floodgates. 'Many birds disturbed (took flight). Sail plane or 'Power Glider'. … [description]. Came low over Wonnerup estuary at c. 100 ft then over Wonnerup estuary floodgates to coastline. Then SW along coast'.

09 Jan 99: 0458hrs. Wonnerup estuary floodgates. 'Three **Nankeen Night Heron** at the water's edge on upstream side of floodgates'.

14 Jan 99: 0628-0655hrs. Wonnerup estuary floodgates. 'Yellow-billed Spoonbill (4), Australian Pelican (30), Great Egret (8), Australian White Ibis (6), Little Black Cormorant (c. 100), Little Pied Cormorant (c. 100), [but] no Silver Gulls, feeding in the 'isolated' lagoon on NE side of Wonnerup estuary exit channel. Pink sulphur bacteria in evidence in decaying plant material at water's edge (submerged). No wind – flat calm. Water surface constantly 'pattering' with very large numbers of fish fry (1-2cm) coming to surface. Very large numbers of 1-2cm pale shrimp also swimming right at the water surface (backs in the surface tension). 0640hrs. One fish c. 8cm long swam past with nose out of water gulping. Several more doing same thing in this 'isolated' lagoon. Water is black with much fine suspended silt. 'Isolated' lagoon still connected to main [Wonnerup estuary] exit channel by its own 3m wide shallow channel'. 'Few birds (now only 1 pelican and 3 Musk Duck) [upstream of floodgates at 0653hrs]'. '100s of gulls flying in to 'isolated' lagoon at 0655hrs'.

15 Jan 99: …?-0735hrs. 'Vasse estuary south side (from access lane at end of Osprey Drive)'. 'Walked to mouth of Sabina River. On the way there were 41 Common Greenshank feeding in the shallows'. 'Two adult Purple Swamphen and 2 juveniles (not red beak) and 1 Dusky Moorhen in [Sabina] river channel [at 0735hrs]'.

16 Jan 99: 0632hrs. 'Scores of birds (gulls, cormorants, Pacific Black Duck, pelican, heron, egret) feeding 0-10m upstream of [flood]gates'.

27 Jan 99: c. 0540hrs. Wonnerup estuary floodgates. 'Quick look, tens of pelicans, 100+ gulls, some cormorants and Pacific Black Duck feeding voraciously in lagoon next to main [exit] channel – particularly in its [i.e. the lagoon's] channel, which is still just connected'.

28 Jan 99: 0837-0914hrs. 'Wonnerup estuary floodgates. 'c. 80 pelicans and egret etc. feeding in [Wonnerup estuary exit] channel 120m upstream (the whole time)'.

29 Jan 99: …?hrs. Vasse estuary, 'limestone reef area just north of the Rushleigh Rd access point'. 'Focussed only on migratory shorebirds. On the reef we saw 2 Red-necked Stint and many Red-capped Plover'.

29 Jan 99: …?hrs. Malbup Creek (western part, from Layman Rd). 'We were looking for Wood Sandpipers. Firstly studied Black-fronted Dotterel (2), then Red-kneed Dotterel (1) and then Wood Sandpiper (1) ...'.

02 Feb 99: 1345-1410hrs. Vasse estuary exit channel at Ballarat Rd access point. 'Power glider 'ultralight' (2 seater) overhead at c. 300 ft disturbed Little Black Cormorant'.

06 Feb 99: 0650-0830hrs. Malbup Creek - 'from the CALM bird hide and walking to the east from there (50m)'. '**Long-toed Stint**!, Red-necked Stint, Common Greenshank, Wood Sandpiper, White Ibis, Australian Pelican, White-faced Heron, Australian Shelduck, Grey Teal, Pacific Black Duck, Black-fronted Dotterel, Australian Spotted Crake, Black Swan, small unidentified grebe, Black-winged Stilt'.

07 May 99: …-1430hrs. Vasse estuary, c. 100m south of Abba River mouth. 'Great Egret, Yellow-billed Spoonbill, White-faced Heron, Whistling Kite, Swamp Harrier, Black-fronted Dotterel, Australian Shelduck, Silver Gull, Pacific Black Duck, Straw-necked Ibis, White-fronted Chat, Grey Teal, Black-winged Stilt, Black Swan'.

22 Feb 2000: 1000-c.1120hrs. Malbup Creek (western part, starting from Layman Rd). 'One male and one female Chestnut Teal with some Grey Teal, one male **Blue-billed Duck**, Pacific Black Duck, Black Swan, Straw-necked Ibis, Australian White Ibis, White-faced Heron, **Pink-eared Duck** (6), Hardhead (3), Eurasian Coot, Yellow-billed Spoonbill (6), Little Pied Cormorant, Australian Shelduck'. 'Approx 30 Yellow-billed Spoonbill and 5 Australian White Ibis roosting in dead trees of Abba River (close to Malbup Creek)'. 'Four Australian Wood Duck'. Also some shorebirds reported in main body of this report.

22 Feb 00: 1210hrs. Vasse estuary, 'where Vasse estuary is narrowest' [probably level with eastern end of Sabina River delta]. 'Sixty-four White-faced Heron in one flock'.

23 Feb 00: 1000hrs. Wonnerup estuary (at SW end of north-eastern basin). Four **Glossy Ibis**.

29 Mar 00: …?hrs. Vasse estuary, 'east of …[kink?]'. '55 Red-necked Stint - at least several are very distinctly coloured (breeding plumage) - feeding furiously'.

29 Mar 00: …?hrs. Lower Vasse River Wetlands (Pioneer Cove). 'No shorebirds, Chestnut Teal (one male), Osprey (1), **Australasian Grebe** (2), Australian Pelican (1), Black Swan (2), Pacific Black Duck, Grey Teal, Purple Swamphen, Dusky Moorhen, Yellow-billed Spoonbill and others'.