



Waterbird Monitoring of the Lake Warden and Lake Gore Wetland Systems, February 2008

**Prepared for
Esperance Regional Forum
by Bennelongia Pty Ltd**

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Report 2008/26



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1 INTRODUCTION

The Lake Warden and Lake Gore wetland systems were nominated by the State Government as Wetlands of International Importance in 1990 and 2000, respectively, and the Lake Warden catchment was made a Natural Diversity Recovery Catchment under the State Salinity Strategy in 1997.

The Lake Warden system lies immediately north of Esperance and encircles the town (Fig. 1.1). It emerged from the sea during the Holocene and the eastern part of the system remains intermittently connected to the sea via Bandy Creek. Most of the larger lakes in the eastern and central parts of the system are permanently inundated and sub-saline with invertebrate faunas that reflects their marine origin.

In the eastern part of the system, Station Lake (Fig. 1.1) usually has a depth in spring of about 0.7 m, dries over summer and has spring salinity about 15 g L⁻¹ (see Lane et al., 2004). Mullet and Wheatfield Lakes are more-or-less permanent and have spring salinities of about 5-8 g L⁻¹. Salinities increase at the western end of the system in Warden and Pink Lakes. Both these large playa lakes are hypersaline, with Warden semi-permanently and Pink Lake seasonally inundated, although in recent years Warden has been retaining more water. Salinities at Lake Warden usually range between 20 and 100 g L⁻¹ (see Lane et al., 2004).

The Lake Warden system provides important waterbird habitat in south-western Australia and waterbird values were much of the reason the system was nominated as a Ramsar wetland. Lake Warden supported the 4th highest waterbird count of 285 wetlands surveyed in south-western Australia between 1981 and 1985 and the system contains important habitat for the Hooded Plover, a shorebird species endemic to Australia (Jaensch et al., 1988).

The Lake Gore system (Fig. 1.2) lies about 40 km west of Esperance and is also close to the coast. Waterbird values were the reason for nominating Lake Gore as a Ramsar wetland and, with a maximum count of 14,179 in November 1984, Gore supported the 7th highest number of waterbirds of 285 wetlands surveyed between 1981 and 1985 (Jaensch et al., 1989). The highest recorded count of waterbirds at Gore is 29,273 in March 1988 when 20,000 Banded Stilt occurred. Banded Stilt are often found at Gore in large numbers in spring and summer. However, the most significant waterbird record from Gore is the occurrence of 1600 Hooded Plover in January 1995: this was almost one-third of the known species population. Previously the highest number of Hooded Plovers recorded at the lake was 393 in February 1993.

1.1 Waterbird monitoring

Many waterbird surveys have occurred over the past 25 years in the Lake Warden and Lake Gore systems but, with the nomination of the Lake Warden system as a Natural Diversity Recovery Catchment, structured waterbird monitoring began at Wheatfield Lake 1997 (Cale et al., 2004). A comparison of Cale et al.'s surveys with results of other survey sets for Wheatfield suggests that bird counts are very strongly influenced by methodology and that counts may vary by a factor of about four between surveys undertaken by different operators (Robertson & Massenbauer, 2005).

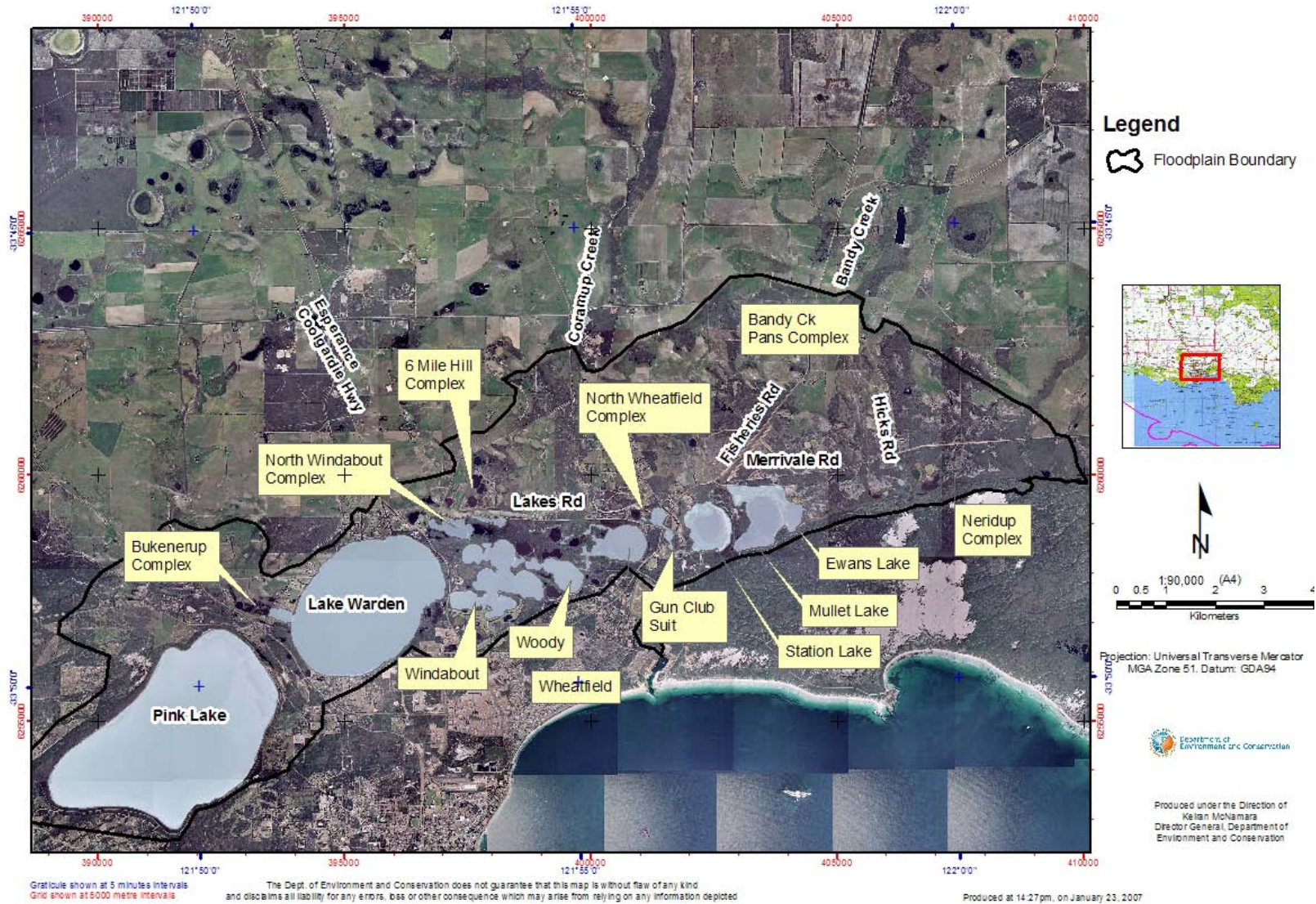


Fig. 1.1. The Lake Warden system showing the wetlands surveyed in February 2008.

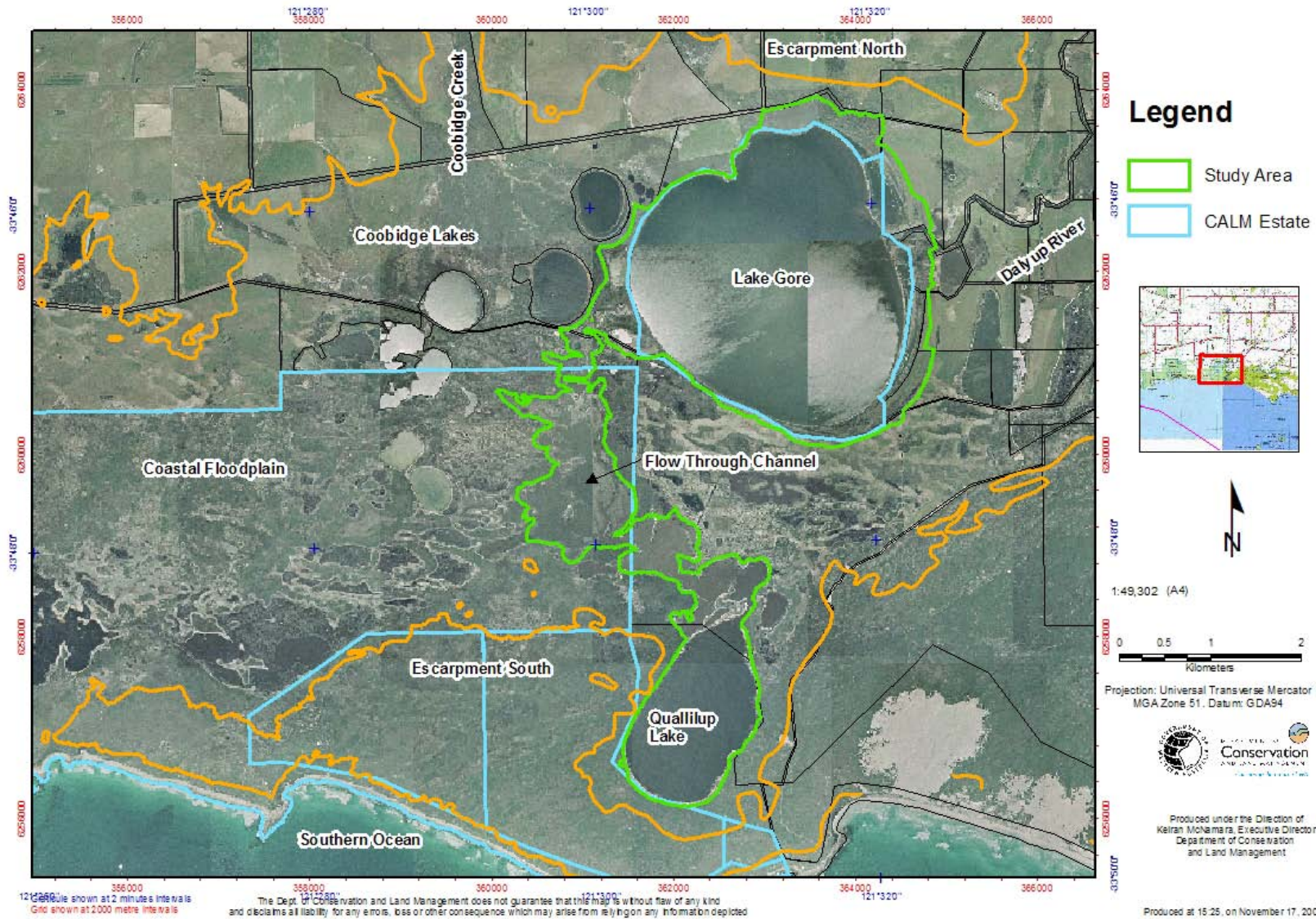


Fig. 1.2. The Lake Gore system showing the wetlands surveyed in February 2008.

