A Waterbird Census of the Lake Warden and Lake Gore Wetland Systems, October 2006

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Contents

1 INTRODUCTION

The Lake Warden wetland system was nominated by the State Government as a Wetland of International Importance in 1990 and the catchment in which it occurs was made a Natural Diversity Recovery Catchment under the State Salinity Strategy in 1997.

The Lake Warden system emerged from the sea during the Holocene and the eastern part of the system remains naturally connected, intermittently, 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 an invertebrate fauna that reflects their marine origin. For example, salinities in Lake Wheatfield (Fig. 1) range between about 8 and 14 g L^{-1}. Species that reflect the marine connection at Wheatfield are the estuarine amphipod *Melita kauerti*, the widespread estuarine copepod *Gladioferans imparipes* that also occurs in Lake Gardner at Two Peoples Bay, the estuarine or freshwater shrimp *Palaemonetes australis*, and the ostracods *Cyprideis australiensis* and *Leptocythere lacustris* (also in Lake Preston, south of Mandurah). The ostracod *Kennethia cristata* , although as freshwater species, is reflects marine connections when found in subsaline water.

Station Lake in the eastern part of the system (Fig. 1) has 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).

Previous surveys of waterbirds have identified the Lake Warden system as important waterbird habitat and waterbird values were much of the reason the system was nominated as a Ramsar wetland. With a maximum count of 16,919 waterbirds in November 1992, Lake Warden supported the 4th highest waterbird count of 285 wetlands surveyed in south-western Australia between 1981 and 1985 (Jaensch et al., 1989). The system contains the most important habitat in Western Australia for Hooded Plover with maximum counts of 539 at Warden (April 1988) and 99 at Station Lake (February 1985).

The Lake Gore system (Fig. 2) has long been recognized as significant for waterbirds and was nominated by the State Government as a Wetland of International Importance in 2000. The system is of Holocene origin and naturally subsaline although Lake Gore itself and upstream lakes are affected by dryland salinization and water volumes, as well as salt loads, have increased since land clearing although no trends at Gore were obvious between 1979 and 2000 (Lane et al., 2004). Salinities at Gore, which is semi-permanent, range from about 10 to 80 g L^{-1}.

Waterbird values were the reason for nominating Lake Gore as a Ramsar wetland and, with a maximum count of 13,505 in November 1984, Gore supported the 7th highest number of waterbirds of 285 wetlands surveyed between 1981 and 1985 [Jaensch et

Fig. 1. The Lake Warden system showing the wetlands surveyed in October 2006

al., 1989 (database suggests count was actually 14179)]. The highest recorded count of waterbirds at Gore is 29,273 but 20,000 of these were Banded Stilt, a species which often occurs at Gore in large numbers in spring and summer. 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.

Many waterbird surveys have occurred over the past 25 years in the Lakes Warden and Gore systems but since the Lake Warden system was nominated as a Natural Diversity Recovery Catchment, structured waterbird monitoring has occurred at Wheatfield Lake (Cale et al., 2004). A comparison of Cale et al.'s surveys with results of other survey sets for Wheatfield suggests that results are very strongly influenced by methodology and may vary by a factor of about four between survey sets (Robertson & Massenbauer, 2005). It is likely that results for waterbird abundance are similarly variable.

The purpose of surveying waterbirds in the Lakes Warden and Gore systems in October 2006 was to provide standardized baseline information about waterbird species composition abundance in both systems. They provide an extremely important drought refuge for many species of water birds and as a result of the national, state and regional drought during this period, this value requires quantifying in association with salinity and waterlogging threats. The systems are being managed largely for their waterbird values and water level criteria have been derived for the Warden system that should be appropriate for the maintenance of waterbird values (Robertson & Massenbauer, 2005). However, a consistent waterbird survey methodology is required to evaluate whether waterbird populations are being maintained.

The specific objectives of the survey were:

1. To compare aerial and ground count data for the same wetlands of the Lake Warden system.
2. To document waterbird use of the different wetlands and wetland suites within the two lake systems.
3. To provide comprehensive data on waterbird activity in each system in spring 2006 as a baseline against which to assess future changes in waterbird numbers.

Results of the spring survey are compared with previous waterbird surveys and interpreted in terms of conditions at the time of survey and historical information on waterbird numbers in the two systems.

2 METHODS

2.1 WETLAND SYSTEMS

Maps of the Lakes Warden and Gore systems are provided in Figs 1 and 2. All waterbodies were surveyed between 11 and 13 October 2006. Local conditions at the time of survey were extremely dry with rainfall from June to October totaling only

about 200 mm and evaporation being about 530 mm. Lake levels were decreasing rapidly yet, because of hydrological change over the last 20 years, water levels were

