

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



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

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Client – Espeance Regional Forum Inc.

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Executive Summary

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.

Waterbird numbers have been monitored each spring since 2006 with standardised methodology to provide a baseline of waterbird usage, with which to assess changes in biological value and wetland condition in future years.

The counts of about 3973 waterbirds of 44 species and 10,325 waterbirds of 21 species in the Lake Warden and Lake Gore complexes, respectively, in October-November 2008 highlight the different spring values of these two Ramsar sites. Lake Warden is used by a greater variety of species but lacks the very large moulting Australian Shelduck concentrations that swell the waterbird population of the Gore system in late spring.

Waterbird numbers in the Warden system from spring 2006-2008 had a coefficient of variation 53%, while species richness had a CV of 10%. Numbers appeared slightly less variable in the Gore system (CV 29%), while species richness had a CV of only 7%.

Further waterbird monitoring should be undertaken, with the methodology outlined in this report, to assess changes in waterbird use of the Lakes Warden and Gore systems as a measure of wetland condition.

- Monitoring should occur no later than October 2015 and be conducted annually for a period of 3 years.
- If any major anthropogenic change is expected, or major management activity is undertaken, monitoring should be undertaken for a 3 year period after the change occurs or is implemented.
- Species richness is relatively stable compared with waterbird abundance and should be considered as an indicator of waterbird use.
- Consideration should be given to monitoring in October and February of spring/summers when hydrological and climatic conditions are likely to be particularly favourable on the Esperance coast to assess whether either Ramsar system meets the current waterbird abundance criterion for a Wetland of International Importance.

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1.0 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).

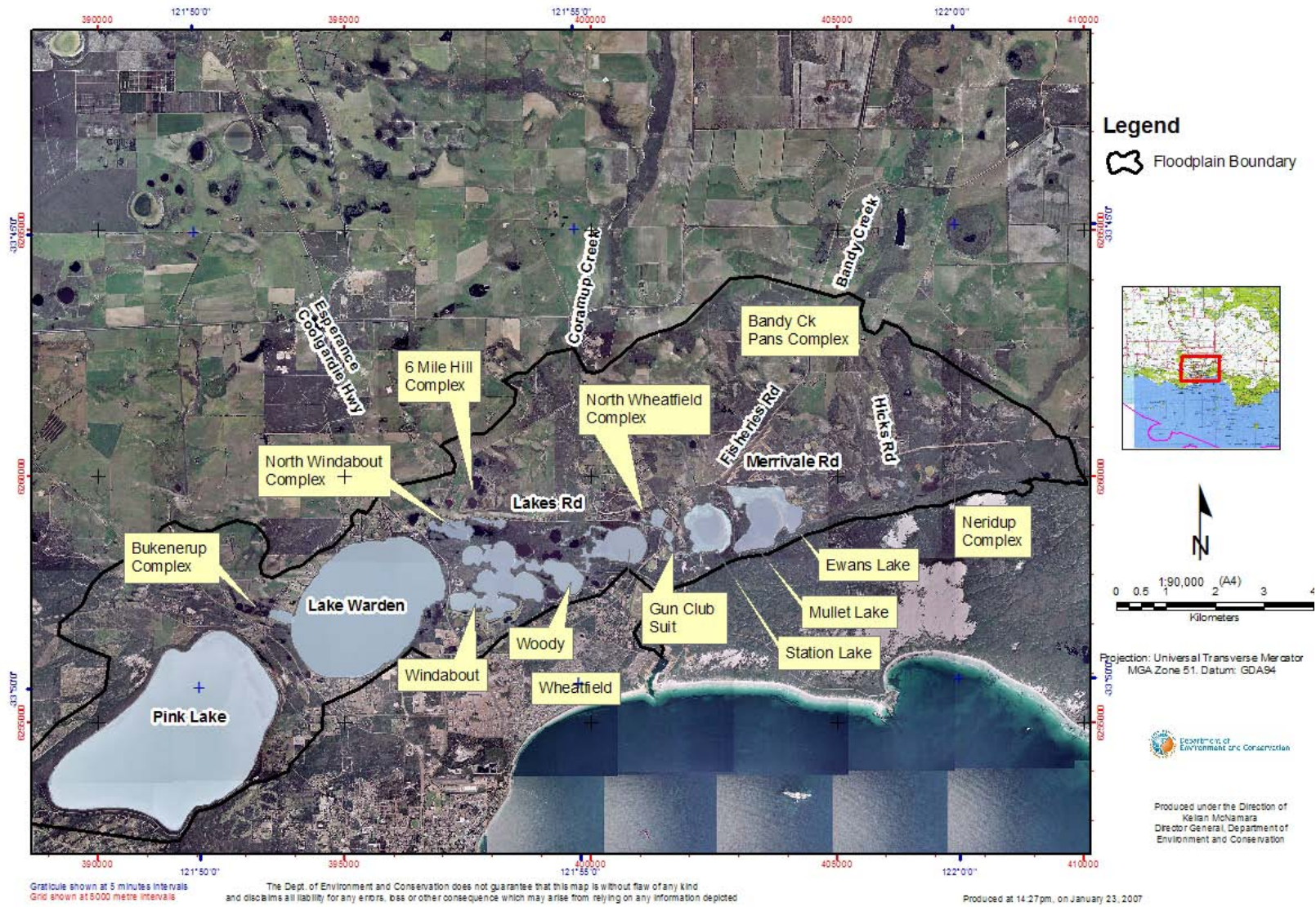


Fig. 1.1. The Lake Warden system showing the wetlands surveyed in February 2008.