Given that methodology strongly influences the number of waterbirds counted, reliance on ad hoc counting to track waterbird use of a wetland through time is unsatisfactory and beset with interpretation difficulties. Trends can only be studied reliably with a structured monitoring program that employs consistent methodology. Structured monitoring was implemented in the Lake Warden and Lake Gore systems in October 2006, when sections of the Lake Warden system were counted on the ground (by foot or boat) and all of the Lake Warden and Lake Gore systems were counted from the air (Halse, 2007). Counts were subsequently made in October 2007 (Bennelongia, 2008) and February 2008 (reported here) and represent the second year of monitoring.

While a wetland's underlying condition (i.e. type of wetland and degree of naturalness) is the strongest determinant of waterbird use, other factors will cause substantial variation across years even in structured counts. The most important external effect is rainfall, which controls the amount of water in the surveyed wetland and surrounding wetlands that may be alternative habitat. Movement between wetlands according to water levels occurs at a series of scales from local through to national and results in seasonal, as well as inter-annual, variation in counts. Seasonal effects are most commonly, but not always, caused by local movements as small wetlands dry and birds move to larger, deeper drought refuges. Superimposed on movement patterns, broad-scale rainfall fluctuations cause overall waterbird numbers in Australia to rise after wet years and decline during widespread drought as a result of increased breeding and mortality, respectively. The current number of waterbirds in Australia is likely to be much lower than the historical average because of prolonged drought in eastern Australia and, to a lesser extent, the south-west. Decline in the amount of habitat also causes population (Nebel et al., 2008).

Given the above background, the specific objectives of the counting in February 2008 were:

1. To undertake aerial surveys of the Lake Warden and Lake Gore systems with the same methodology as October 2006 and 2007
2. To undertake ground surveys in the same parts of the Lake Warden system as counted in October 2006 and 2007.
3. To begin establishing a baseline of usage in February to compare with October usage to quantify the increase in numbers that occurs over summer as a result of movement into drought refuges. Once a measure of natural variability in counts between years and seasons has been obtained, thresholds can be calculated for use in monitoring programs to detect changes in waterbird numbers. These thresholds will represent real changes in waterbird usage because of underlying wetland condition rather than natural fluctuations

This report provides the results of counting in February 2008 and interprets them in relation to conditions at the time of survey and historical information on waterbird numbers in the Lake Warden and Lake Gore systems.

2 CLIMATE

The 2008 survey occurred after 30 months of very dry conditions in south-west and eastern Australia, in contrast to wet conditions in the north-west (Fig. 2.1). It is likely that waterbird numbers in southern Australia had declined because the very significant reduction of available inland aquatic habitats led to insufficient waterbird breeding to replace mortality (see discussion of drought in Frith, 1982).

Rainfall at Esperance was average slightly above average (625 mm) for the period March 2007 to February 2008 (see Table 2.1) and greater than in most other parts of south-west Western Australia because of heavy rainfall in April (125 mm), significant winter/spring rainfall (July, 84 mm, August, 86

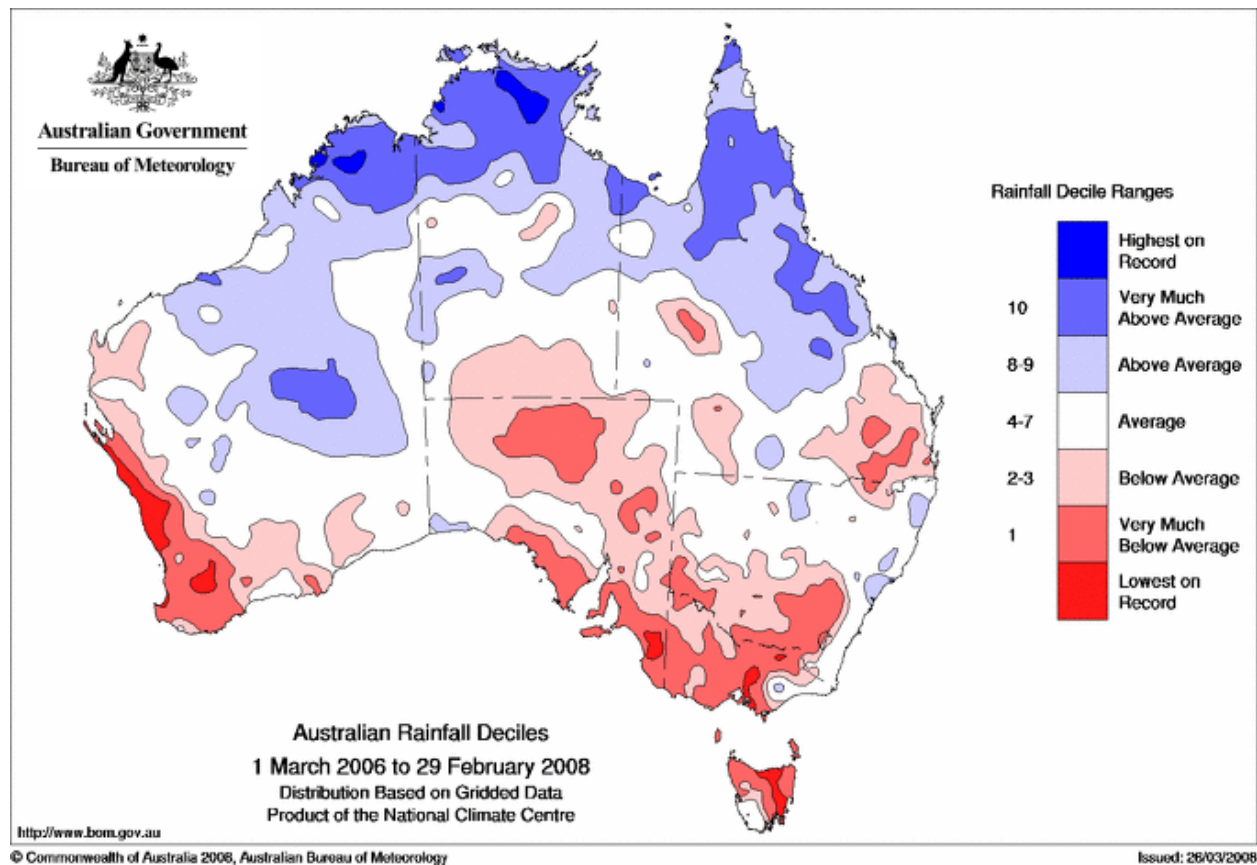


Fig. 2.1. Rainfall in Australia, March 2006 to February 2008, expressed in deciles and showing drought in southern Australia and wet conditions in the north. Esperance rainfall was average for the period.

mm, September 86 mm, October 84mm) and relatively heavy December rainfall (45 mm). These wet periods filled local wetlands, including the Lake Warden and Lake Gore systems. Wetland depths are reported in the lake accounts below and compared with February 2006 levels in Fig. 3.2.

3 METHODS

3.1 Monitored wetlands

Maps of the Lake Warden and Lake Gore systems are provided in Figs 1.1 and 1.2. All water bodies were surveyed between 27 and 29 February 2008. Water levels had declined since October 2007 and many of the peripheral wetlands in the Warden system, such as Merivale Road and most 6 Mile Hill wetlands, had dried (Fig. 3.1). However, due to hydrological changes over the last 30 years, water levels remained relatively high in the major lakes in the Warden system (and probably also the Gore system).

3.2 Survey methods

Three survey methods were used – aerial, boat and ground. The aim of survey was to record all birds of all species present at the wetland at the time of survey.

Aerial survey was flown mid-afternoon on 29 February at a height of 25 to 30 m and speed of 60 to 80 knots using a Cessna 172 with a front-right-seat observer (SH) and a rear left- seat observer (GP).