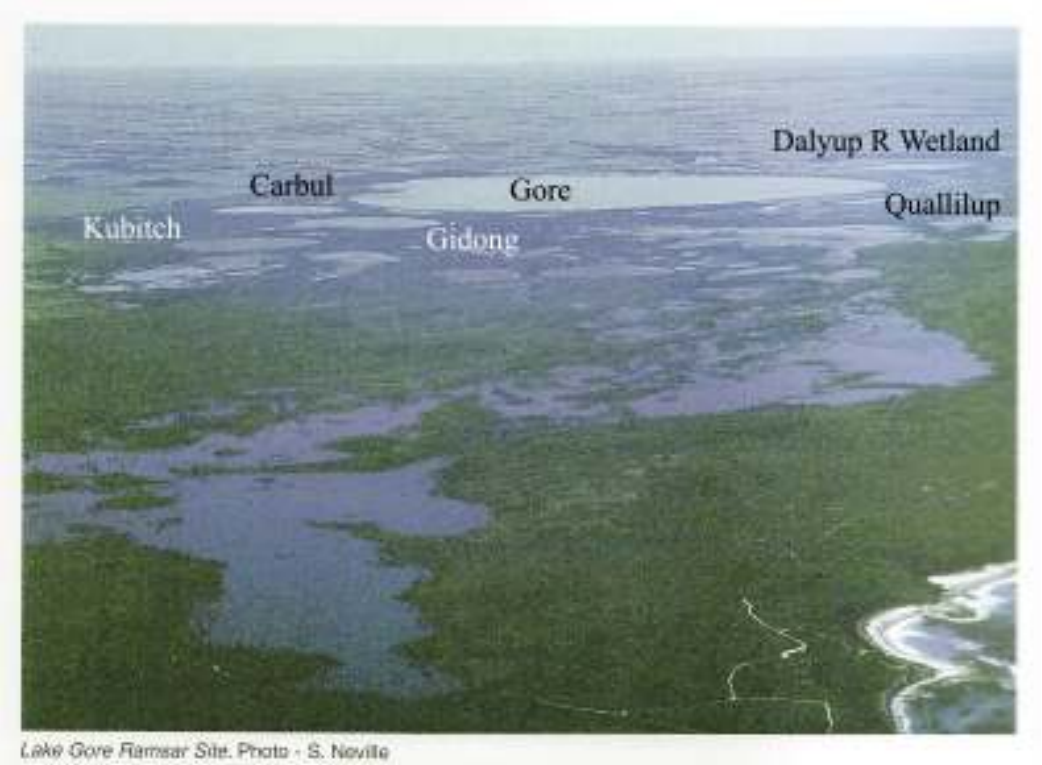

Fig. 2 Lake Gore system, viewed from Barkers Inlet in a very wet year, showing the wetlands surveyed (Lake Quallilup extends to right of photo) (from Anon. 2000). Barker Inlet wetlands dry in October 2006

mostly still high in relation to established wetland boundaries and there was very little habitat for shorebirds. Owing to the hot weather and low rainfall, filamentous algae was clearly evident throughout the systems.

It is important to note that the dry period during which surveys were done coincides with a regional, state and national drought, which has resulted in significant reduction in inland aquatic habitats available to water birds.

2.2 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 surveys were flown using a Cessna 172 flying at a height of 25 to 30 m and speed of 60 to 80 knots with a single front-seat observer (SH). Large wetlands were orbited anticlock-wise, about 70 m inside the wetland boundary, and waterbirds on the shore and in the wetland margins were counted. Conditions were very windy during the surveys, especially on 11 October, and sub-optimal for counting because birds were sheltering under vegetation and reluctant to take flight. Furthermore it was difficult to position the plane ideally in relation to the edge of the wetland etc. 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. No birds occurred in the centre of large wetlands, probably because of the windy conditions. Identifications and estimates of numbers were made with the naked eye and results recorded on digital tape for later transcription to datasheets.

Lakes Wheatfield, Woody and Windabout were surveyed in a small punt by SH, Ken Read and Tilo Massenbauer 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 but with short detours into areas of open water within the stands of trees. To avoid excessive disturbance, little attempt was made to count accurately in the flooded trees on the south side of Wheatfield, where colonies of cormorants and other birds were breeding. Bird identifications were mostly made using binoculars and results were recorded in a notebook.

Most wetlands other than Woody and Windabout were surveyed on the ground. Observations were made from vantage points around the wetland using a spotting scope and an attempt was made to view all parts of the wetlands and count all birds present. This did not happen at Wheatfield, however, were observations were made only from the bird hide on the south side of the lake. Results were recorded in a notebook.

3 WATERBIRD COUNTS

3.1 LAKE WARDEN SYSTEM

3.1.1 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 of unknown depth but probably retain water year-round.

Waterbird survey: Waterbirds were surveyed by plane on 11 and 12 October. No birds were recorded on 11 October but 29 Pacific Black Ducks, 1 Little Pied Cormorant and 1 Great Egret occurred on 12 October (Table 1). While it is possible some ducks were present on 11 October but not sighted, the differences in counts of the two days is likely to reflect the extent of movement that occur within wetland systems.

Previous surveys: There are no previous recorded surveys of the linear wetlands, which are unlikely to contain significant numbers of waterbirds at any time in relation to waterbird use of the Lake Warden system as a whole

3.1.2 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 wetlands were three-quarters full at the time of survey and all had a narrow band of open shoreline. Depth is unknown but the wetlands were likely to be moderately shallow. They dry most summers.

Waterbird survey: Totals of 743 waterbirds of 10 species and 555 waterbirds of 9 species were counted on 12 and 12 October, respectively (Table 1). Altogether 12 species were seen with Grey Teal, Pacific Black Duck, Chestnut Teal and Australian Shelduck the most abundant species.

Previous surveys: There are no previous recorded surveys of the Bandy Creek complex, which is likely to sometimes contain up to one-quarter of all waterbirds in part of the Lake Warden system east of Norseman Road.