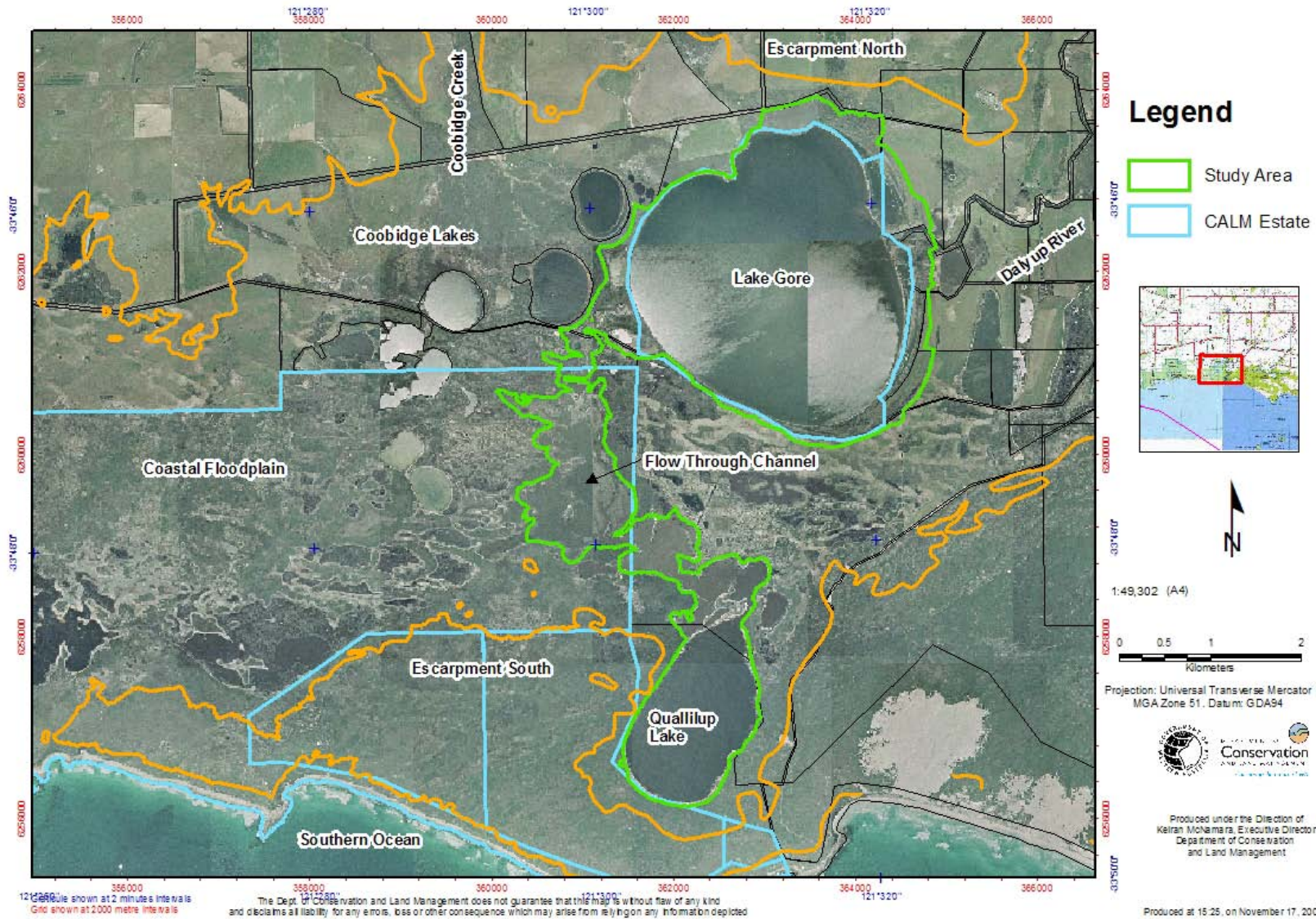


Fig. 1.2. The Lake Gore system showing the wetlands surveyed in February 2008.

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 beset with interpretational 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, 2007), February 2008 (Bennelongia, 2008) and October-November 2008 (reported here).

While a wetland's underlying condition (i.e. type of wetland and degree of naturalness) is the strongest determinant of waterbird use, other factors cause substantial variation in numbers of waterbirds 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 the effects of 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 October-November 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 November 2008 in the same parts of the Lake Warden system as counted in October 2006 and 2007
3. To calculate numbers that represent existing waterbird use in October for use as thresholds in future years to assess whether change in waterbird use has occurred in future years.

This report provides the results of counting in October-November 2008, summarizes results since 2006 and makes recommendations for future monitoring.

2.0 Climate

The October 2008 survey occurred after approximately average rainfall at Esperance (510 vs 517 mm) for the period March to October 2008, albeit with two months of >100 mm (July and September). As a result, surface water was plentiful around Esperance. Depths of the lakes surveyed are reported in the lake accounts below and compared with 2006 and 2007 levels in Fig. 2.2.

Most of south-west Western Australia experienced approximately average rainfall during the March to October period as a result of April being wet and August dry. Many wetlands contained water but few were fully flooded. In contrast, many episodically filled wetlands in the Murchison retained water from cyclones in February and average rainfall conditions subsequently.

3.0 Methods

3.1 Monitored wetlands

Wetlands in the Lake Warden and Lake Gore systems were surveyed from the air on 27 October 2008. Most of the wetlands in the Lake Warden system were also surveyed by boat or on foot two weeks later, between 10 and 11 November 2008.

3.2 Survey methods

The aim of survey in each wetland was to record all individuals of all waterbird species present at the wetland at the time of survey. It is recognized that this aim was unlikely to be achieved in all wetlands and some of the reasons for under- or over-counting are mentioned in section 5.1. For the purposes of comparing waterbird numbers between wetlands and years, aerial survey results are used because this survey method was used at all wetlands and appeared to provide accurate data for the more abundant species (see Kingsford et al. 2008). For the purpose of comparing numbers of species between wetlands and years, data from all survey methods were used. This biases the results towards wetlands that were surveyed on the ground as well as from the air because, firstly, twice the survey effort was applied to these wetlands and, secondly, ground counting detects some species (rails, shorebirds, grebes) more efficiently.

Unlike previous years, the aerial survey in October 2008 was undertaken as part of Western Australia-wide survey. It was flown in a Cessna 210 at a height of about 30 m and speed of 100-130 knots with a front right-seat observer (SH) and a rear left-seat observer (AB). This was about 40% faster than previous surveys were flown. Large wetlands were orbited anti-clock-wise, about 100 m inside the wetland boundary, and waterbirds on the shore and in the wetland margins were counted. Wind during the aerial survey was 15-20 knots. 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, Tilo Massenbauer and Owen 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.

Some other wetlands in the Lake warden system were surveyed on the ground (Mullet, Station, Merivale Road, Gun Club, North Windabout, Six Mile Hill, Warden, Bukenerup, Pink). Observations were made from vantage points around these wetlands using a spotting scope, usually attempting to view all parts of the wetlands and count all birds present. Coverage in Warden and Pink Lakes was obviously incomplete. Results were recorded in a notebook.

4.0 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 both contained water. Depth was estimated to be about 0.5 m.

Waterbird survey: Waterbirds were surveyed by plane on 27 October 2008. A single Black Swan was 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.

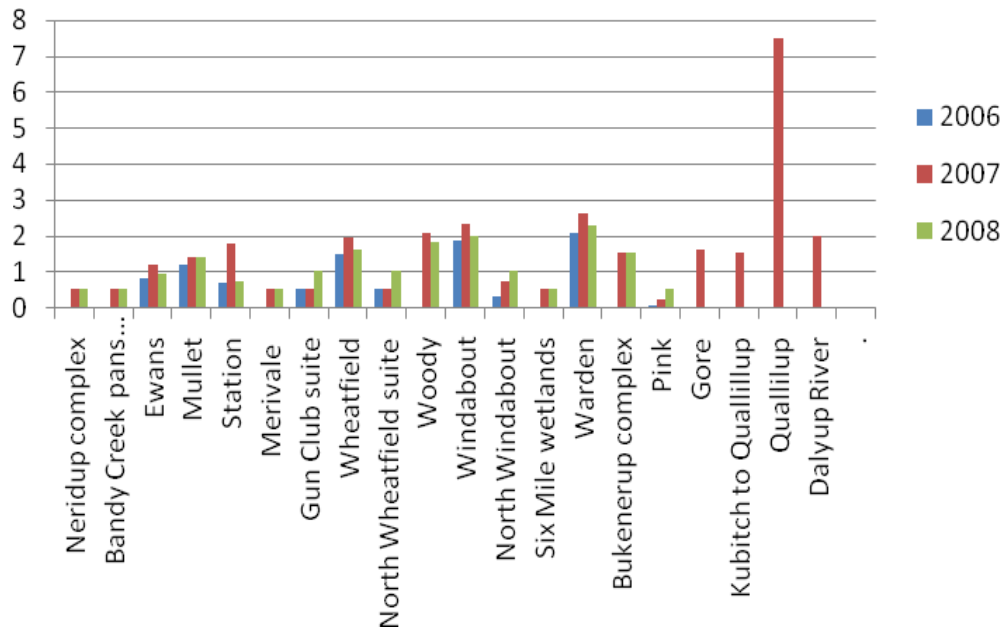


Fig. 2.2. Wetland depths in October 2006-2008 at monitored wetlands. Note some depths are estimated – many depths are missing in 2006. Data provided by Tilo Massenbauer and John Lizamore (DEC)

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: The system was flooded at the time of survey. Depth was probably 0.5 m.

Waterbird survey: A total of 68 waterbirds of 10 species were counted on 27 October, (Appendix 1). Black Swan 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 was different in 2008, with the Bandy Creek complex holding <5% of birds in this 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 together in the October 2008 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 full at the time of counting. Depth in Ewans was 0.95 m, Mullet was 1.38 m and Station was 0.73 m.