Table. 2.2 Climatic averages for Esperance (1969-2007)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean max. temp. (°C)	26.1	26.2	25.2	23.1	20.4	17.9	17.1	17.8	19.3	21.0	23.0	24.5	21.8
Mean min. temp. (°C)	15.5	16.0	15.0	13.2	11.0	9.1	8.3	8.6	9.5	10.6	12.7	14.3	12.0
Mean rainfall (mm)	26.2	25.3	28.0	47.5	72.5	82.3	96.0	83.2	60.5	47.2	33.2	18.1	619.3
Median rainfall (mm)	11.8	15.6	15.3	42.6	70.7	76.4	92.3	80.6	48.6	46.6	26.0	12.0	623.8
Mean number of days of rain \geq 1 mm	3.1	3.1	4.1	7.2	10.1	11.9	13.0	12.3	10.2	7.8	5.3	3.4	91.5

Large wetlands were orbited anti-clock-wise, about 50 m inside the wetland boundary, and waterbirds on the shore and in the wetland margins were counted. Wind during the aerial survey was about 20 knots, making counting difficult (an attempt to count in the morning with wind of 30 knots was abandoned). Smaller wetlands were counted during a single pass along their length or a pass down each side of the wetland. If necessary, additional passes were made to confirm species identifications and the composition of mixed species flocks. Few birds occurred in the centre of large wetlands. Identifications and estimates of numbers were made with the naked eye and results recorded onto digital voice recorders for later transcription to datasheets.

Lakes Wheatfield, Woody and Windabout were surveyed in a small punt by SH, GP and Tilo Massenbauer by following along the shoreline of the lakes and counting birds ahead of the punt or as they flushed from lakeside vegetation. Where trees were extensive, the punt usually traveled on the lakeside of the trees, with short detours into areas of open water within the stands of trees. Little attempt was made to count accurately in the flooded trees on the south side of Wheatfield because of difficulty of access. Bird identifications were made using binoculars and results were recorded in a notebook.

Other wetlands were surveyed on the ground. Observations were made from vantage points around them using a spotting scope, usually attempting to view all parts of the wetlands and count all birds present. Results were recorded in a notebook.

4 WATERBIRD COUNTS

4.1 Lake Warden system

4.1.1 Neridup complex

Location: South of Merivale Road, east of Hicks Road and Nature Reserve 23825. West of eastern end of the escarpment.

Land status: Freehold

Wetland description: Three small linear wetlands fringed by sedges and occasional *Melaleuca* trees at the eastern end of the Lake Warden system. The wetlands are connected to other wetlands and marshland in the Warden system by a drainage line on the south side of system. The land around the linear wetlands supports terrestrial vegetation and there is a small escarpment to the east.

Extent of water and depth: The wetlands are small and only one contained water in February. Depth was estimated to be about 0.3 m.

Waterbird survey: Waterbirds were surveyed by plane on 29 February 2008. No birds were seen (Appendix 1).

Previous surveys: These wetlands held low numbers of waterbirds in October 2006 and 2007 and are unlikely to ever contain significant numbers of waterbirds.

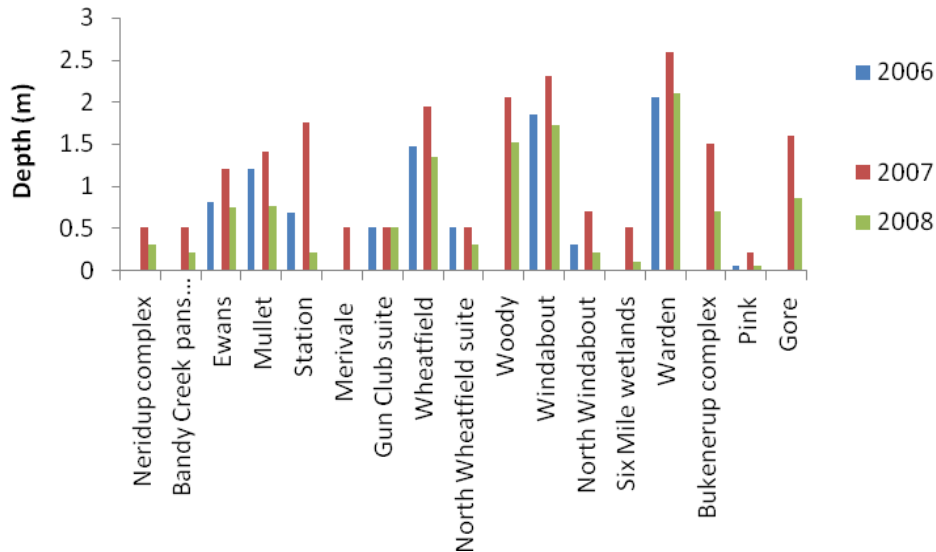


Fig. 2.2. Wetland depths in October 2006, 2007 and February 2008 at monitored wetlands. Note some depths are estimated and seasonal; the extent of variation between counts suggests error in these estimates. Data provided by Tilo Massenbauer (DEC)

4.1.2 Bandy Creek pans complex

Location: South of Merivale Road, east of Ewans Lake and west of Hicks Road Reserve.

Land status: Nature Reserve 23825.

Wetland description: Four interconnected circular wetlands east of Ewans Lake in the eastern part of the Lake Warden system. Surrounding land is low-lying marsh with samphire and low thickets of *Melaleuca*.

Extent of water and depth: Two of the wetlands were dry, the other two were nearly empty at the time of survey and all had wide shorelines. Depth was probably 0.2 m.

Waterbird survey: A total of 71 waterbirds of 11 species were counted on 29 February (Appendix 1). Eurasian Coot was the most abundant species.

Previous surveys: The October 2006 survey suggested that the Bandy Creek complex may sometimes contain one-quarter of all waterbirds in Lake Warden system east of Norseman Road. The picture is very different in summer, however, and in February 2008 the Bandy Creek complex contained only about 1 % of the birds in that area.

4.1.3 Ewans, Mullet, Station Lakes

Location: South of Merivale Road, east of Fisheries Road, in the western part of Nature Reserve 23825.

Land status: Nature Reserve 23825.

Wetland description: Mullet and Ewans Lakes are now permanent wetlands that are connected to a series of smaller wetlands around them. These smaller wetlands grade into the surrounding marsh and dry out during summer. Station Lake is usually seasonal and, together with a couple of satellite wetland areas forms a more discrete wetland body. The flow of water in the system is from Ewans through the Merivale Road wetlands (overflowing into Mullet) and into Station Lake before passing into Bandy Creek and the sea. Ewans, Mullet and Station were counted separately in February aerial survey because it was difficult for the rear observer to keep track of location. The wetlands close to Merivale

Road, on the north side of Mullet, consist of an inter-connected series of small seasonal wetlands and were counted separately as the Merivale Road wetlands.

Extent of water and depth: The large lakes were half empty at the time of counting, with a wide band of bare shoreline around parts of all lakes. Depth in Ewans was 0.75 m (and conductivity 2890 mS m⁻¹), Mullet was 0.76 m (4820 mS m⁻¹) and Station was 0.21 (8130 mS m⁻¹).

Waterbird survey: Totals of 21 species and 6445 waterbirds were recorded during surveys of the system in February 2008 (Appendix 1). Ewans contained 16 species and about 1300 birds, Mullet 15 species and about 4000 birds and Station 10 species and about 900 birds. The numerically dominant species were Banded Stilt, Australasian Shoveler, Pacific Black Duck and Grey Teal, although the composition of the duck community appears variable over short time scales (see Discussion). Species of interest were Australasian Shoveler (estimated number in complex 717), Banded Stilt (2805) and Red-necked Stint (477).

Previous surveys: Numbers in the system were much higher in February 2008 than in October 2006 or 2007 (Halse, 2007; Bennelongia, 2008) although species richness was slightly reduced (abundance of 6445, 2700, and 4073, respectively, and richness of 21, 24 and 23). A count by Clarke & Lane (2003) in February 2003 recorded 27 species and 4087 waterbirds. This count included 9 species of shorebird, compared with 6 in February 2008.

Ewans, Mullet and Station Lakes were surveyed regularly during the early 1980s (Jaensch et al., 1989). Results of February (or late January 1982) counts for the systems combined were 469 waterbirds of 14 species in 1982, 2838 waterbirds of 9 species in 1983, 814 waterbirds of 13 species in 1984, and 5127 waterbirds of 23 species in 1986. The number of shorebird species was 7 in 1982, 9 in 1983, 6 in 1984 and 9 in 1986. Conditions in the complex were very dry in 1984 and relatively wet in 1986.

Aerial counts of ducks, coots and swans made in Ewans and Mullet each March between 1989 and 1992 were 1204, 815, 3608, and 4074 birds (Halse et al., 1995 and earlier publications) compared with 1937 in February 2008, which is similar to the 1621 counted by Clarke & Lane (2003) in February 2003 with similar water depths.

4.1.4 Merivale Road Wetlands

Location: South of Merivale Road, east of Fisheries Road, in the western part of Nature Reserve 23825.

Land status: Nature Reserve 23825.

Wetland description: The wetlands close to Merivale Road, on the north side of Mullet, consist of an inter-connected series of small seasonal wetlands.

Extent of water and depth: Dry.

Waterbird survey: No waterbirds present.

Previous surveys: The Merivale Wetlands were surveyed by air and ground in October 2006 and 2007 and contained about 200 waterbirds each date.

4.1.5 Gun Club suite

Location: East of Fisheries Road, 1 km south of Merivale Road and south of Station Lake.

Land status: Nature Reserve 15231.

Wetland description: Small oval permanent wetland fringed by *Melaleuca*, which is dense at northern end.

Extent of water and depth: Depth was unknown but likely to about 0.5 m.

Waterbird survey: These wetlands were counted both air and ground on different days with a substantial difference between counts and some species turnover (808 birds from ground and 490 from air) (Appendix 1). Eight species were recorded with Grey Teal the most numerous.

Previous surveys: The only previous surveys of the wetland were in October 2006 and 2007 when 85 and 25 birds, respectively, were counted. Usage appears to be greater in summer than spring.