3.1.3 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. Most of the wetlands around Mullet and Ewans were included in the counts of these wetlands but it was difficult to be consistent in how this was done during aerial surveys. Station Lake is usually seasonal and, together with a couple of satellite wetland areas forms a more discrete wetland body. 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.

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.

Extent of water and depth: The large lakes were nearly full at the time of counting, with a narrow band of bare shoreline around parts of all lakes. The Merivale Road wetlands were three-quarters full with more bare shoreline. Depth in Ewans was 0.8 m, Mullet was 1.2 m and Station was 0.68 m.

Waterbird survey: A total of 25 species were recorded in two aerial surveys on 11 and 12 October and one ground count on 12 October. About 2000 waterbirds were recorded each count (Table 1). The numerically dominant species were Australian Shelduck, Black Swan, Pacific Black Duck, Grey Teal and Chestnut Teal. Species of interest were Musk Duck (maximum count 80), Great Crested Grebe (24) and Hooded Plover (3). Counts of individual species were quite variable across the surveys and, while some of the variation in numbers of duck species may have related to mis-identification, the occurrence of other species undoubtedly showed true daily variability (e.g. Silver Gull).

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 2006 counts, apart from the overall differences the fact that 2006 was higher in terms of total numbers and species richness, were the lower numbers of dominant duck species in the 1980s (Black Swan numbers were similar) and the absence of Eurasian Coots in 2006.

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 October 2006.

3.1.4 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 semi-permanent wetland fringed by *Melaleuca*, which is dense at northern end.

Extent of water and depth: Depth was unknown but likely to be approximately 0.5 m or less.

Waterbird survey: About 80 birds of 7 species occurred on this wetland on 11 and 12 October but there were significant discrepancies between aerial and ground counts (Table 1). While there may have been species turnover between 11 and 12 October, small vegetated wetlands can be difficult to survey from the air and it is likely that this wetland requires repeated aerial passes before most species will be seen. The small size of the wetland makes ground counting straightforward.

Previous surveys: There are no previous recorded surveys of the flow though wetland, which is never likely to contain a significant number of birds in relation to the total in the Lake Warden system.

3.1.5 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 1.47 m.

Waterbird survey: A total of about 800 or 900 waterbirds of 24 species occurred at Wheatfield. The lake and surrounding satellite wetlands were surveyed from the air on 11 and 12 October. The section of the lake visible from the southern bird hide was counted on 12 October and the Wheatfield complex through to Woody Lake (other than satellite wetlands) was surveyed by boat on 13 October. Grey Teal

and Pacific Black were over-counted (probably substantially) in the boat count on 13 October as a result of flocks constantly moving around the wetland, making it impossible to judge whether they had been previously counted. The dominant species were Little Black Cormorant, Straw-necked Ibis, Hardhead, Pacific Black Duck, Grey teal, Chestnut Teal, Eurasian Coot and Yellow-billed Spoonbill. There was a large breeding colony of Little Black Cormorant, Straw-necked Ibis Yellow-billed Spoonbills (and perhaps other species in the flooded trees on the south side of the lake.

Counts were fairly consistent between surveys. Records of significant numbers of Australian Shelduck and Black Swans during aerial surveys compared with their virtual absence during ground counts reflected the occurrence of these species in satellite wetlands only. The higher aerial counts of Great Crested Grebe and ground counts of Hoary-headed Grebe suggest there may have been confusion in the identification of these species from the air. Both species are usually difficult to detect from the air because they dive as the plane approaches.

Previous surveys: Wheatfield has been surveyed in October (as well as August and March) biennially since 1997 by boat (Cale et al., 2004). Numbers have been variable but usually lower than in 2006 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 and 224 waterbirds of 18 species in 2005. Counts in October or November of the early 1980s (Jaensch et al., 1989) were particularly low in terms of species richness 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 November between 1988 and 1991 were 101 in 1988, 58 in 1999, 182 in 1990 and 424 in 1991 (Halse et al., 1995 and earlier publications) compared with about 500 in October 2006 but counts were not comparable, with greater aerial survey effort as well as ground effort in 2006. More species were counted in 2006.

3.1.6 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 moderately full at time of survey but depth was likely to have been < 0.5 m.

Waterbird survey: Aerial counts on 11 and 12 October recorded 8 waterbirds of 6 species and 10 waterbirds of 3 species. The wetlands were open and easy to survey. Differences between counts reflect variation in use, with Lake Wheatfield very close so that regular movement in and out of the North Wheatfield wetlands is likely to occur most of the day.

Previous surveys: There are no previous recorded surveys of the John Porter wetlands, which do not contain a significant number of birds in relation to the total in the Lake Warden system.

3.1.7 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 Windabout was 1.84 m.

Waterbird survey: A total of about 1300 waterbirds of 26 species occurred in the Windabout complex. The numerically dominant species were Australian Shelduck, Pacific Black Duck, Grey Teal, Little Black Cormorant and Eurasian Coot. There was some discrepancy between ground (mostly 13 October with some areas counted on 11 October) and aerial counts (11 and 12 October). Higher numbers of Australian Shelduck and Black Swans were recorded in the aerial counts as a result counting birds in satellite wetlands (that tended to contain a lot of shelducks and swans). Conversely, there was some over-counting of Grey and Chestnut Teal (and perhaps Pacific Black Duck and Eurasian Coot) during the boat survey as a result of birds moving between bays in Windabout, although it is also likely aerial counts of teal were under-estimates.