Waterbird survey: Totals of 14 species and 1667 waterbirds were recorded during surveys of the system in October 2008 (Appendix 1). The numerically dominant species were Black Swan and Australian Shelduck. A species of interest was the Musk Duck (130 birds counted). Numbers counted from the air were slightly higher than ground counts (2015 vs 1392 in 2006, 3090 vs 2080 in 2007, 1667 vs 630 in 2008), with the discrepancy more exaggerated in 2008 because Ewans was not counted on the ground.

Previous surveys: Ewans, Mullet and Station Lakes were surveyed regularly during the early 1980s (Jaensch et al., 1989). Results of October counts were 413 waterbirds of 18 species in 1982, 1013 waterbirds of 18 species in 1983, 380 waterbirds of 13 species in 1984 (a dry year when Station held about 15 cm of water), and 1236 waterbirds of 22 species in 1985. The most notable differences between the 1980s and recent counts were the lower numbers of dominant duck species in the 1980s (Black Swan numbers were similar) and the absence of Eurasian Coots recently.

Counts of ducks, coots and swans made in Ewans and Mullet each November between 1988 and 1991 were 1171, 1202, 1439, and 1461 birds (Halse et al., 1995 and earlier publications) compared with about 1400 in 2006, 3400 in October 2007 and 1600 in 2008.

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: Estimated to be about 0.5 m deep and fully flooded.

Waterbird survey: About 200 waterbirds of 11 species were recorded in aerial and ground surveys.

Previous surveys: The Merivale Road 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 1.0 m.

Waterbird survey: These wetlands were counted from both air (14 waterbirds) and ground (5 waterbirds) about two weeks apart. Altogether 6 species were recorded.

Previous surveys: The only previous surveys of the wetland were in October 2006 and 2007 when 85 and 25 birds, respectively, were counted. The wetland does not support a significant proportion of the waterbirds in the Lake Warden system.

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 1.61 m.

Waterbird survey: Totals of 182 and 277 waterbirds were recorded at Wheatfield in the aerial and boat surveys, respectively, representing 23 species (Appendix 1). The breeding colony of Straw-necked Ibis appeared to have fewer birds than previous years but more Yellow-billed Spoonbills were breeding. No evidence of breeding by cormorants was observed. The most abundant bird was the Straw-necked Ibis but counts were characterized by surprisingly low numbers of most species. Conditions for aerial survey were sub-optimal but the results were considered to be fairly reliable. For example, four species of cormorants were identified despite few birds being counted (Appendix 1).

Previous surveys: Wheatfield has been surveyed in October biennially since 1997 by boat (Cale et al., 2004). Numbers have been variable with 1246 waterbirds of 23 species in 1997, 726 waterbirds of 21 species in 1999, 212 waterbirds of 21 species in 2001, 191 waterbirds of 18 species in 2003, 224 waterbirds of 18 species in 2005 and 318 waterbirds of 25 species in 2007. Counts in October or November of the early 1980s (Jaensch et al., 1989) recorded relatively few species with 410 waterbirds of 14 species in 1982, 176 waterbirds of 10 species in 1983, 167 waterbirds of 15 species in 1984, and 220 waterbirds of 11 species in 1985. There is no definite evidence of change in species composition over time.

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) compared with ground counts of 702 in 2006, 73 in 2007 and 90 in 2008 (aerial counts were slightly lower).

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 full at the time of survey and depth was likely to have been about 0.5 m.

Waterbird survey: Aerial survey recorded 20 waterbirds 6 species were recorded with considerable differences in the species.

Previous surveys: There are no previous summer counts of the North Wheatfield system, which does not contain a significant number of birds in relation to the total population in the Lake Warden system.

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 1.8 m and Windabout was 1.98 m.

Waterbird survey: A total of 2330 waterbirds was recorded from the air on 27 October but only 414 during the boat survey two weeks later. The cause of the discrepancy appears to be an influx of about 1400 Australian Shelduck during the intervening period, as well as a significant increase in Hardheads (251 vs 7). Twenty-five species were recorded. Few birds were observed on Woody Lake. The numerically dominant species were Australian Shelduck and Hardhead.

Previous surveys: Lakes Woody and Windabout were surveyed regularly during the early 1980s with November 1983, 1984 and 1985 (Jaensch et al., 1989) counts of 481 waterbirds of 13 species, 403 waterbirds of 8 species and 144 waterbirds of 16 species, although satellite wetlands were not surveyed. Recent counts were much higher than in the 1980s but there is little suggestion of changes in species composition and improved coverage of the wetland complex is likely to be the main reason significantly more waterbirds were seen recently.

The count made in February 2008 was higher than all the 1980s but was similar to the boat count of Windabout made at the same time of the year by Clarke & Lane (2003), reinforcing the picture from spring counts that incomplete coverage leads to severe under-counting.

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: The wetland was fully flooded and depth was about 1.0 m.

Waterbird survey: The North Windabout wetlands supported about 170 waterbirds of 10 species. The numerically dominant species were Black Swan and Hoary-headed Grebe.

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: The southern two wetlands were about half full, with an estimated depth of 0.3 m.

Waterbird survey: The wetlands supported about 50 waterbirds of 12 species, including 6 species of shorebird.

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 2.28 m.

Waterbird survey: Lake Warden was surveyed from the air on 27 October and from the ground two weeks later. Totals of 400 and 25 waterbirds were recorded, respectively, representing 13 species. Little Black Cormorant and Whiskered Tern were the numerically dominant species. Neither species is likely to roost in Lake Warden and they were probably feeding opportunistically at the time of survey (the cormorants are likely to have been roosting in Wheatfield).

Previous surveys: Lake Warden was surveyed regularly in the early 1980s with November 1982, 1983, 1984 and 1985 counts of 16,919 waterbirds of 15 species, 1062 waterbirds of 5 species, 883 waterbirds of 10 species and 2872 waterbirds of 12 species. Counts of ducks, coots and swans made in Wheatfield each November between 1988 and 1991 were 810 in 1988, 55 in 1989, 87 in 1990 and 878 in 1991 (Halse et al., 1995 and earlier publications) compared with 9 in 2006, 16 in 2007 and 76 in 2008. While the very high numbers of waterbirds recorded in 1982 should probably be regarded as unusual, the more recent counts are relatively low in historical terms and are likely to reflect high water levels.

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 full at the time of survey and depth was about 1.5 m.

Waterbird survey: The wetland supported about 200 waterbirds of 15 species, with Australian Shelduck the dominant species. About 40 Little Black Cormorant were observed during the aerial survey but were absent on the ground visit.

Previous surveys: The only previous surveys have been in October 2006 and 2007 survey when bird numbers were relatively low but species richness was high.

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 0.5 m water.

Waterbird survey: Pink Lake supported about 500 waterbirds of 10 species. The numerically dominant species were Australian Shelduck and Red-necked Stint, with a large number of identified small shorebirds. Although dominant during the aerial survey, no shelduck were present during the ground count two weeks later, highlighting the fluctuations that occur in waterbird numbers and composition.

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 (e.g. 2007).

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 full at the time of survey. Depth was 1.52 m.

Waterbird survey: A total of 6242 waterbirds of 12 species were recorded in Lake Gore and adjacent inflow wetlands on 29 February 2008. The numerically dominant species were Australian Shelduck (85 % of birds). There were also 480 Red-necked Avocet.