4.1.6 Lake Wheatfield

Location: On west side of Norseman Road about 1.5 km south of Merivale Road.

Land status: Nature Reserve 15231.

Wetland description: Moderate-sized lake (ca. 50 ha) fringed with *Melaleuca*. It receives water from Coramup Creek and discharges into Woody Lake to the west. There are extensive stands of flooded *Melaleuca* on the south side of Wheatfield where colonial waterbirds (cormorants, ibis, spoonbills etc) nest. There are also extensive flooded stands of trees and open channels along the drainage between Wheatfield and Woody and a number of small satellite wetlands that hold water seasonally.

Extent of water and depth: Depth was 1.34 m (1573 mS m⁻¹).

Waterbird survey: A total of 1187 waterbirds of 24 species were recorded at Wheatfield in the aerial survey on 29 February. The boat survey on 28 February recorded 1337 waterbirds of 26 species (Appendix 1). Combining boat and aerial counts, 28 species were recorded. Interestingly, two independent counters in the boat (GP and SH) returned very different counts for some species (e.g. 299 vs 558 Grey Teal, 59 vs 361 Chestnut Teal that reflected different views about whether the same birds were being continually encountered). The dominant species were Pacific Black Duck and Grey Teal, with significant numbers of Little Black Cormorant, Hoary-headed Grebe and Yellow-billed Spoonbill.

Previous surveys: Wheatfield has been surveyed in March biennially since 1997 by boat (Cale et al., 2004). Numbers have been very variable with 4542 waterbirds of 18 species in 1998, 426 waterbirds of 16 species in 2000, 895 waterbirds of 21 species in 2002, 1632 waterbirds of 26 species in 2004 and 1161 waterbirds of 18 species in 2006. Clarke & Lane (2003) counted 3024 waterbirds of 17 species in 2003, when water was significantly shallower than 2008 (0.95 vs 1.34 m). Counts in February and March of the early 1980s (Jaensch et al., 1989) were mostly low with 527 waterbirds of 10 species in 1982, 719 waterbirds of 15 species in 1984, 351 waterbirds of 11 species in 1985 and 2308 waterbirds of 15 species in 1986.

Counts of ducks, coots and swans made in Wheatfield each March between 1988 and 1991 were 1790 in 1989, 622 in 1990, 3612 in 1991 and 2429 in 1992 (Halse et al., 1995 and earlier publications).

Numbers of birds in Wheatfield were higher in February than October 2006 or 2007.

4.1.7 North Wheatfield suite

Location: On west side of Fisheries Road about 1.3 km south of Merivale Road, immediately north of Lake Wheatfield.

Land status: Freehold.

Wetland description: Two small wetlands. Surrounding land cleared and wetlands degraded.

Extent of water and depth: Wetlands were about half full at the time of survey and depth was likely to have been about 0.3 m.

Waterbird survey: Aerial counts on 29 February recorded 97 waterbirds and ground counts the previous day found 108 waterbirds. A total of 14 species were recorded with considerable differences in the species present on the different days. This is unlikely to represent survey error and illustrates how extensive species turnover may be on small wetlands within a wetland complex.

Previous surveys: There are no previous summer counts of the North Wheatfield system, which appears never to contain a significant number of birds in relation to the total in the Lake Warden system. October counts in 2006 and 2007 were lower than February.

4.1.8 Windabout complex

Location: East of Coolgardie-Esperance Highway and west of Lake Wheatfield.

Land status: Nature Reserves 15231 and 32259.

Wetland description: Woody Lake receives water from Lake Wheatfield and, in turn, flows into Windabout Lake. There are a number of small satellite wetlands around Woody and Windabout, some of which are on the connecting drainage line while others are separate. The lakes are fringed with *Melaleuca*, although there is a boat ramp on the shores of Woody and the Lake Windabout Golf Club is located on the edge of Windabout. There are several small wetlands within the golf course supporting *Melaleuca*. The condition of these wetlands varies from degraded to moderately intact.

Extent of water and depth: Wetlands were full at the time of survey and depth in Woody was 1.52 m (1673 mS m⁻¹) and Windabout was 1.72 m (2040 mS m⁻¹).

Waterbird survey: The Windabout complex was surveyed by boat on 28 February and by air on 29 February 2008 with totals of 5769 and 4884 waterbirds, representing 27 species, being recorded from the ground and air, respectively. Counts were about three times higher in Windabout than Woody Lake although species richer was similar (27 vs 22 species). The numerically dominant species were Pacific Black Duck, Black Swan, Eurasian Coot, Grey Teal and Chestnut Teal, although there were significant complementary discrepancies in the ground and aerial counts of the latter two species that suggested many Chestnut Teal were identified from the air as Grey Teal. The ground counters varied considerably in their estimates of the number of Grey Teal present, reflecting different interpretations of whether birds has been encountered before (see section 4.1.6).

Previous surveys: Woody and Windabout Lakes were surveyed regularly during the early 1980s with February or March counts in Woody being 731 waterbirds of 9 species in 1982, 552 waterbirds of 10 species in 1983, 316 waterbirds of 13 species in 1984, 696 waterbirds of 13 species in 1985 and 85 waterbirds of 14 species in 1986 (Jaensch et al., 1989). Counts in Windabout were 728 waterbirds of 11 species in 1982, 2830 waterbirds of 19 species in 1983 when 1000 Banded Stilt were present, 221 waterbirds of 12 species in 1985 and 559 waterbirds of 14 species in 1986. The satellite wetlands around Woody and Windabout were not included in these surveys. Clarke & Lane (2003) counted 4675 waterbirds of 23 species in Windabout and 32 waterbirds of 10 species in Woody. Depth in Windabout in 2003 was 1.36 m.

The counts February 2008 were higher than all the 1980s surveys but there is little suggestion of changes in species composition and improved coverage of the wetlands is likely to be the main reason for more birds being counted in 2008, which recorded similar numbers for Windabout as Clarke & Lane (2003). The low count at Woody by Clarke and Lane reflects some October 2006 and 2007 counts of that wetland, in which numbers appear to be very variable (see Halse, 2007; Bennelongia, 2008). The 10-fold increase in waterbird numbers in Woody between the spring counts of 2006 and 2007 and the summer count of 2008 could be interpreted as a drought-refuge for the lake or more evidence of variability. Abundance increased across seasons at Windabout by a factor of 2-3.

4.1.9 North Windabout complex

Location: South of Lakes Road about 0.8 km east of the Coolgardie-Esperance Highway, north of the Windabout Complex.

Land status: Nature Reserve 15231.

Wetland description: Shallow seasonally filled playa wetlands with low gypsum dunes around them. The wetlands are subsaline with shores that are largely open and fringed with samphire. Low *Melaleuca* occurs behind.

Extent of water and depth: Nearly all the lakebed was exposed and depth was about 0.2 m.

Waterbird survey: The North Windabout wetlands were surveyed from the ground and air on 29 February. They supported about 250 waterbirds of 11 species. The numerically dominant species were Red-necked Avocet and, surprisingly given the shallow depth, Black Swan.

Previous surveys: Surveys in October 2006 and 2007 showed the wetland supported about 500 waterbirds. Its shallow depth means that the complex that is likely to have maximum value in spring.

4.1.10 Six Mile wetlands

Location: North of Lakes Road about 1.3 km east of the Coolgardie-Esperance Highway.

Land status: Freehold.

Wetland description: A series of at least 5 small seasonal wetlands in a cleared paddock with open shorelines. A few sedges occur.

Extent of water and depth: All but the northernmost wetland, which had about 0.1 m of water, were dry at the time of survey.

Waterbird survey: The wetlands were surveyed from the ground and air on 29 February, with 2 Black-fronted Plover and 2 Common Greenshank seen from the ground.

Previous surveys: Apart from the October 2006 and 2007 surveys there are no previous recorded surveys of the Six Mile wetlands, which will at times contain significant species diversity during spring although never a high proportion of total bird numbers in Lake Warden system.

4.1.11 Lake Warden

Location: Between Coolgardie-Esperance and South Coast Highways about 6 km from the centre of Esperance.

Land status: Nature Reserve 32257.

Wetland description: A large semi-permanent saline wetland. At water depths experienced historically, it usually has a short open shoreline fringed by samphire and low *Melaleuca* trees (Halse et al., 1993). Water levels in Lake Warden are principally an expression of groundwater, although the lake receives surface water input from Bukenerup Creek to the north and overflow from the Windabout complex to the east.

Extent of water and depth: Warden was three-quarters full at the time of survey, with a narrow band of exposed shoreline. Depth was 2.10 m (8790 mS m⁻¹).

Waterbird survey: Lake Warden was surveyed from the ground on 27 February and air on 29 February 2008. About 950 waterbirds of 12 species were recorded. Musk Duck and Hoary-headed Grebe were the numerically dominant species, with up to 100 Silver Gull as well. Australian Shelduck were absent from the aerial count and only 6 were seen during the ground count. Large numbers of Little Black Cormorant were seen during the aerial survey, whereas this species was absent during the ground count. This sporadic occurrence reflects daytime movement from roosting areas at Wheatfield Lake (and perhaps elsewhere) into Warden to feed.