Previous surveys: Lakes Woody and Windabout were surveyed regularly during the early 1980s with November 1983, 1984 and1985 (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. Although the counts were much higher in 2006 than the 1980s, there is little suggestion of changes in species composition and improved coverage of the wetland is likely to be the main reason significantly more species were counted in 2006.

3.1.8 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: Depth unknown but probably < 0.3 m. Extensive bare shoreline occurred around these wetlands.

Waterbird survey: The North Windabout wetlands were surveyed from the air on 11 and 12 October and from the ground on 11 October. They supported about 500 waterbirds of 21 species. Five species of shorebird were recorded, including 2

Hooded Plovers, and the wetlands are likely to be an important shorebird site. Small shorebirds were not detected during aerial surveys, reflecting the fact that when many birds are present and counting is hectic they are usually overlooked. Similarly grebes were not seen from the air, although both Hoary-headed and Great Crested Grebes were seen in low numbers during ground-counting.
Previous surveys: There are no previous recorded surveys of the North Windabout wetlands, although these wetlands are likely to contain significant numbers of waterbirds, especially shorebirds, at times.

3.1.9 Six Mile wetlands

Location: North of Lakes Road about 1.3 km east of the Coolgardie-Esperance Highway.
Land status: Freehold.
Wetland description: Two small seasonal wetlands in a cleared paddock with open shorelines. A few sedges occur.
Extent of water and depth: Most of the wetlands were almost dry when surveyed and depth was Tilo??
Waterbird survey: The Six Mile wetlands were surveyed from the air on 11 and 12 October and about 50 waterbirds of 9 species were seen. Grey Teal were the numerically dominant species but the wetland is probably characterized by small numbers of an array of species.
Previous surveys: There are no previous recorded surveys of the Six Mile wetlands, which are highly unlikely to contain significant numbers of waterbirds in the context of the Lake Warden system.

3.1.10 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 full at the time of survey, with little exposed shoreline. Depth was 2.05 m.
Waterbird survey: Lake Warden was surveyed from the air on 11 and 12 October and about half the lake was surveyed from the ground on 11 October. About 20 waterbirds of 12 species were recorded. No species was abundant and, because of high water levels and strong winds at the time of survey, the lake appeared to provide sub-optimal waterbird habitat. The discrepancies between counts in 2006 are probably mostly the result of different wind conditions during each survey, although they support the observation that aerial survey underestimates the numbers of diving birds.
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 1999, 87 in 1990 and 878 in 1991

(Halse et al., 1995 and earlier publications) compared with < 20 in October 2006. While the very high numbers of waterbirds recorded in 1982 should probably be regarded as unusual, the 2006 counts represent uniquely low numbers and suggest that the attractiveness of the lake to waterbirds has declined.

3.1.11 Bukenerup complex

Location: Wetlands along Bukenerup Creek at south-western side on 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 moderately full at the time of survey and depth was about Tilo.
Waterbird survey: About 20 birds of 20 species were recorded. More birds were recorded from the air on 12 October than 11 October and ground counting on 11 October showed the same trend. No species was abundant.
Previous surveys: There are no previous published surveys from the complex, which supports only low numbers of waterbirds so that the complex does not constitute important habitat despite species richness being quite high.

3.1.12 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 was almost dry, containing only a few centimetres of water outside the evaporation ponds (which were deeper).
Waterbird survey: Pink Lake contained 100-200 waterbirds in total, with Australian Shelduck, Silver Gulls and shorebirds being the only species present.
Previous surveys: There are no previous published surveys from Pink Lake but it is likely that numbers of shorebirds are high during summer if water is present in the wetland.

3.2 LAKE GORE SYSTEM

3.2.1 Lake Gore

Location: Terminus of Dalyup River, south of McCalls Road between SouthCoast 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 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 Kubitch to Quallilup flow-through system.
Extent of water and depth: Lake Gore was full at the time of survey with little exposed shoreline and a considerable amount of flooding around the inflow of the Dalyup River. Depth was about xxxxx Tilo.
Waterbird survey: A total of about 6000 waterbirds of 17 species occurred on Lake Gore and adjacent inflow wetlands. The lower numbers counted from the air on 11 October partly undoubtedly reflected the very poor flying conditions, with strong winds. The inflow wetlands to the east of Lake Gore were not surveyed properly, although it is likely that many birds moved into this more sheltered habitat because of wave action on the main waterbordy. Nine species were recorded on Lake Gore on 11 October compared with 15 on 12 October. The numerically dominant species was the Australian Shelduck, which accounted for more than 80% of birds in both counts. Chestnut Teal occurred in significant, albeit much lower, numbers as well and were more abundant than Grey Teal. Musk Duck occurred in comparatively high numbers, although seen only on 12 October when flying conditions improved, once again highlighting that this species is easily overlooked during aerial counting.
Previous surveys: Counts in October in the 1980s by Jaensch et al. (1988) yielded highly variable numbers of birds and similar, or fewer, species than recorded in October 2006. 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, 14327 waterbirds of 19 species and 12000 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 higher numbers of teal and Musk Duck are unclear, although they may relate to counting methods. 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 1908s.

Counts of ducks, coots and swans made in Gore each November between 1988 and 1991 were 3928 in 1988, 7741 in 1999, 12172 in 1990 and 6147 in 1991 (Halse et al., 1995 and earlier publications) compared with about 6000 in October 2006. About 600 Pink-eared Ducks were counted in November 1990 but this species was not recorded in the earlier 1980s counts or 2006, 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 earlier 1980s counts and were not seen in 2006 although the habitat appears to be suitable.