Previous surveys: Counts in October in the 1980s by Jaensch et al. (1988) yielded highly variable numbers of birds and species in relation to recent results. Counts in October 1982, 1983, 1984, 1985, 1986 (November) and 1987 (November) were 1880 waterbirds of 9 species, 3763 waterbirds of 14 species, 5996 waterbirds of 18 species, 2500 waterbirds of 1 species, 14,327 waterbirds of 19 species and 12,000 waterbirds of 2 species. A more recent comprehensive count on 8 September 1998 (part of the State Salinity Strategy survey, Halse et al., 2004) recorded 9832 waterbirds of 21 species. The early counts were dominated by Australian Shelduck and Banded Stilt, with Musk Duck recorded in very low numbers (1 in 1984, 5 in 1998). The main differences in recent counts are increases in Chestnut Teal, Grey Teal and Musk Duck and a decrease in Banded Stilt. The reasons for the variations in numbers of teal and Musk Duck are unclear. The decrease in Banded Stilt probably reflects the high water levels in recent years. The 1998 count, which was done from a boat, recorded 349 Hoary-headed Grebe. This species is usually missed from the air and seems likely to have been under-counted in the early 1980s.

Counts of ducks, coots and swans made in Gore each November between 1988 and 1991 were 3928 in 1988, 7741 in 1999, 12,172 in 1990 and 6147 in 1991 (Halse et al., 1995 and earlier publications) compared with 4812 in October 2006, 7815 in 2007 and 5647 in 2008. About 600 Pink-eared Ducks

were counted in November 1990 but this species was not recorded in the early 1980s, 2006 or 2007, highlighting that occurrence of some species is sporadic and determined by lake conditions. Eurasian Coot, which were seen in 1989 and 1990, were recorded only once in low numbers during October or November of the early 1980s counts and have not been seen recently although the habitat appears to be suitable.

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 Gidong, Coobidge 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 full, and the flow-through system was flooded south to Quallilup. Depth in Lake Coobidge was not estimated; depth in Lake Quallilup was not estimated.

Waterbird survey: The Coobidge to Quallilup contained 3780 waterbirds of 19 species. The numerically dominant species was Australian Shelduck and Black Swan. 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 November between 1988 and 1991. Totals of 5455 waterfowl were counted in 1988, 745 in 1989, 5761 in 1990 and 1788 in 1991 (Halse et al., 1995 and earlier publications) compared with about 2839 in 2006, 4755 in 2007 and 3361 in 2008. The dominant species in all earlier counts was the Australian Shelduck, with Black Swan and Eurasian Coot occurring in substantial numbers in 1990.

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: Only a small part of this system was flooded and depth was probably <0.5 m.

Waterbird survey: The Barker Inlet flow-through system was included in the Coobidge-Quallilup count in 2008. The system held few birds.

Previous surveys: The Barker Inlet flow-through did not contain water in 2006.

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 which the trees present have died. The river retains riparian vegetation in moderately good condition.

Extent of water and depth: The river channel was full at the time of survey.

Waterbird survey: The Dalyup River and associated wetlands supported 213 waterbirds of 7 species.

Previous surveys: The only previous spring count was October 2007, when the Dalyup system supported 653 waterbirds.

5.0 Discussion

The counts of about 3973 waterbirds of 44 species and 10,325 waterbirds of 21 species in the Lake Warden and Lake Gore complexes, respectively, in October-November 2008 highlight the different spring values of these two Ramsar sites. Lake Warden is used by a greater variety of species but lacks the very large moulting Australian Shelduck concentrations that swell the waterbird population of the Gore system in late spring.

Similar numbers of waterbirds are likely to occur in both systems during summer and autumn (e.g. 14,408 in Warden and 14,672 in Gore in February 2008).

5.1 Counting accuracy

The three monitoring surveys in spring 2006-2008 employed the same methods and counted the same wetlands or wetland sections (albeit with small ground count omissions some years, as noted in text). This was done to minimize differences in results across years due to differences in counting techniques rather than real changes in waterbird use of wetlands. However, it can be seen from 2006 and 2007, when ground and air counts were made either on the same or successive days, that there is often a difference between ground and aerial estimates of the waterbird population in a wetland. While generalisations can be made about likely errors in both ground and aerial counts, substantial differences in sequential counts will sometimes occur, no matter how precise and accurate counts are, because of waterbird movement between wetlands and feeding sites from one hour to the next. The large discrepancies in aerial and ground counts of the Windabout system in 2008 were caused by an influx of

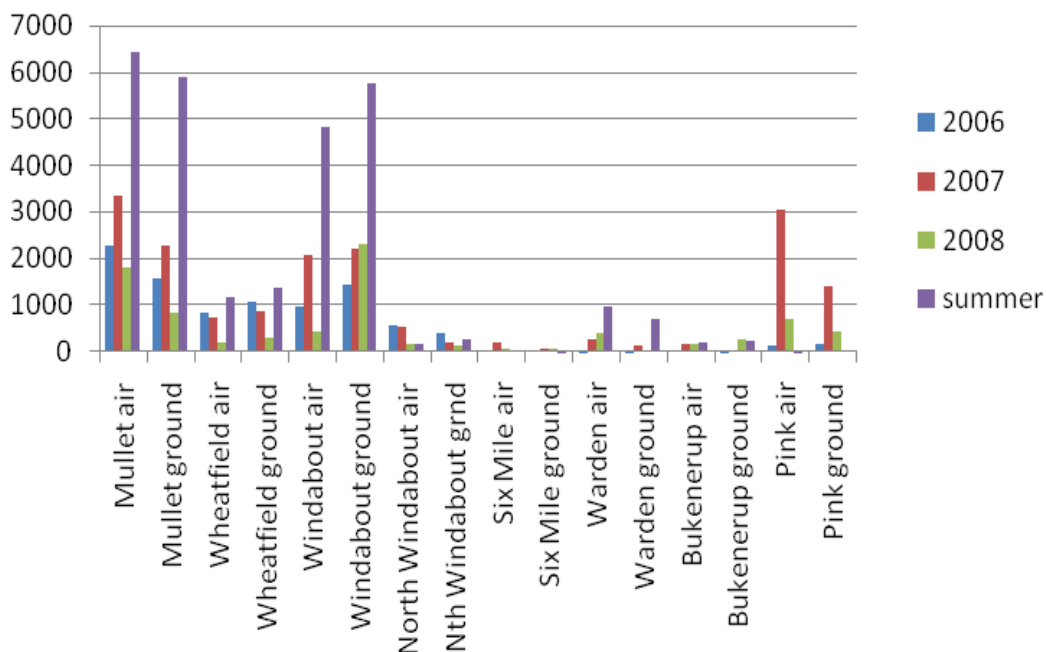


Fig. 5.1. Differences between ground and aerial counts at different wetlands in the Warden system during four surveys (October 2006, 2007, 2008 and February 2008 – summer)

Australian Shelduck and Hardhead during the two weeks between the aerial and boat surveys. We used the aerial survey values in analyses. The most common causes of error in ground counts are failing to gain access to the whole wetland, and double-counting (or ignoring) birds in large wetlands where the observer is required to move through the wetland. When birds are flushing and re-settling, it is difficult to determine whether birds in new areas (such as the next bay) have been counted before. The most common causes of error in aerial counts are failing to see birds that dive and small or cryptic species, observers becoming confused in the brief time available to make observations, and the plane being too far from the birds for accurate counting and identification.

Despite some counting errors, the results in Fig. 5.1 strongly suggest that both ground and aerial counting can be used successfully to document the differences between wetlands, or the seasonal and annual change experienced by one wetland. For example, the Mullet system clearly supports more birds than Wheatfield and the order of abundance across years at Mullet was summer 2008, spring 2007, spring 2006 and spring 2008. Comparison of ground and aerial counts elsewhere in south-western Australia gave similar results (Kingsford et al., 2008).