Previous surveys: Lake Warden was surveyed regularly in the early 1980s with counts of 2158 waterbirds of 5 species in January 1982, 327 waterbirds of 5 species in January 1983, 4177 waterbirds of 19 species in January 1985, 3629 waterbirds of 13 species in February 1985 and 5497 waterbirds of 7 species in January 1986. Counts in 1982 and 1986 comprised almost entirely Australian Shelduck, while counts in 1985 were dominated by shelduck and Banded Stilt. Counts of ducks, coots and swans made in Warden each March between 1989 and 1992 were 0 birds in 1988, 203 in 1990, 4287 in 1991 with 1760 Australian Shelduck, and 745 in 1992 (Halse et al., 1995 and earlier publications) compared with 446 from the air in February 2008 with no Australian Shelduck. Clarke & Lane (2003) counted 4384 waterbirds of 18 species. They recorded 6 species of shorebird accounting for 389 birds compared with 1 species represented by 20 birds in 2008. Depth was shallower in 2003 than 2008 (1.50 vs 2.10 m).

Summer counts of Lake Warden have been highly variable over the past 25 years but it appears that high numbers are recorded only when Australian Shelduck make up a substantial proportion of the waterbird community.

4.1.12 Bukenerup complex

Location: Wetlands along Bukenerup Creek at south-western side of Lake Warden. North of South Coast Highway and both sides of railway.

Land status: Freehold and railway reserve.

Wetland description: A series of small semi-permanent wetlands along the inflow into Lake Warden from Bukenerup Creek, fringed by sedges and *Melaleuca* trees. Some of the wetlands are degraded and a rail line passes through the complex.

Extent of water and depth: The Bukenerup wetlands were half full at the time of survey and depth was about 0.7 m.

Waterbird survey: The wetlands were surveyed from the ground and air on 29 February 2008 with about 210 birds of 18 species being recorded. There were substantial differences in the numbers recorded from the ground and air of several species, particularly Australian Shelduck, Grey Teal, Little Black Cormorant and Hoary-headed Grebe. While the lower aerial count of grebe is likely to be survey error, movement in or out of the wetland during the day was probably the principal cause of other differences. Australian Shelduck and Little Black Cormorant were the dominant species but the shorebird community was rich, being represented by 7 species and about 50 birds.

Previous surveys: The only previous surveys have been in October 2006 and 2007 survey when bird numbers were relatively low, as was the case in February 2008, although species richness was relatively high (11) in 2006.

4.1.13 Pink Lake

Location: South-west of South Coast Highway about 6 km from the centre of Esperance.

Land status: Unallocated Crown land, freehold and Nature Reserve 24511 on western side.

Wetland description: A large seasonally drying hypersaline wetland containing a series of evaporation ponds in the northern end for salt production. The western side of the wetland contains freshwater seeps along the shore and extensive sedges and samphire, with *Melaleuca* behind. The remainder of the shoreline supports samphire and scattered *Melaleuca* trees.

Extent of water and depth: At the time of survey the wetland contained almost no water other than within the evaporation ponds of the salt works.

Waterbird survey: Pink Lake was surveyed from the ground on 27 February and air on 28 February 2008. No birds were seen on the ground but 2 Cape Barren Geese and 8 Hooded Plover were seen near the salt works during the aerial survey.

Previous surveys: The previous surveys of Pink Lake in October 2006 and 2007 showed it supports at least several thousand of shorebirds when water levels are suitable.

4.2 Lake Gore system

4.2.1 Lake Gore

Location: Terminus of Dalyup River, south of McCall's Road between South Coast Highway and coast. About 40 km west of Esperance in a direct line.

Land status: Nature Reserve 32419.

Wetland description: Lake Gore is a large open saline lake fringed with *Melaleuca cuticularis* trees, many of which have died over the past 25 years. The Dalyup River enters on the eastern side of Lake Gore and there is a long lagoon-like backwater, parallel to the shoreline of the main waterbody, associated with the river inflow. There are other wetlands associated with the Dalyup as it approaches

the lake. Although Lake Gore is the terminus for the Dalyup River in most years, it overflows to the west in wet years into the Coobidge to Quallilup flow-through system.

Extent of water and depth: Lake Gore was two-thirds full at the time of survey with exposed shoreline and little water in the lagoon associated with the Dalyup River. Depth was 0.85 m and salinity was 7990 mS cm⁻¹.

Waterbird survey: A total of 4616 waterbirds of 15 species were recorded in Lake Gore and adjacent inflow wetlands on 29 February 2008. The numerically dominant species were Australian Shelduck (73 % of birds) and Chestnut Teal (19 %). There were very few Grey Teal.

Previous surveys: Counts in February in the 1980s by Jaensch et al. (1988) yielded highly variable numbers of birds and it is likely that some counts were incomplete. However, 792 waterbirds of 9 species were recorded in February 1982, and a series of counts in January, February and March 1983 yielded 10,389, 1540 and 5173 waterbirds of up to 9 species, with Banded Stilt comprising nearly all the birds. A total of 189 waterbirds of 6 species in was counted in January 1984, 1513 waterbirds of 6 species in February 1984, and 4127 waterbirds of 18 species in January 1986. Clake & Lane (2003) counted 1139 waterbirds of 15 species in February 2003 at a depth of 0.65 m compared with 0.85 m in 2008.

Counts of ducks, coots and swans made at Gore each March between 1989 and 1992 were 1876 in 1989, 3025 in 1990, 11,267 in 1991 and 4 in 1992 (Halse et al., 1995 and earlier publications) compared with about 4600 in February 2008. Increased water depth is likely to account for most of the increased waterbird use in summer.

October counts in the early 1980s were usually higher than summer counts and consisted of substantially more species, although Australian Shelduck and Banded Stilt dominated the community. The same pattern was observed by Clarke & Lane (2003) with 6927 birds of 24 species in November compared with 1139 of 15 species in October and was repeated from October 2007 to February 2008 (8317 of 18 species vs 4616 of 15 species). The substantial reduction in numbers that usually occurs after spring highlight the role of the lake as moulting habitat for Australian Shelduck, as well as reflecting the low water levels and high salinities often found in summer.

4.2.2 Coobidge to Quallilup flow-through system

Location: The Coobidge to Quallilup flow-through system consists of four named wetlands – Lakes Carbul, Coobidge, Gidong in the north and Quallilup in the south – and many flow-through channels and smaller wetlands between them. The system is west of Lake Gore and not easily accessible. Lake Coobidge is the terminus of Coobidge Creek.

Land status: Freehold and Reserve. Lake Quallilup is in Reserve 30672 and much of the flow-through system south of Lakes Carbul, Kubitch and Carbul is in Nature Reserve 26885.

Wetland description: Gidong, Coobidge, Carbul receive overflow from Lake Gore and flow through into Lake Quallilup.

Extent of water and depth: The lakes were about half full, with lower waterlevels in the south-west of the system where south wetlands were dry. Depth in Lake Kubitch was not estimated; depth in Lake Quallilup was not estimated.

Waterbird survey: The Coobidge to Quallilup flow-through system was counted from the air on 29 February and 9478 waterbirds of 23 species. The numerically dominant species was the Banded Stilt (41 % of birds, with Australian Shelduck and Little Black Cormorant each accounting for about 15 %. Lake Quallilup contained 128 waterbirds of 10 species. Silver Gull and Little Black Cormorant were the dominant species.

Previous surveys: Counts of ducks, coots and swans were made in the Coobidge to Quallilup flow-through system each March between 1989 and 1992. Lake Quallilup itself was included in these counts (it was done separately in 2008). Totals of 712 waterfowl were counted in 1989, 3299 in 1990, 594 in 1991 and 311 in 1992 (Halse et al., 1995 and earlier publications) compared with 2947 in 2008. When numbers were low in earlier counts conditions were dry.

4.2.3 Barker flow-through system

Location: Barker Inlet flow-through system consists of one main waterbody about 2.5 km long and 1.2 km wide and two smaller interconnected waterbodies to the west. The system is west of Coobidge to Quallilup flow-through system.

Land status: Nature Reserve 27888

Wetland description: The system represents a series of swamps that fill in wet years as water overflows from the Coobidge to Quallilup flow-through system into Barker Inlet.

Extent of water and depth: The system was almost dry and difficult to distinguish from the Coobidge to Quallilup flow-through.

Waterbird survey: The Barker Inlet flow-through system was counted as part of the Coobidge to Quallilup flow-through but contributed only a small number of birds

Previous surveys: The Barker Inlet flow-through has not been counted separately in summer.

4.2.4 Dalyup River complex

Location: Dalyup River as it flows into Lake Gore and two satellite wetlands to the south-east of the junction of Gore and the Dalyup.

Land status: Private freehold cleared for farming.

Wetland description: The wetlands are circular swamps, in the which the trees present have died. The river retains riparian vegetation in moderately good condition.

Extent of water and depth: Water levels were low in the wetlands but a significant depth of water remained in the river.

Waterbird survey: The Dalyup River complex was counted from the air on 29 February 2008 and contained 400 waterbirds of 9 species. Black-winged Stilt and Red-necked Avocet were the dominant species.

Previous surveys: There have been no previous summer counts of this complex.

5 DISCUSSION

The aerial counts of about 14,603 waterbirds of 42 species and 14,622 waterbirds of 24 species in the Lake Warden and Lake Gore complexes, respectively, in October 2007 (Appendix 1) represent significant concentrations of waterbirds in south-west Western Australia, although higher counts have been recorded from the Warden and Gore complexes previously (see Jaensch et al. 1989; Halse et al. 1995 and earlier publications).

Three patterns emerge when looking at counts from October 2006 and 2007 and February 2008. Firstly, most of the waterbirds in the Warden and Gore systems occur in four wetland groups: Lake Gore, the Coobidge to Quallilup flow-through system, Windabout Lake and the Ewans/Mullet complex (Fig. 5.1). While Lake Warden has historically been regarded as the most significant waterbird habitat in the Warden system and one of the wetlands supporting very high waterbird abundance in south-western Australia, this was not reflected in recent surveys.