3.2.2 Kubitch to Quallilup flow-through system

Location: The Kubitch to Quallilup flow-through system consists of four named wetlands – Lakes Carbul, Kubitch, 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 Kutich 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, Kutich, Carbul – overflow from Lake Gore and flow through into Lake Quallilup.
Extent of water and depth: Not that much water in lakes but extensive in flow through, especially towards south
Waterbird survey: The Kutich to Quallilup flow-through system was counted from the air on 11 and 12 October and appeared to support more than 3000 waterbirds of 22 species. The dominant species was the Australian Shelduck, accounting for about 80 % of all birds. Chestnut Teal and Little Black Cormorants occurred in significant numbers, as did Red-necked Avocet (seen as a single flock near Lake Quallilup both counts). Flying conditions were difficult both days because of strong winds. There was undoubtedly substantial under-counting on 11 October and there may have been some over-counting in the southern part of the system on 12 October.
Previous surveys: Counts of ducks, coots and swans made in the Kubitch to Quallilup flow-through system each November between 1988 and 1991. Lake Quallilup itself was included in these counts (it was done separately in 2006). Totals of 5455 birds were counted in 1988, 745 in 1989, 5761 in 1990 and 1788 in 1991 (Halse et al., 1995 and earlier publications) compared with about 3000-3500 birds in 2006. The dominant species was Australian Shelduck, with Black Swan and Eurasian Coot occurring in substantial numbers in 1990.

4 DISCUSSION

The counts of about 6000 waterbirds of 35 species and 9000 waterbirds of 25 species in the Lake Warden and Lake Gore complexes, respectively, in October 2006 (Appendix) represent significant concentrations of waterbirds in south-west Western Australia, although higher counts have been recorded from the Warden and Gore complexes previously, especially in late summer (see Jaensch et al. 1989; Halse et al. 1995 and earlier publications). Counts at the two wetland complexes would have been expected to increase over summer but the heavy rainfall in early January 2007 (approximately 200 mm at Esperance townsite), which flooded wetlands along the South Coast, is likely to have resulted in dispersion of waterbirds and lower numbers in large wetlands.

4.1 COUNTING VARIABILITY

The October survey is intended to provide a baseline against which to compare results of future surveys. Future work will employ the same techniques as the October 2006 counts to minimize the difference in results across years owing to different counting techniques rather than changed waterbird use of wetlands. However, there were occasionally quite large differences between counts made on successive days during the October surveys (Appendix).

Some of the count differences in October might be dismissed as poor survey but, in fact, such variation is commonly observed in waterbird studies (e.g. Bekle 1983;

Weston & Elgar 2000). A series of midday and evening counts of Hooded Plover on Lake Gore in 1995, made on the same days, showed differences of 18-6000 % (the very large difference was the result of nearly all birds moving away from Lake Gore during the middle of the day) (Weston & Elgar 2000). The danger of this type of variation is that it may to be appear significant if statistical tests are misapplied, falsely suggesting there has been a real change in waterbird use across years when, in fact, the differences in annual counts are reflecting differences in factors such as weather, time of day or observer alertness. Therefore, even when using a consistent technique, results from a program based on one or two surveys a year should be analysed cautiously. It is better to examine broad trends in waterbird numbers and species composition rather than the behavior of single species and individual wetlands in isolation.

Potential fluctuations in waterbird abundance, although a reason for caution, should not prevent use of waterbirds in monitoring programs. Counts of abundant waterbird species usually have < 50 % variability unless the birds move away from the wetland during part of the day (see Appendix). Other aquatic organisms, such as invertebrates and algae, are equally variable (Shiel et al. 1998; Cale et al. 2004). Bird numbers counted during the two October aerial surveys were in general agreement for most species at most wetlands. This gives some confidence that the counts were reasonably accurate (see below) and repeatable, especially when it is likely that some discrepancies can be accounted for by movements of waterbirds between adjacent wetlands. To minimize the impact of small-scale movement in analyses, wetlands should be aggregated into the largest possible units compatible with providing appropriate monitoring information.

There was a tendency for waterbird numbers to be higher in the second aerial count on 12 October than the first; this was more marked in the Lake Gore system, especially the Kubitch to Quallilup flow-through system. Some increase in numbers of birds counted is to be expected in a second flight, especially when the pilot and observer have not flown together before, as they become clearer about an appropriate course over the wetlands and can better anticipate the location and species composition of flocks. The higher count in the Gore system during the second aerial survey, however, was probably largely due to better flying conditions (it was very windy on 11 October, which enabled wetlands associated with the Dalyup River and the Kutich to Quallilup flow-through were to be flown more thoroughly (sections were missed on 11 October).

4.2 GROUND AND AERIAL COMPARISONS

Waterbird numbers obtained during ground counts were usually of similar magnitude to those from aerial counts except for small shorebirds, grebes and diving ducks, which are consistently undercounted from the air (e.g. Kingsford et al. 1999). This provided reassurance that the aerial counts were reasonably accurate and fits with earlier assessment that careful aerial and ground-counting produces total counts within 20 % of each other (Halse & Pearson 2003). In addition to overlooking some cryptic species, sources of inaccuracy including overlooking a significant proportion of the birds on some small wetlands (i.e. 0.1-0.5 ha), especially if they had fringing trees and contained mixed species flocks. Many species tend to shelter under trees and there is insufficient time when crossing small wetlands for the observers to notice the birds responding to the plane and identify them. There were also cases where

substantially higher numbers of some species (e.g. Australian Shelduck) were recorded from the air because birds were on satellite waterbodies not accessible or visible from the ground.