5.2 Waterbird use of the Lakes Warden and Gore systems

During spring, most of the waterbirds in the Lake Warden system occur in the Mullet or Windabout groups of wetlands or in Pink Lake (Fig. 5.2). These represent the main waterbodies in the system, other than Lake Warden itself (Fig 1.1). Numbers appear to fluctuate least in the Mullet group of wetlands [coefficient of Variation (CV) of 32%], while Pink Lake is characterised by extreme variability (CV of 118%) according to water depth (Table 5.1). Variability in Windabout was increased by the low 2008 count, which may be uncharacteristic. In contrast to waterbird numbers, species richness shows relatively little variation with a CV of only 6% in Windabout (Table 1).

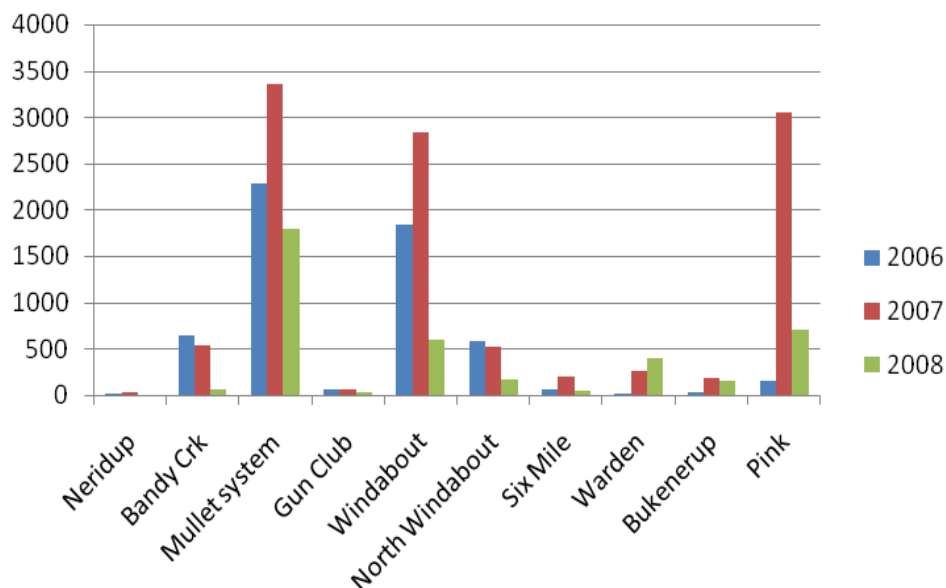


Fig. 5.2. Annual variation in spring waterbird numbers in the Lake Warden system based on aerial counts (Mullet system includes Ewans, Mullet, Station and Merivale Rd; Windabout system includes Wheatfield, Woody and Windabout)

Table 5.1. Numbers of waterbirds and numbers of species in spring 2006-2008 in the main waterbodies of the Lake Warden system, showing coefficients of variation for each waterbody and Lower and Upper 90 % Confidence Limits

	2006	2007	2008	CV (%)	LCL	UCL
<i>Abundance</i>						
Mullet	2284	3355	1791	32	1129	3825
Windabout	1842	2838	596	64	0	3652
Pink	146	3052	712	116	0	3901
Warden	14	260	400	87	0	554
Whole system	5695	11037	3973	53	692	13111
<i>Richness</i>						
Mullet	24	23	18	15	16	27
Windabout	29	33	31	6	28	34
Pink	4	9	4	51	1	11
Warden	12	14	13	8	11	15
Whole system	36	42	44	10	34	48

Approximately equal numbers of waterbirds occur during spring in the two main groups of wetlands in the Lake Gore system, namely Gore and the Coobidge-Quallilup overflow (Fig. 5.3). Coefficients of variation for waterbird abundance range from 27 to 35%, while those for richness range from 8 to 23% (Table 5.2). Species richness appears to be more variable at Lake Gore itself than the other wetlands (CV 23 vs 7-8%).

5.3 Monitoring waterbirds in the Lakes Warden and Gore systems

The best information about condition of any natural resource is provided by frequent monitoring, especially if resource condition fluctuates with seasonal and inter-annual climatic variations. However, frequent monitoring is often expensive and appropriate monitoring regimes are usually a trade-off between information loss and the cost of frequent monitoring. It was considered that monitoring one year in three should be sufficient at Lakes Warden and Gore but results of monitoring at intervals of three years are more difficult to analyse than two clusters of three years separated by six years of no monitoring. The latter design is more likely to enable the effects of the anthropogenic influences on waterbird numbers to be separated from annual climatic effects (see Green, 1979).

Table 5.2. Numbers of waterbirds and numbers of species in spring 2006-2008 in the main waterbodies of the Lake Gore system, showing coefficients of variation for each waterbody and Lower and Upper 90 % Confidence Limits

	2006	2007	2008	CV (%)	LCL	UCL
<i>Abundance</i>						
Gore	4914	8316	4616	35	2483	9414
Coobidge overflow	3114	5278	3780	27	2189	5926
Whole system	8030	14315	10325	29	5528	16252
<i>Richness</i>						
Gore	17	17	11	23	9	21
Coobidge overflow	21	19	18	8	17	22
Whole system	24	22	21	7	20	25

Useful information about trends in waterbird use of the Lakes Warden and Gore systems will not be possible until the second three years of monitoring is undertaken. Data from earlier surveys has been shown to provide little information about waterbird trends when compared to waterbird numbers recorded during recent monitoring because of greater survey efficiency, and more accurate counts, in the recent monitoring (Robertson & Massenbauer, 2005). Prior to the second band of monitoring, however, the upper and lower confidence limits shown in Tables 5.1 & 5.2 provide an indication of the likely variability in waterbird numbers and richness during any one year, as a result of climatic fluctuations, while the wetland systems remain in their current ecological state. This climate-induced variability highlights how difficult it is to interpret a single year of monitoring.

High count variability means that Pink Lake and many of the small wetlands in the Warden system will always be difficult to monitor meaningfully and the best data will come from the Mullet and Windabout systems and from an amalgamation of all wetlands in the Warden system (see Table 5.1).

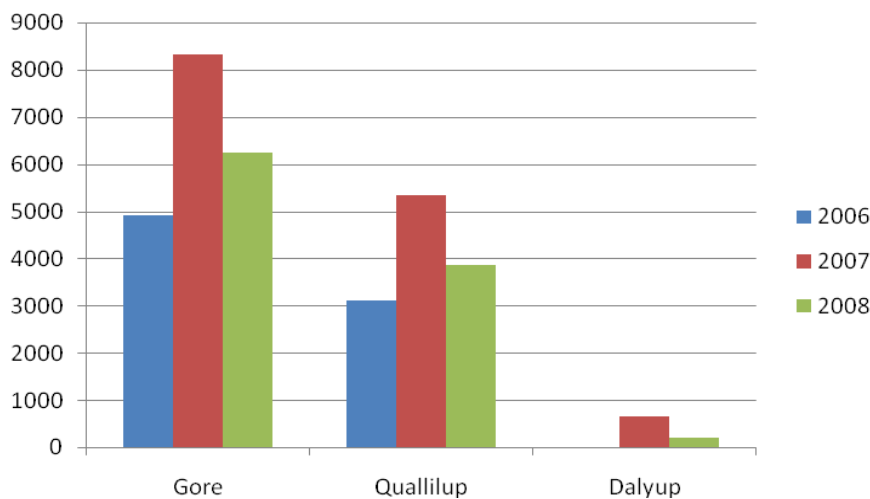


Fig. 5.3. Annual variation in spring waterbird numbers in the Lake Gore system based on aerial counts

5.4 Ramsar criteria

During spring 2007 and summer 2008, the Lake Warden system contained 11,037 waterbirds in October and 14,408 in February. This exceeds the threshold that existed for Ramsar nomination in 1990, when the wetland was listed (criterion 3a – regularly supports more than 10,000 waterbirds). This criterion was met shortly before nomination (12,636 waterbirds in the Mullet system, Windabout system and Ewans, Jaensch et al., 1989). It is unlikely the threshold was reached in February 2007 or 2009. More importantly, it is unlikely that the current criterion for waterbird numbers (20,000) is met regularly.