Second, differences between wetlands are less marked for species richness than abundance, although the Coobidge to Quallilup through-flow system, Windabout Lake, Wheatfield Lake and Lake Gore were

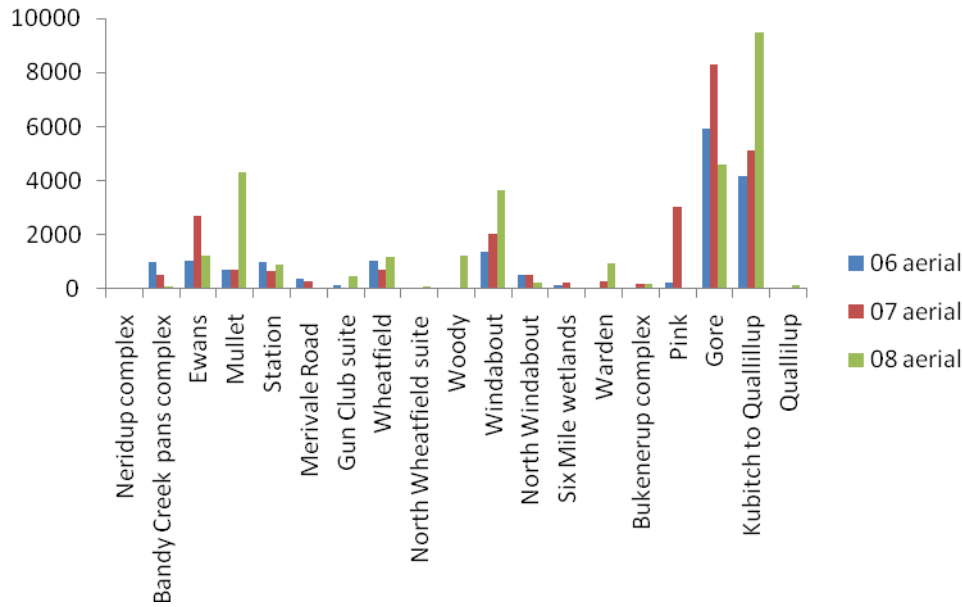
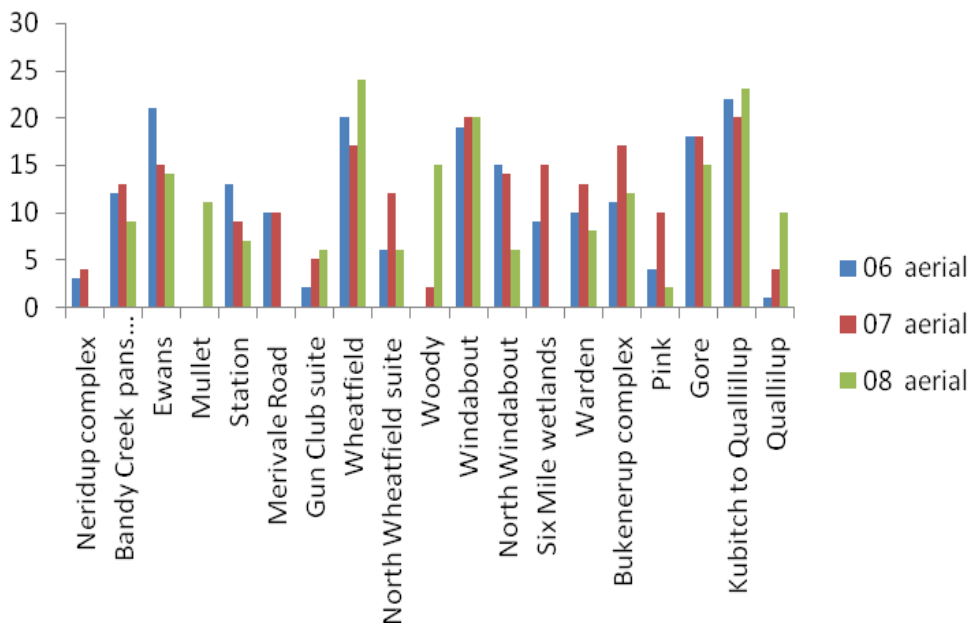


Fig. 5.1. Comparison of waterbird numbers in the different wetlands across years



5.2. Comparison of waterbird species richness in the different wetlands across years (Ewans and Mullet combined in 2006 and 2007)

consistently richer in waterbirds than most other wetlands and the Ewans/Mullet complex was rich on occasion (Fig. 5.2).

Third, the numbers of waterbirds in both the Warden and Gore systems increases over summer as water in smaller wetlands in the vicinity dries up. However, this drought refuge function in relation to the region is more clearly expressed in the Warden system (21 % increase in numbers between October and

February). Even in the Warden system, a considerable amount of the increase over summer in waterbird numbers on deeper Warden system wetlands, such as Windabout, appears to be the result of movement within the system rather from the region. This was even more pronounced in the Gore system, where about 4000 birds (30 % of those in system) appeared to transfer from Gore to the Coobidge to Quaililup flow-through system between October and February, while overall numbers in the system increased only 6 %. Readers must be aware, however, that this is a preliminary interpretation of movement patterns based largely on 1 year of data and patterns are likely to vary across years.

5.1 Counting consistency

The February 2008 survey employed the same methods and counted the same wetlands or wetland sections as in October 2006 and 2007 in order to minimize differences in results across seasons and years owing to different counting techniques rather than real changes in abundance. Variations between aerial and ground counts were relatively small with the same patterns between wetlands shown by both survey techniques (Figs 5.3 & 5.4). The differences observed in counts with the two techniques reflected known biases of each method (e.g. under-counting diving birds from the air and over-counting some species on the ground as they move ahead of the observer, Halse 2007). This provides confidence in using the results of aerial surveys to make comparisons between the Warden and Gore systems (see also Kingsford et al. 2008).

The Warden and Gore surveys reinforce conclusions of Kingsford et al. (2008) that aerial surveys results that can be used to characterize any wetland in a cost-effective way. It is less suited to small wetlands with lots of trees in them than ground counting but more effective than in very large and diffuse wetland complexes, such as the Coobidge to Quaililup through-flow system, that tend to contain most of the birds present in a system.

Ground counting is often used as the benchmark for validating aerial survey without much investigation of its accuracy. The ground counts at Wheatfield and Windabout (Appendix 1) show that confidence in ground counts may sometimes be misplaced, especially when the observer needs to travel around a wetland, thus disturbing birds and creating the need for decisions about whether they have been previously encountered in another part of the wetland. This caused observers to differ in estimates of Grey Teal, Chestnut Teal and Little Black Cormorant numbers at Wheatfield by factors of 1.9, 6.1 and 1.5, respectively. Estimates of Pacific Black Duck numbers at Windabout differed by 20 % (the discrepancies in swans and coot were largely associated with one observer taking a phone call – mobile phones constitute a modern cause of error).

Another important issue in the verification of counting techniques is that comparisons should be made simultaneously. Many discrepancies between different counts may be attributable to bird movement rather than counting error. For example, 5 Australian Pelicans were observed during the aerial survey of Station Lake whereas none was seen on the ground two days earlier, which almost certainly reflects movement. This variation in counts resulting from bird movement represents intrinsic variability in bird counts. Effort spent trying to be more precise than this level of variation is misplaced in single-season surveys, a point that is rarely appreciated and makes documenting daily variability in bird numbers of useful research topic to underpin survey.

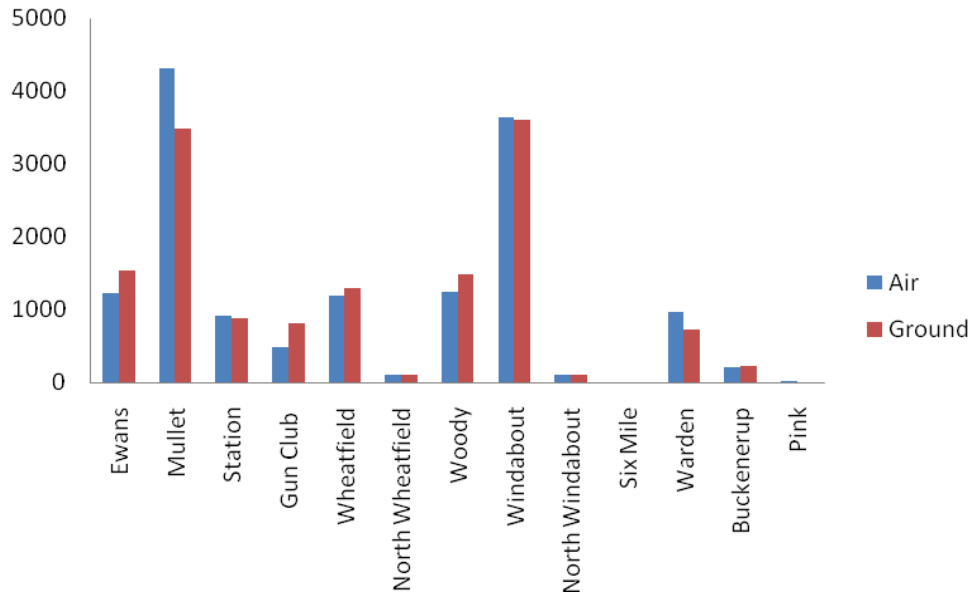


Fig. 5.3. Comparison of the numbers of waterbirds counted from the air and ground in the Warden system in February 2008 showing the similarities of the counts