The advantage of aerial counts was that an entire wetland system could be surveyed in about 30-45 minutes when a ground count would have taken longer than a day. Overall waterbird numbers will be more accurately determined from the air because of the many small wetlands that are inaccessible from the ground. Trying to get into all wetlands on the ground is likely to cause substantial movements of waterbirds within the wetland system and, because observers cannot keep track of these movements while accessing wetlands, the likelihood of double-counting or overlooking flocks of birds becomes high. This is illustrated by the counting uncertainty created by waterbird movement between bays on Lake Windabout during the boat survey of this wetland.

4.3 HOODED PLOVER

Few Hooded Plover were present in the Warden system during the October 2006 surveys. However, this species will not be surveyed effectively from the air and there is a need to monitor it separately, using ground surveys. It is suggested that specific areas are selected for survey. These may be Station Lake, North Windabout suite and Pink Lake in the Warden system and the north-eastern part of Lake Gore in the Gore system.

4.4 THE 2007 BASELINE

The counts made in October 2006 suggest that the Warden and Gore systems continue to have high waterbird values. In the Lake Warden system, this includes the extensive breeding of colonial waterbirds at Lake Wheatfield, and the high numbers and species diversity of birds from Lake Windabout eastwards. Lake Warden itself supported few birds and is probably unlikely to do so while water levels remain high throughout the system. Historically, it has provided important October habitat for Australian Shelducks, Black Swans and migratory shorebirds but the open shorelines required by shorebirds are currently under water. Even Australian Shelducks and Black Swans appear to be finding much of the lake inaccessible for feeding at current depths and are seeking more suitable habitat in other parts of the Warden system or beyond it. There was a very considerable contrast between the October 2006 survey, when Lake Warden was 2.05 m deep, and that of Clarke & Lane (2003) in February 2003 when the lake was 1.50 m deep and 4484 waterbirds of 18 species were recorded. However, more surveys in the October/November period are required to confirm that a trend of low waterbird use is becoming establishing at Lake Warden and to establish whether this is associated with high water levels. Summer surveys, which reflect drought-refuge values of wetlands, would provide additional information about any change of function of Lake Warden.

In the Lake Gore system, waterbirds on Lake Gore itself were mostly Australian Shelducks, which reflects the historical pattern. The lake is a major moulting habitat for Australian Shelduck, which also dominated the Kubitch to Quallilup flow-through system.

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6 REFERENCES

Anon. 1990. *List of Wetlands nominated by the State of Western Australia to the List of Wetlands of International Importance*. Government of Western Australia, Perth, 43 pp.

Anon. 2000. *Wetlands nominated by the Government of Western Australia for inclusion on the List of Wetlands of International Importance: Ramsar Convention*. Government of Western Australia, Perth, 48 pp.

Bekle, H. 1982. Effects of unseasonable rains in January 1982 on waterfowl in south-western Australia. I. Reponses of selected species on coastal summer refuges. *Western Australian Naturalist* **15**, 117-122.

Cale, D.J., Halse, S.A. & Walker, C.D. 2004. Wetland monitoring in the Wheatbelt of south-west Western Australia: site descriptions, waterbird, aquatic invertebrate and groundwater data. *Conservation Science Western Australia* **5**, 20-135.

Clarke, A.G. & Lane, J.A.K. 2003. A waterbird census of selected wetlands along the coastal margins of the Esperance district, Feb-Mar 2003. Unpublished report. Department of Conservation and Land Management, Woodvale.

Halse, S.A., Pearson, G.B., Vervest, R.M. & Yung, F.H. 1995. Annual waterfowl counts in south-west Western Australia - 1991/92. *CALMScience* **2**, 1-24.

Halse, S.A. & Pearson, G.B. 2003. A comparison of ground and aerial counts of waterfowl in Western Australia: getting the numbers of species and individuals right. Program and Proceedings, Australasian Ornithological Conference, December 2003, Australian National University, Canberra, p. 46. Birds Australia, Melbourne.

Jaensch, R.P., Vervest, R.M & Hewish, M.J. 1988. Waterbirds in nature reserves of south-western Australia 1981-1985: reserve accounts. Report 30, Royal Australasian Ornithologists Union, Melbourne.

Lane, J.A.K., Pearson, G.B, Clarke, A.G., Wincombe, Y.C. & Munro, D.R. 2004. *Depths and salinities of wetlands in south-western Western Australia: 1977-2000*. Department of Conservation and Land Management, Perth, 129 pp.

Robertson, D. & Massenbauer, T. 2005. Applying hydrological thresholds to wetland management for waterbirds, using bathymetric surveys and GIS. In MODSIM 2005 International Congress on Modelling and Simulation, December 2005 (eds Zerger, A. & Argent, R.M.), pp. 2407-2413. Modelling and Simulation Society of Australia and New Zealand, Sydney. http://www.mssanz.org.au/modsim05/papers/robertson_2.pdf

Shiel, R.J., Green, J.D. & Nielsen, D.L. 1998. Floodplain biodiversity: why are there so many species? *Hydrobiologia* **387**, 39-46.
Weston, M.A. & Elgar, M.A. 2000. The effect of a major rainfall event on Hooded Plovers on a salt-lake in Western Australia. *Emu* **100**, 64-69.