During spring 2007 and summer 2008, the Lake Gore system contained 14,315 waterbirds in October and 14,622 in February. It contained 10,325 waterbirds in October 2008. Lake Gore itself contained 11,267 waterfowl in March 1991. The only record of more than 20,000 waterbirds is from March 1988, when 20,000 Banded Stilt occurred (Anon. 2000). While it is likely that the system will occasionally contain 20,000 waterbirds (revised criterion 5 – regularly supports more than 20,000 waterbirds) in future years of appropriate water depth and climatic conditions, there are no other past records of this occurring.

5.5 Recommendations

Further waterbird monitoring should be undertaken, with the methodology outlined in this report, to assess changes in waterbird use of the Lakes Warden and Gore systems as a measure of wetland condition.

- Monitoring should commence no later than October 2015 and be conducted annually for a period of 3 years.
- If any major anthropogenic change is expected, or major management activity is undertaken, monitoring should be undertaken for a 3 year period after the change occurs or is implemented.
- Species richness is relatively stable compared with waterbird abundance and should be considered as an indicator of waterbird use.
- Consideration should be given to monitoring in October and February of spring/summers when hydrological and climatic conditions are likely to be particularly favourable on the Esperance coast to assess whether either Ramsar system meets the current waterbird abundance criterion for a Wetland of International Importance.

6.0 Acknowledgments

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Appendix 1. Results of waterbird counts in spring 2006-2008

Waterbird counts of Warden and Gore wetlands 2006-2008								
	Oct-06		Oct-07		Feb-08		Oct/Nov-08	
	Air	Ground	Air	Ground	Air	Ground	Air	Ground
LAKE WARDEN SYSTEM								
Neridup complex								
Black Swan			4				1	
Australian Shelduck			1					
Pacific Black Duck	14		11					
Grey Teal			10					
Little Pied Cormorant	1							
Great Egret	1							
Subtotal	16	0	26	0	0	0	1	
Bandy Creek pans complex								
Blue-billed Duck							1	
Musk Duck					4			
Black Swan	38		197		10		31	
Australian Shelduck	107		75				21	
Pacific Black Duck	185		110		4		5	
Australian Shoveler	158		20					
Grey Teal	87		10					
Chestnut Teal			60					
Unidentified Duck					5			
Hoary-headed Grebe			4					
Darter					2			
Little Pied Cormorant	1		2		5		2	
Little Black Cormorant	3						2	
White-faced Heron	23		1		2			
Great Egret	7		2				1	
Australian White Ibis					2			
Straw-necked Ibis	3						2	
Eurasian Coot					50			
Common Greenshank			47		1		1	
Black-winged Stilt	6						2	
Banded Stilt	30							
Unidentified wader			6					
Subtotal	648	0	534	0	85	0	68	0
Ewans/Mullet/Station complex								
Ewans/Mullet combined								
Musk Duck	22		22	3			129	
Black Swan	88		576	166	108	77	576	
Australian Shelduck	956		1519	373	65	2	820	
Pacific Black Duck	78		324	120	346	82	2	
Australasian Shoveler	22		30	23	410	692		
Grey Teal	70		2	30	202	459	80	
Chestnut Teal	45		94	14	32	27		
Hardhead	10							
Hoary-headed Grebe	1		45	94		58		
Great Crested Grebe	1							
Little Pied Cormorant	2		1		8	1	34	
Little Black Cormorant	10		19	5			14	
Australian Pelican	2			3	8	8		
White-faced Heron	2			1	2	2	3	
Great Egret	19		13	4	2	1	3	
Australian White Ibis			1	4				

Waterbird counts of Warden and Gore wetlands 2006-2008									
	Oct-06		Oct-07		Feb-08		Oct/Nov-08		
Straw-necked Ibis	2		2						
Yellow-billed Spoonbill	6		5	5	2		4		
Marsh Harrier									
Eurasian Coot					30		88		
Common Greenshank	8		31	2	2		22	1	
Ruddy Turnstone				2					
Red-necked Stint				1					
Sharp-tailed Sandpiper									
Banded Stilt	12								
Red-necked Avocet									
Red-capped Plover					6		3		
Unidentified wader	15							5	
Silver Gull					2		3		
Whiskered Tern	1								
<i>Tally</i>	1372	0	2684	856	1219		1529	1667	0
Mullet									
Musk Duck		79		17	31		22		73
Black Swan		68		104	164		118		160
Australian Shelduck		100		458	80		61		125
Pacific Black Duck		130		25	113		134		
Australasian Shoveler				16	57		25		
Grey Teal		60		10	240		150		
Chestnut Teal		40			70				
Unidentified Ducks		250							
Hoary-headed Grebe		11		105					13
Great Crested Grebe		24		20					4
Little Pied Cormorant		9		1					
Little Black Cormorant		5							
Australian Pelican				1					
White-faced Heron		1		3	1		1		
Great Egret		1		2					
Australian White Ibis		1		1					
Straw-necked Ibis		1		2					
Yellow-billed Spoonbill				2					
Common Greenshank					11		16		
Red-necked Stint							107		
Banded Stilt					3510		2800		
Red-necked Avocet							16		
Red-capped Plover							28		
Silver Gull					30		4		
<i>Tally</i>	0	780	0	767	4307		3482	0	375
Station									
Musk Duck		1							1
Black Swan	174	231	250	207	2				136
Australian Shelduck	228.5	85	100	127					15
Pacific Black Duck	87.5	35	30	49					13
Australian Shoveler	5	0		2					2
Grey Teal	68	152	10	6					62
Chestnut Teal	30	30							9
Hoary-headed Grebe	0	57	1	31					17
Little Pied Cormorant	6	5							
Little Black Cormorant	8		15						
Australian Pelican				1	5				

Waterbird counts of Warden and Gore wetlands 2006-2008								
	Oct-06	Oct-07		Feb-08		Oct/Nov-08		
White-faced Heron	7	3		4	7			
Great Egret	4	2		4				
Australian White Ibis		2		1				
Straw-necked Ibis	1	1		20				
Yellow-billed Spoonbill	4	3		4				
Common Greenshank				1			3	
Curlew Sandpiper							210	
Red-necked Stint							370	
Banded Stilt					10		5	
Red-necked Avocet		1			177		280	
Red-capped Plover							6	
Hooded Plover		3						
Unidentified wader		1			700			
Silver Gull	20				18			
<i>Tally</i>	643	612	406	457	919	874	0	255
Merivale Road wetlands (north of Ewans/Mullet/Station)								
Black Swan	68	60	39	21			32	92
Australian Shelduck	128	26	105	85			67	95
Pacific Black Duck	47	62	61	49			4	14
Australasian Shoveler				1				2
Grey Teal			32	11				8
Chestnut Teal		20	14	20				2
Pink-eared Duck			5					
Hardhead							3	
Hoary-headed Grebe				1				
Little Pied Cormorant	5	0						
Little Black Cormorant			2					
Australian Pelican							1	
White-faced Heron	9	1	4	2				1
Great Egret	5	0	2	1			2	1
Australian White Ibis	1	2						
Straw-necked Ibis	3	0	1	1				
Yellow-billed Spoonbill	2	1					15	
Silver Gull	1	0						
<i>Tally</i>	269	172	265	192	0	0	124	215
Subtotal	2284	1564	3355	2272	6445	5885	1791	845
Gun Club suite								
Musk Duck		1					12	
Black Swan					35	32		
Australian Shelduck					50			
Australian Wood Duck								2
Pacific Black Duck		6			40			1
Australasian Shoveler					80	87		
Grey Teal		12			270	658		
Chestnut Teal		18	20			12		2
Hardhead	40	29						
Unidentified duck	25	0						
Hoary-headed Grebe		17	1	16				
Little Pied Cormorant			1	1			1	
White-faced Heron			3					
Straw-necked Ibis			3					
Yellow-billed Spoonbill							1	