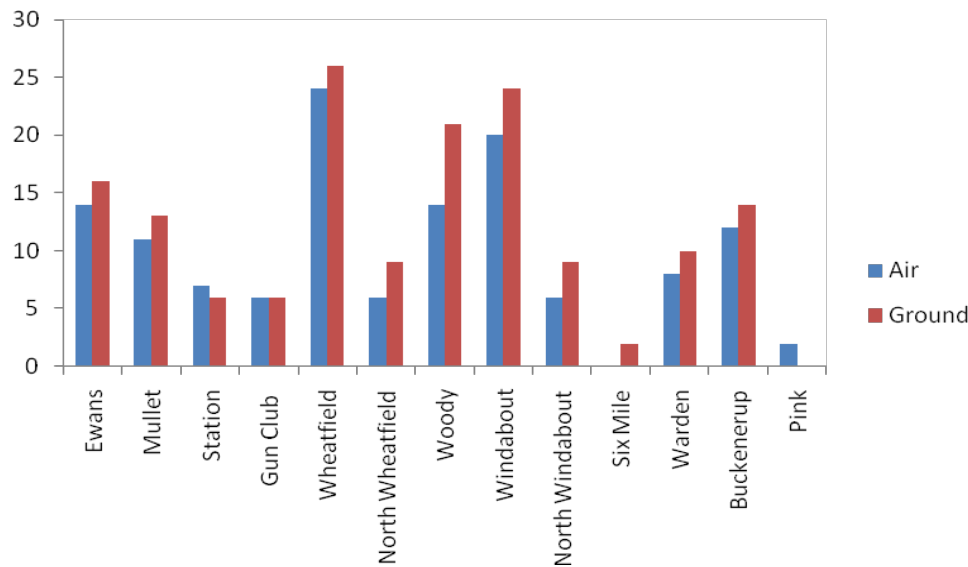


Fig. 5.4. Comparison of species richness estimates from ground and aerial counting in February 2008 that higher estimates are usually obtained on the ground but that both methods show the same pattern

5.2 Species of interest

The Warden and Gore systems are regarded as strongholds for Hooded Plover in Western Australia (e.g. Weston & Elgar 2000) but the only count of this species seen during the February surveys was 8 birds at Pink Lake, although aerial surveys in the Gore system are likely to have missed any birds present there. Counts of this species were 4 birds at Warden in October 2006 and in 2007 and 3 birds at Station and 4 at Bukenerup in October 2007 and are showing substantial differences from the historical picture.

A total of 785 Australasian Shoveler were counted on the ground in the Warden system in February (aerial estimates were slightly lower). This contrasts with October 2006 and 2007 when 44 and 46 birds were counted from the ground (aerial counts were slightly higher) and represents a high concentration of the species in Western Australia. For example the highest counts of Australasian Shoveler each March between 1989 and 1992 were 960 at Lake Forrestdale, 395 at Eyrie Lake, 450 at Lake Coyrecup and 385 at Lake Coyrecup.

The warm summer of 2008 appeared to cause significant numbers of Cape Barren Geese to move from adjacent islands of the Archipelago of the Recherche to the mainland to feed. Forty-three birds were seen feeding on the golf course adjacent to Windabout during the boat survey on 28 February and 2 birds were seen at Pink Lake on 29 February. Although the species occurs on the mainland regularly, only 5 birds were seen on the golf course (during aerial survey) in October 2006 and none was seen in 2007.

Other interesting records in February were 6 Spotless Crakes at Wheatfield and 5 Freckled Duck (Woody and Windabout). Spotless Crake appear not to have been recorded at Wheatfield before.

5.3 Wetland values

The counts made in February 2008 suggest that the Lake Warden and Lake Gore systems, with a total of more than 29,000 waterbirds between them, continue to have high conservation values.

Perhaps the major feature of the counts in February was the count of 9478 birds in the Coobidge to Quallilup flow-through system. This area has been poorly surveyed in the past because of lack of ground access and its significance is probably under-estimated. Ground surveys of the system are warranted, despite logistical difficulties and high cost, to develop species lists fully and estimate the importance of the wetlands for shorebirds. A significant number of small shorebirds were noted during the aerial survey.

5.6 Monitoring the systems

The aim of the October 2006, October 2007 and February 2008 surveys is to establish the current level of waterbird use of the Lakes Warden and Lake Gore systems in terms of the species present and their overall numbers. This baseline will reflect the changes in species and numbers that occur in the two systems between years as a result of different rainfall patterns, both locally and at larger spatial scales (see Introduction). Without understanding the magnitude of changes due to waterbird movements and climate fluctuations, the significance of observed changes in waterbird populations at any two points in time cannot be assessed. Some analysis of annual change in spring counts was provided in Bennelongia (2008) and changes between October 2007 and February 2008 are described here. Further spring and summer counts are required to enable annual and seasonal changes to be documented adequately.

6 ACKNOWLEDGEMENTS

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Appendix 1. Waterbird counts from the Lake Warden and Lake Gore systems, February 2008

	Aerial			Ground					
	GP	SH	GP+SH	GP	GP	SH	GP	SH	SH/GP
	29/2/08	29/2/08	Total	27/2/08	28/2/08	28/2/08	29/2/08	29/2/08	Total
LAKE WARDEN SYSTEM									
Neridup Complex									
No birds	0	0	0						
<i>Subtotal</i>	0	0	0						
Neridup Complex									
Musk Duck	4		4						
Black Swan	10		10						
Pacific Black Duck	4		4						
Unidentified Duck	5		5						
Darter	2		2						
Little Pied Cormorant	5		5						
White-faced Heron		2	2						
Australian White Ibis		2	2						
Eurasian Coot	50		50						
Common Greenshank		1	1						
<i>Subtotal</i>	80	5	85						
Ewans/Mullet/Station complex									
Ewans									
Black Swan	12	96	108	77					77
Australian Shelduck	25	40	65	2					2
Pacific Black Duck	196	150	346	82					82
Australasian Shoveler	190	220	410	692					692
Grey Teal	52	150	202	459					459
Chestnut Teal	2	30	32	27					27
Great Crested Grebe									
Hoary-headed Grebe				58					58
Little Pied Cormorant	8		8	1					1
Australian Pelican		8	8	8					8
White-faced Heron	1	1	2	2					2
Australian White Ibis									
Great Egret	2		2	1					1
Yellow-billed Spoonbill	2		2	4					4
Eurasian Coot	30		30	88					88
Common Greenshank	2		2	22					22
Ruddy Turnstone									

	Aerial			Ground					
	GP	SH	GP+SH	GP	GP	SH	GP	SH	SH/GP
	29/2/08	29/2/08	Total	27/2/08	28/2/08	28/2/08	29/2/08	29/2/08	Total
Red-necked Stint									
Sharp-tailed Sandpiper									
Red-capped Plover				3					3
Silver Gull	2		2	3					3
<i>Tally</i>	524	695	1219	1529					1529
<i>Mullet</i>									
Musk Duck	30	1	31	22					22
Black Swan	72	92	164	118					118
Australian Shelduck	30	50	80	61					61
Pacific Black Duck	45	68	113	134					134
Australasian Shoveler	25	32	57	25					25
Grey Teal	100	140	240	150					150
Chestnut Teal	50	20	70						
White-faced Heron	1		1	1					1
Yellow-billed Spoonbill									
Common Greenshank	1	10	11	16					16
Red-necked Stint				107					107
Banded Stilt	10	3500	3510	2800					2800
Red-necked Avocet				16					16
Red-capped Plover				28					28
Silver Gull	30		30	4					4
<i>Tally</i>	394	3913	4307	3482					3482
<i>Station</i>									
Black Swan	2		2						
Australian Pelican	5		5						
White-faced Heron	2	5	7						
Curlew Sandpiper				210					210
Red-necked Stint				370					370
Banded Stilt		10	10	5					5
Red-necked Avocet		177	177	280					280
Red-capped Plover				6					6
Unidentified wader	500	200	700						
Greenshank				3					3
Silver Gull		18	18						
<i>Tally</i>	509	410	919	874					874
<i>Merivale Rd wetlands</i>									
No birds	0	0	0						

	Aerial			Ground					
	GP	SH	GP+SH	GP	GP	SH	GP	SH	SH/GP
	29/2/08	29/2/08	Total	27/2/08	28/2/08	28/2/08	29/2/08	29/2/08	Total
<i>Tally</i>	0	0	0						
Subtotal	1507	5023	6530	5885	0	0	0	0	5885
Gun Club suite									
Black Swan		35	35	32					32
Australian Shelduck		50	50						
Pacific Black Duck	40		40						
Australasian Shoveler	50	30	80	87					87
Grey Teal	200	70	270	658					658
Chestnut Teal				12					12
Eurasian Coot				18					18
Common Greenshank				1					1
Red-necked Avocet		15	15						
Subtotal	290	200	490	808					808
Wheatfield									
Musk Duck	5		5		3				3
Black Swan	1		1						
Pacific Black Duck	156	80	236		383	388			388
Australasian Shoveler	11		11		40	10			40
Grey Teal	250	53	303		299	558			299
Chestnut Teal	20	52	72		59	361			59
Pink-eared Duck	50		50		52	50			52
Hardhead	101		101		40	20			40
Hoary-headed Grebe	20	50	70		73	71			73
Great Crested Grebe					2	2			2
Darter	1	4	5		24	14			24
Pied Cormorant		1	1						
Little Pied Cormorant	2	1	3			1			1
Little Black Cormorant	50	137	187		48	72			72
Great Cormorant	5		5		5	2			5
Australian Pelican	20	1	21		6	9			9
White-faced Heron	5	2	7		4	5			5
Great Egret	1		1		5	3			5
Australian White Ibis		1	1		3	2			3
Straw-necked Ibis	5	1	6		30	31			31
Yellow-billed Spoonbill	6	57	63		88	83			88
Spotless Crake					6	6			6
Eurasian Coot	14	4	18		68	116			116
Common Greenshank	3	2	5		33	32			33