Appendix. Waterbird counts of the Lakes Warden and Gore systems, October 2006.

	Aerial survey		Ground counts		
	11/10/2006	12/10/2006	11/10/2006	12/10/2006	13/10/2006
LAKE WARDEN SYSTEM					
Neridup complex					
Pacific Black Duck		29			
Little Pied Cormorant		1			
Great Egret		1			
Subtotal	0	31			
Bandy Creek pans complex					
Black Swan	52	25			
Australian Shelduck	12	203			
Pacific Black Duck	300	70			
Grey Teal	200	115			
Chestnut Teal	100	75			
Little Pied Cormorant	1				
Little Black Cormorant	6				
White-faced Heron	5	42			
Great Egret	7	7			
Straw-necked Ibis		6			
Black-winged Stilt		12			
Banded Stilt	60				
Subtotal	743	555			
Ewans/Mullet/Station complex					
Ewans					
Black Swan	30	39			
Australian Shelduck	300	635			
Pacific Black Duck	61	50			
Australasian Shoveler		40			
Grey Teal	40	80			
Chestnut Teal	20	70			
Little Pied Cormorant	2				
Little Black Cormorant		10			
Great Egret		12			
Straw-necked Ibis	1				
Common Common Greenshank		16			
Banded Stilt	25				
Unidentified wader		30			
Tally	479	982			
Mullet					
Musk Duck	6	39		79	
Black Swan	67	39		68	
Australian Shelduck	488	334		100	
Pacific Black Duck	23	22		130	
Australasian Shoveler	5				
Grey Teal	20			60	
Chestnut Teal				40	
Hardhead	20				
Unidentified Ducks				250	

	Aerial survey		Ground counts		
	11/10/2006	12/10/2006	11/10/2006	12/10/2006	13/10/2006
Hoary-headed Grebe	1			11	
Great Crested Grebe		2		24	
Little Pied Cormorant	2			9	
Little Black Cormorant	3	8		5	
Australian Pelican	5				
White-faced Heron	1	2		1	
Great Egret	25	2		1	
Australian White Ibis				1	
Straw-necked Ibis	2			1	
Yellow-billed Spoonbill	12				
Whiskered Tern		1			
Tally	680	449		780	
Station					
Musk Duck				1	
Black Swan	120	228		231	
Australian Shelduck	46	411		85	
Pacific Black Duck	100	75		35	
Australian Shoveler		10			
Grey Teal	50	86		152	
Chestnut Teal		60		30	
Hoary-headed Grebe				57	
Little Pied Cormorant		12		5	
Little Black Cormorant		16			
White-faced Heron	6	9		3	
Great Egret	4	4		2	
Australian White Ibis				2	
Straw-necked Ibis		1		1	
Yellow-billed Spoonbill	8			3	
Red-necked Avocet				1	
Hooded Plover				3	
Unidentified wader				1	
Silver Gull	40				
Tally	374	912		612	
Merivale Road wetlands (north of Ewans/Mullet/Station)					
Black Swan	52	85		60	
Australian Shelduck	75	180		26	
Pacific Black Duck	70	25		62	
Chestnut Teal				20	
Little Pied Cormorant	10				
White-faced Heron	13	4		1	
Great Egret	4	7			
Australian White Ibis	3			2	
Straw-necked Ibis		6			
Yellow-billed Spoonbill	3			1	
Silver Gull	2				
Tally	232	307		172	
Subtotal	1765	2650		1564	

	Aerial survey		Ground counts		
	11/10/2006	12/10/2006	11/10/2006	12/10/2006	13/10/2006
Gun Club suite					
Musk Duck				1	
Pacific Black Duck				6	
Grey Teal				12	
Chestnut Teal				18	
Hardhead	80			29	
Unidentified duck		50			
Hoary-headed Grebe				17	
Eurasian Coot				2	
Subtotal	80	50		85	
Wheatfield					
Musk Duck	30	8		18	24
Black Swan	8	15			
Australian Shelduck	125	248			25
Pacific Black Duck		71		12	174
Grey Teal	40	60		23	304
Chestnut Teal	40	70		10	45
Hardhead	4	110		37	130
Great Crested Grebe	10	6		2	
Hoary-headed Grebe				1	8
Darter		3		1	1
Little Pied Cormorant				1	3
Little Black Cormorant	317	165		46	178
Great Cormorant		2		3	5
Australian Pelican	8	1			
White-faced Heron		1		2	2
Great Egret	16	7		1	4
Australian White Ibis	5	7			7
Straw-necked Ibis	77	101		26	34
Yellow-billed Spoonbill	43	20		10	48
Swamp Harrier					1
Eurasian Coot		60		5	63
Common Common Greenshank		20			
Common Sandpiper					4
Black-winged Stilt	4				
Subtotal	727	975		198	1060
North Wheatfield suite					
Little Pied Cormorant	2				
Little Black Cormorant	2	10			
White-faced Heron	1	1			
Great Egret	1	1			
Australian White Ibis	1				
Common Greenshank	1				
Subtotal	8	12			