Waterbird counts of Warden and Gore wetlands 2006-2008								
	Oct-06	Oct-07		Feb-08		Oct/Nov-08		
Eurasian Coot		2				18		
Common Greenshank						1		
Red-necked Avocet					15			
Subtotal	65	85	28	17	490	808	14	5
Wheatfield								
Blue-billed Duck			2					
Musk Duck	19	24			5	3		
Black Swan	11		1		1		2	
Australian Shelduck	187	25					36	41
Pacific Black Duck	36	174	7		236	388	3	7
Australasian Shoveler					11	40		12
Grey Teal	50	304	10		303	299		12
Chestnut Teal	55	45	16		72	59		18
Pink-eared Duck					50	52		
Hardhead	57	130			101	40		
Hoary-headed Grebe	0	8			70	73		6
Great Crested Grebe	8	2				2		
Darter	1	1	1		5	24	3	3
Little Pied Cormorant	0	3	10		3	1	3	2
Pied Cormorant					1		2	
Little Black Cormorant	241	178	108		187	72	5	36
Great Cormorant	1	5	5		5	5	6	6
Australian Pelican	4		15		21	9	6	20
White-faced Heron	1	2	5		7	5		3
Little Egret								1
Great Egret	11	4	14		1	5		1
Rufous Night Heron				2				
Glossy Ibis			70					
Australian White Ibis	6	7			1	3		2
Straw-necked Ibis	89	34	350		6	31	103	70
Yellow-billed Spoonbill	32	48	51		63	88	12	16
Marsh Harrier		1						
Spotless Crake						6		
Eurasian Coot	30	63	52		18	116	1	12
Common Greenshank	10	0			5	33		
Common Sandpiper		4				2		3
Black-winged Stilt	2	0						
Black-fronted Plover						14		1
Red-kneed Dotterel						4		
Banded Lapwing			30					
Unidentified wader					10			
Silver Gull					5	3		
Whiskered Tern								5
Subtotal	851	1062	747	2	1187	1377	182	277
North Wheatfield suite								
Musk Duck								2
Australian Shelduck			2					10
Pacific Black Duck			8			20		
Grey Teal								5
Chestnut Teal			4			3		
Hoary-headed Grebe			3			33		
Darter			6		3	3		
Little Pied Cormorant	1		2					

Waterbird counts of Warden and Gore wetlands 2006-2008								
	Oct-06	Oct-07		Feb-08		Oct/Nov-08		
Little Black Cormorant	6		2				1	
Australian Pelican							1	
White-faced Heron	1		2			1		
Great Egret	1		1			1		
Australian White Ibis	1		1					
Yellow-billed Spoonbill			1				1	
Eurasian Coot			6					
Common Greenshank	1				29	29		
Black-fronted Plover						14		
Red-kneed Dotterel						4		
Subtotal	11	0	38	0	32	108	20	0
Windabout complex								
Woody								
Musk Duck		1			6	16		2
Freckled Duck						1		
Black Swan					150	37	5	
Australian Shelduck		12						1
Pacific Black Duck		28			277	501		10
Australasian Shoveler					4	2		
Grey Teal					100	563		4
Chestnut Teal		7			97	159		2
Pink-eared Duck					5	18		
Hardhead		4			5	6		31
Unidentified Ducks					500			
Hoary-headed Grebe					20	83		3
Darter						1		2
Little Pied Cormorant		4	3					
Little Black Cormorant		20	51			4		
Great Cormorant								1
Australian Pelican						1		
White-faced Heron		1			2	1		
Great Egret		2			3	7		
Australian White Ibis						2		
Straw-necked Ibis								
Yellow-billed Spoonbill						10		
White-bellied Sea-eagle					1			
Eurasian Coot		23				63		21
Common Greenshank						5		
Common Sandpiper					2			
Caspian Tern						1		
Whiskered Tern								14
<i>Tally</i>	0	102	54	3	1172	1481	5	91
Windabout								
Blue-billed Duck			3					3
Musk Duck	2	5	4		557	434	5	6
Freckled Duck						4		
Black Swan	93	41	43		916	779	180	30
Cape Barren Goose	2	5			20	43	11	1
Australian Shelduck	318	110	122		73	166	69	1417
Pacific Black Duck	117	263	36	10	593	882	28	76
Australasian Shoveler						26		1
Grey Teal	100	265	30		720	366	2	12
Chestnut Teal	64	225	18	10	201	607		62

Waterbird counts of Warden and Gore wetlands 2006-2008								
	Oct-06	Oct-07	Feb-08	Oct/Nov-08				
Pink-eared Duck						60		90
Hardhead	1	3	1440	220	100	123	7	251
Hoary-headed Grebe		13	2	6	10	53	9	35
Great Crested Grebe		3	6					2
Darter	6	1	6		10	8	6	3
Little Pied Cormorant	25	3	3		1	5		2
Little Black Cormorant	127	110	129	1	1		5	5
Great Cormorant						1	1	32
Australian Pelican	2	2	3		12	40	1	4
White-faced Heron	3	4	1	1	9	7	2	1
Great Egret	14	4	2		7	7	2	2
Rufous Night Heron						2		
Australian White Ibis	2	1						
Straw-necked Ibis			3					3
Yellow-billed Spoonbill	3	6	4		21	18		2
Marsh Harrier		1						
Spotless Crake						2		
Black-tailed Native-Hen		2		3				10
Eurasian Coot	110	263	180	20	295	600	50	83
Common Greenshank		2			1			
Common Sandpiper				5				
Black-winged Stilt	1	0	2					
Masked Lapwing	1	0						
Silver Gull		1			90	53		
Gull-billed Tern							2	
Caspian Tern					1	2		
Whiskered Tern		6					29	106
<i>Tally</i>	991	1339	2037	276	3638	4288	409	2239
Subtotal	991	1441	2091	279	4810	5769	414	2330
North Windabout								
Musk Duck		1		2				3
Black Swan	65	77	188	127	82	81	65	72
Australian Shelduck	319	169	118	3	10	5	26	5
Pacific Black Duck	130	40	2					
Australasian Shoveler	2	46						
Grey Teal	15	1		3				1
Chestnut Teal	18							
Hoary-headed Grebe		17	2	14		6	3	46
Great Crested Grebe		1						
Darter			2		2			
Australian Pelican			2	2			10	
Little Pied Cormorant	1				2			
Little Black Cormorant			9		2			
White-faced Heron	13	5	5	1	3	2	7	
Great Egret	5	4	2	1	2			
Glossy Ibis			15					
Australian White Ibis	1			3				
Straw-necked Ibis	6			1				
Yellow-billed Spoonbill			1					
Marsh Harrier	1							
Eurasian Coot	4		149	25				
Common Greenshank	5		15	1		6	6	1
Red-necked Stint		41						
Black-winged Stilt			10			4	50	