	Aerial			Ground					
	GP	SH	GP+SH	GP	GP	SH	GP	SH	SH/GP
	29/2/08	29/2/08	Total	27/2/08	28/2/08	28/2/08	29/2/08	29/2/08	Total
Common Sandpiper						2	1		2
Red-kneed Dotterel						4	4		4
Black-fronted Plover						14	12		14
Silver Gull	5		5				3		3
Unidentified wader	10		10						
Subtotal	736	446	1182			1288	1856		1374
North Wheatfield suite									
Black Swan		3	3						
Australian Shoveler		50	50						
Pacific Black Duck					20				20
Grey Teal		30	30						
Chestnut Teal					3				3
Darter		2	2		3				3
Little Black Cormorant		10	10						
Hoary-headed Grebe					33				33
White-faced Heron					1				1
Great Egret					1				1
Common Greenshank		2	2		29				29
Black-fronted Plover					14				14
Red-kneed Plover					4				4
Subtotal	0	97	97		108				108
Windabout complex									
Woody									
Musk Duck	6		6		16	10			16
Freckled Duck					1	1			1
Swan	85	65	150		37	13			37
Pacific Black Duck	140	137	277		419	501			501
Australasian Shoveler	4		4		2	2			2
Chestnut Teal	47	50	97		159	159			159
Grey Teal	100		100		552	563			563
Pink-eared Duck	5		5		17	18			18
Hardhead	5		5		6	6			6
Unidentified Ducks	500		500						
Hoary-headed Grebe		20	20		83	80			83
Darter					1	1			1
Little Pied Cormorant					1	1			1
Little Black Cormorant					3	4			4
Australian Pelican					1	1			1

	Aerial			Ground					
	GP	SH	GP+SH	GP	GP	SH	GP	SH	SH/GP
	29/2/08	29/2/08	Total	27/2/08	28/2/08	28/2/08	29/2/08	29/2/08	Total
White-faced Heron		2	2			1	1		1
Great Egret		3	3			7	5		7
Australian White Ibis						1	2		2
Straw-necked Ibis		1	1						
Yellow-billed Spoonbill		3	3			5	10		10
Eurasian Coot	50	23				63	54		63
Common Greenshank						1	5		5
Caspian Tern						1	1		1
<i>Tally</i>	<i>942</i>	<i>304</i>	<i>1173</i>			<i>1377</i>	<i>1438</i>		<i>1481</i>
Windabout									
Musk Duck	195	362	557			434	351		434
Freckled Duck						4	4		4
Black Swan	301	615	916			779	765		779
Cape Barren Goose	20		20			43	42		43
Australian Shelduck	8	65	73			166	132		166
Pacific Black Duck	242	351	593			483	882		882
Australasian Shoveler						26	13		26
Grey Teal	660	60	720			366	344		366
Chestnut Teal	120	81	201			564	607		607
Pink-eared Duck						4	60		60
Hardhead		100	100			123	65		123
Hoary-headed Grebe		10	10			48	53		53
Darter	9	1	10			5	8		8
Little Pied Cormorant		1	1			4	5		5
Little Black Cormorant		1	1						
Great Cormorant							1		1
Australian Pelican		12	12			40	40		40
White-faced Heron	5	4	9			7	7		7
Great Egret	3	4	7			6	7		7
Rufous Night Heron						2	2		2
Yellow-billed Spoonbill	10	11	21			18	15		18
Spotless Crake						2	2		2
Eurasian Coot	80	215	295			401	600		600
Common Greenshank	1		1						
Silver Gull	30	60	90			53	50		53
Caspian Tern		1	1			2	2		2
<i>Tally</i>	<i>1684</i>	<i>1954</i>	<i>3638</i>			<i>3580</i>	<i>4057</i>		<i>4288</i>
Subtotal	2626	2258	4811			4957	5495		5769

	Aerial			Ground					
	GP	SH	GP+SH	GP	GP	SH	GP	SH	SH/GP
	29/2/08	29/2/08	Total	27/2/08	28/2/08	28/2/08	29/2/08	29/2/08	Total
North Windabout									
Black Swan	82	70	82				81	74	81
Australian Shelduck		10	10				5	5	5
Hoary-headed Grebe							5	6	6
Darter	2		2						
Little Pied Cormorant	2		2						
Little Black Cormorant	2		2						
White-faced Heron	3		3				1	2	2
Eurasian Coot	2		2						
Common Greenshank							5	6	6
Black-winged Stilt							4	4	4
Red-necked Avocet	70		70				176	170	176
<i>Subtotal</i>	163	80	243				277	267	280
Six Mile wetlands									
Black-fronted Plover							2	2	2
Common Greenshank							2	2	2
<i>Subtotal</i>							4	4	4
Warden									
Musk Duck	50	346	396		411				411
Black Swan		50	50		41				41
Australian Shelduck					6				6
Hoary-headed Grebe	116	200	316		97				97
Great Crested Grebe					11				11
Little Black Cormorant	30	104	134						
Australian Pelican	1		1						
White-faced Heron		1	1		12				12
Red-necked Avocet		20	20		44				44
Silver Gull		50	50		96				96
Crested Tern					1				1
Caspian Tern					2				2
<i>Subtotal</i>	197	771	968		721				721
Bukenerup complex									
Musk Duck		4	4				31	26	31
Black Swan		1	1						
Australian Shelduck	20	68	88					2	2
Pacific Black Duck	4	6	10						
Australasian Shoveler									

	Aerial			Ground					
	GP	SH	GP+SH	GP	GP	SH	GP	SH	SH/GP
	29/2/08	29/2/08	Total	27/2/08	28/2/08	28/2/08	29/2/08	29/2/08	Total
Grey Teal	9	20	29						
Chestnut Teal		7	7				4	6	6
Hoary-headed Grebe		20	20				95	93	95
Little Pied Cormorant								1	1
Little Black Cormorant		13	13				48	56	56
White-faced Heron		3	3				4	2	4
Great Egret							2	2	2
Black-winged Stilt	7	20	27				13	12	13
Common Greenshank							3	2	3
Wood sandpiper							2	2	2
Red-necked Stint							9	9	9
Sharp-tailed Sandpiper							6	6	6
Black-fronted Plover							2	2	2
Unidentified Lapwing	1		1						
Unidentified waders		5	5						
Subtotal	41	167	208				219	221	232
Pink									
Cape Barren Goose		2	2						
Hooded Plover		8	8						
Subtotal	0	10	10						0
WARDEN SYSTEM TOTAL			14624						15177
LAKE GORE SYSTEM									
Gore									
Black Swan	26		26						
Australian Shelduck	450	2901	3351						
Grey Teal		28	28						
Chestnut Teal		884	884						
Darter		1	1						
Little Black Cormorant		1	1						
White-faced Heron		2	2						
Australian White Ibis		4	4						
Yellow-billed Spoonbill		1	1						
Eurasian Coot		4	4						
Greenshank		4	4						
Black-winged Stilt		12	12						
Red-necked Avocet		140	140						
Unidentified wader		3	3						

	Aerial			Ground					SH/GP Total
	GP	SH	GP+SH	GP	GP	SH	GP	SH	
	29/2/08	29/2/08	Total	27/2/08	28/2/08	28/2/08	29/2/08	29/2/08	
Silver Gull		155	155						
Subtotal	476	4140	4616						
Coobidge to Quallilup flow-through									
Black Swan	330	117	447						
Australian Shelduck	475	995	1470						
Pacific Black Duck	26	44	70						
Grey Teal	495	59	554						
Chestnut Teal	65	31	96						
Darter	35	8	43						
Little Pied Cormorant	38	5	43						
Pied Cormorant	6	1	7						
Little Black Cormorant	378	1056	1434						
Great Cormorant		3	3						
Australian Pelican	6	23	29						
White-faced Heron	47	46	93						
Great Egret	77	70	147						
Australian White Ibis		34	34						
Glossy Ibis		1	1						
Yellow-billed Spoonbill		23	23						
Eurasian Coot		310	310						
Common Greenshank	48	2	50						
Black-winged Stilt	12		12						
Banded Stilt	1450	2410	3860						
Red-necked Avocet	230	30	260						
Unidentified wader	150	310	460						
Silver Gull	2	30	32						
Subtotal	3870	5608	9478						
Quallilup									
Darter		1	1						
Little Pied Cormorant		1	1						
Little Black Cormorant		53	53						
Great Cormorant		1	1						
Australian Pelican		1	1						
White-faced Heron		2	2						
Yellow-billed Spoonbill		1	1						
Common Greenshank		1	1						
Caspian Tern		2	2						
Silver Gull		65	65						

	Aerial			Ground					
	GP	SH	GP+SH	GP	GP	SH	GP	SH	SH/GP
	29/2/08	29/2/08	Total	27/2/08	28/2/08	28/2/08	29/2/08	29/2/08	Total
Subtotal	0	63	63						
Dalyup River									
Pacific Black Duck	10	12	22						
Grey Teal	90	6	96						
Chestnut Teal		21	21						
Darter	1	2	3						
Swamp Harrier		2	2						
Common Greenshank		2	2						
Black-winged Stilt		140	140						
Red-necked Avocet		110	110						
Banded Lapwing	2	2	4						
Subtotal	103	297	400						
GORE SYSTEM TOTAL			14557						
GRAND TOTAL			29181						