	Aerial survey		Ground counts		
	11/10/2006	12/10/2006	11/10/2006	12/10/2006	13/10/2006
Windabout complex					
Woody					
Musk Duck					1
Australian Shelduck					12
Pacific Black Duck					28
Chestnut Teal					7
Hardhead					4
Little Pied Cormorant					4
Little Black Cormorant					20
White-faced Heron					1
Great Egret					2
Eurasian Coot					23
Tally	0				102
Windabout					
Musk Duck	1	3	1		5
Black Swan	77	109			41
Cape Barren Goose	5		5		2
Australian Shelduck	164	473	1		110
Pacific Black Duck	2	232	26		263
Grey Teal	100	100	41		265
Chestnut Teal	75	52	134		225
Hardhead	1		1		3
Hoary-headed Grebe			13		6
Great Crested Grebe			3		3
Darter	6	6			1
Little Pied Cormorant	23	27	2		3
Little Black Cormorant	54	200			110
Australian Pelican		5			2
White-faced Heron	2	3	4		3
Great Egret	4	25			4
Australian White Ibis	2	1			1
Yellow-billed Spoonbill		6			6
Swamp Harrier					1
Black-tailed Native-Hen			2		
Eurasian Coot	85	134	95		263
Common Greenshank					2
Black-winged Stilt		2			
Masked Lapwing		3			
Silver Gull			1		
Whiskered Tern					6
Tally	601		329		1325
Subtotal	601	1381	329		1427
North Windabout					
Musk Duck			1		
Black Swan	50	80	77		
Australian Shelduck	476	162	169		
Pacific Black Duck	100	160	40		
Australasian Shoveler	2	2	46		
Grey Teal	20	10	1		
Chestnut Teal	5	30			

	Aerial survey		Ground counts		
	11/10/2006	12/10/2006	11/10/2006	12/10/2006	13/10/2006
Hoary-headed Grebe			17		
Great Crested Grebe			1		
Little Pied Cormorant	1				
White-faced Heron	16	11	5		
Great Egret	7	3	4		
Australian White Ibis		1			
Straw-necked Ibis		12			
Swamp Harrier	1				
Eurasian Coot	8				
Common Common Greenshank		10			
Red-necked Stint			41		
Red-necked Avocet	5		6		
Red-capped Plover			9		
Hooded Plover			2		
Subtotal	691	481	418		
Six Mile wetlands					
Black Swan		6			
Australian Shelduck		1			
Pacific Black Duck		12			
Grey Teal	80				
Chestnut Teal		2			
Little Pied Cormorant		1			
Little Black Cormorant	3				
White-faced Heron	1	9			
Common Geenshank		5			
Subtotal	84	36			
Warden					
Musk Duck	1		5		
Black Swan	5				
Australian Shelduck		2			
Pacific Black Duck	8				
Chestnut Teal	2				
Hoary-headed Grebe			2		
Great Crested Grebe			1		
Little Pied Cormorant		2			
Darter	1	1			
White-faced Heron	3		1		
Great Egret	1	1			
Swamp Harrier	1				
Subtotal	22	6	9		
Bukenerup complex					
Australian Shelduck	8	5			
Pacific Black Duck		4			
Little Black Cormorant	5	1			
White-faced Heron	1		1		
Great Egret	1	1	1		
Australian White Ibis		3	1		
Common Greenshank			1		

	Aerial survey		Ground counts		
	11/10/2006	12/10/2006	11/10/2006	12/10/2006	13/10/2006
Black-winged Stilt		2			
Red-necked Avocet	3	2			
Hooded Plover		4			
Masked Lapwing		2			
Unidentified wader	1				
Subtotal	19	24	4		
Pink					
Australian Shelduck	25		30		
Red-necked Stint			37		
Banded Stilt	12		12		
Red-capped plover			78		
Unidentified wader	52	190			
Silver Gull	5	9			
Subtotal	94	199	157		
WARDEN SYSTEM TOTAL	4834	6400	917	1847	2487
LAKE GORE SYSTEM					
Gore					
Musk Duck		159			
Black Swan	32	70			
Australian Shelduck	3483	4799			
Pacific Black Duck	26	30			
Australasian Shoveler		20			
Grey Teal	160	206			
Chestnut Teal	199	439			
Unidentified duck		8			
Great Crested Grebe		6			
Little Pied Cormorant	1				
White-faced Heron	3	25			
Australian White Ibis		2			
Common Greenshank	2				
Black-winged Stilt	4	3			
Banded Stilt		20			
Red-necked Avocet		121			
Masked Lapwing		4			
Silver Gull		6			
Subtotal	3910	5918			
Kubitch to Quallillup flow-through					
Musk Duck		20			
Black Swan	39	71			
Australian Shelduck	1753	3179			
Pacific Black Duck	10	98			
Australasian Shoveler	15				
Grey Teal	102	71			
Chestnut Teal	34	262			
Pink-eared Duck		20			
Hardhead		2			
Darter	1	1			
Little Pied Cormorant		3			

	Aerial survey		Ground counts		
	11/10/2006	12/10/2006	11/10/2006	12/10/2006	13/10/2006
Little Black Cormorant	240	4			
Great Cormorant	7	2			
Australian Pelican	6	15			
White-faced Heron	9	11			
Common Common Greenshank	1				
Black-winged Stilt	2	6			
Banded Stilt		14			
Red-necked Avocet	130	95			
Unidentified wader	1				
Silver Gull	2				
Caspian Tern		1			
Subtotal	2352	3875			
Quallilup					
Australian Shelduck	1	2			
Subtotal	1	2			
GORE SYSTEM TOTAL	6263	9795			
GRAND TOTAL	11097	16195			