Waterbird counts of Warden and Gore wetlands 2006-2008								
	Oct-06	Oct-07		Feb-08		Oct/Nov-08		
Red-necked Avocet	2	6		70		176		
Red-capped Plover		9						
Hooded Plover		2						
Whiskered Tern				18			5	3
Subtotal	587	419	520	201	173	280	172	131
Six Mile wetlands								
Musk Duck			1					
Black Swan	3	7		11			8	5
Australian Shelduck	1	32		8			10	
Pacific Black Duck	6	35		8				9
Australasian Shoveler		30		2				
Grey Teal	40						2	
Chestnut Teal	1	19		6				2
Little Pied Cormorant	1	3		2			1	
Little Black Cormorant	1	2		1				
White-faced Heron	5	28		11				
Eurasian Coot		29						
Great Egret		3		2				
Yellow-billed Spoonbill		1						
Straw-necked Ibis		1		1				
Common Greenshank	2	2		12		2		5
Black-winged Stilt		12					2	
Sharp-tailed Sandpiper						2		5
Red-kneed Dotterel								1
Unidentified wader							20	
Whiskered Tern							0	35
Subtotal	60	0	205	64	0	4	43	62
Warden								
Musk Duck	1	5	10	6	396	411	25	1
Black Swan	2		1	4	50	41	21	
Australian Shelduck	1		5	2		6	28	
Pacific Black Duck	4						2	
Chestnut Teal	1							
Hoary-headed Grebe		2	2	34	316	97		3
Great Crested Grebe		1		2		11		
Darter	1		1					
Little Pied Cormorant	1							
Little Black Cormorant			11	4	134		182	
Australian Pelican			1		1		1	
White-faced Heron	1	1	5		1	12	2	
Great Egret	1		2					1
Yellow-billed Spoonbill			7					
Marsh Harrier	1							
Common Greenshank			19					
Red-necked Avocet					20	44		
Silver Gull			74	17	50	96	5	
Gull-billed Tern							3	
Caspian Tern						2	1	
Crested Tern						1		
Whiskered Tern			122	52			130	20
Subtotal	14	9	260	121	968	721	400	25

Waterbird counts of Warden and Gore wetlands 2006-2008								
	Oct-06		Oct-07		Feb-08		Oct/Nov-08	
Bukenerup complex								
Musk Duck					4		31	
Black Swan					1			
Australian Shelduck	6		2	2	88	2	70	172
Pacific Black Duck	2		3	1	10			4
Australasian Shoveler			1					
Grey Teal			1		29		12	4
Chestnut Teal			79	12	7	6		24
Hoary-headed Grebe			3	23	20	95		5
Great Crested Grebe			12	3				
Darter							1	
Little Black Cormorant	3		10	1		1	42	
Australian Pelican			1	1	13	56	16	1
White-faced Heron	1	1	3	2	3	4		13
Great Egret	1	1	3	2		2	3	11
Australian White Ibis	2	1	2					
Straw-necked Ibis			2					
Yellow-billed Spoonbill			2	1			1	4
Common Greenshank		1	2			3	10	3
Wood sandpiper						2		3
Red-necked Stint						9		
Sharp-tailed Sandpiper						6		
Black-winged Stilt	1		54		27	13		
Red-necked Avocet	2							
Black-fronted Plover						2		
Hooded Plover	2							
Masked Lapwing	1				1			4
Unidentified wader	1		1		5			
Whiskered Tern							1	
Subtotal	22	4	181	48	208	232	156	248
Pink								
Cape Barren Goose					2			
Australian Shelduck	12	30	37				368	
Unidentified ducks								40
White-faced Heron			1					
Red-necked Stint		37	330	131				
Banded Stilt	6	12	2290	970				
Red-necked Avocet			10	24			70	189
Red-capped plover		78	50	86				10
Greater Sand Plover			2	3				
Hooded Plover			2	6	8			4
Unidentified wader	121	0	329	201			100	170
Silver Gull	7	0	1				54	8
Caspian Tern								2
Whiskered Tern							120	
Unidentified Tern			0	1				
Subtotal	146	157	3052	1422	10	0	712	423
WARDEN SYSTEM TOTAL	5695	4741	11037	4426	14408	15184	3973	4346
LAKE GORE SYSTEM								
Gore								
Musk Duck	80		9				3	
Black Swan	51		577		26		123	

Waterbird counts of Warden and Gore wetlands 2006-2008								
	Oct-06		Oct-07		Feb-08		Oct/Nov-08	
Australian Shelduck	4141		6789		3351		5331	
Pacific Black Duck	28		1					
Australasian Shoveler	10							
Grey Teal	183		157		28		190	
Chestnut Teal	319		282		884			
Unidentified duck	4							
Great Crested Grebe	3							
Little Pied Cormorant	1		2		1			
Little Pied Cormorant							2	
Little Black Cormorant			88		1			
Australian Pelican			15					
White-faced Heron	14		39		2		1	
Great Egret			7					
Australian White Ibis	1				4			
Yellow-billed Spoonbill			54		1			
Eurasian Coot					4			
Common Greenshank	1		15		4		1	
Black-winged Stilt	3		57		12		92	
Banded Stilt	10							
Red-necked Avocet	60		202		140		480	
Banded Lapwing			3					
Masked Lapwing	2							
Unidentified wader			2		3		15	
Silver Gull	3		17		155		1	
							3	
Subtotal	4914	0	8316	0	4616	0	6242	0
Kubitch to Quallilup flow-through								
Blue-billed Duck			2					
Musk Duck	10		1					
Black Swan	55		1314		447		601	
Australian Shelduck	2466		3227		1470		2634	
Pacific Black Duck	54		37		70		4	
Australasian Shoveler	8							
Grey Teal	86		33		554		35	
Chestnut Teal	148		134		96		2	
Pink-eared Duck	10							
Hardhead	1							
Darter	1		2		43		7	
Little Pied Cormorant	1		1		43		4	
Pied Cormorant					7			
Little Black Cormorant	122		15		1434		86	
Great Cormorant	5		1		3		4	
Australian Pelican	10		4		29		12	
White-faced Heron	10		8		93		2	
Great Egret			17		147		6	
Glossy Ibis					1			
Australian White Ibis					34		1	
Straw-necked Ibis			1					
Yellow-billed Spoonbill			17		23		10	
Eurasian Coot			274		310		228	
Common Greenshank	1		16		50		1	
Black-winged Stilt	4				12			
Banded Stilt	7				3860			
Red-necked Avocet	112				260			

Waterbird counts of Warden and Gore wetlands 2006-2008								
	Oct-06		Oct-07		Feb-08		Oct/Nov-08	
Unidentified wader	1		1		460		140	
Silver Gull	1		2		32		2	
Caspian Tern	1						1	
<i>Tally</i>	3114	0	5107	0	9478	0	3780	0
Barker Overflow								
Black Swan			22					
Australian Shelduck			32					
Grey Teal			4					
Chestnut Teal			25					
Eurasian Coot			5					
Little Pied Cormorant			82					
Darter			1					
<i>Tally</i>	0	0	171	0	0	0	0	0
Subtotal	3114	0	5278	0	9478	0	3780	0
Quallilup								
Australian Shelduck	2		7				85	
Darter					1		1	
Little Pied Cormorant					1		1	
Little Black Cormorant			57		53		1	
Great Cormorant			1		1			
Australian Pelican			3		1			
White-faced Heron					2		1	
Yellow-billed Spoonbill					1			
Common Greenshank					1			
Caspian Tern					2			
Silver Gull					65		1	
Subtotal	2	0	68	0	128	0	90	0
Dalyup River								
Musk Duck							1	
Black Swan			5				5	
Australian Shelduck			344				73	
Pacific Black Duck					22			
Grey Teal			55		96		120	
Chestnut Teal					21			
Little Pied Cormorant							1	
Little Black Cormorant							3	
Darter					3			
Australian Pelican			15				0	
Yellow-billed Spoonbill			30				0	
Marsh Harrier					2			
Common Greenshank					2		0	
Black-winged Stilt					140		10	
Red-necked Avocet			200		110		0	
Banded Lapwing					4			
Unidentified wader			2				0	
Silver Gull			2				0	
Subtotal			653		400		213	
GORE SYSTEM TOTAL	8030		14315		14622		10325	
GRAND TOTAL	13725	4741	25352	4426	29030	15184	14298	4346