2015 update on monitoring of waterbirds of the Warden and Gore Wetland systems (2006 to 2015)

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Introduction

The Department of Parks and Wildlife have monitored waterbirds populations using the Warden and Gore-Quallilup wetland systems annually (in spring) or biannually (in spring and summer) since 2006. This work has been carried out as part of the Lake Warden Natural Diversity Recovery Catchment (LWNDRC) program but included the Gore-Quallilup wetlands to 1) provide data on regional waterbird populations as context, 2) to provide baseline data on the basis that the Gore-Quallilup system might have become the focus of a new recovery catchment and 3) to provide data for triennial reporting against Ramsar criteria for the Lake Gore Ramsar wetlands.

The aims of this work are to

1. describe the spatial and temporal patterns in contemporary usage of wetlands by waterbirds within these systems in order to better understand the relative conservation values of wetlands and wetland suites.
2. provide data on waterbird populations for Ramsar Convention triennial reporting.
3. Guide and measure the effectiveness of management actions on waterbird populations.

The first survey was undertaken by Stuart Halse and Grant Pearson from Parks and Wildlife (then Department of Conservation and Land Management). The next three surveys were undertaken by the same researchers as the consultants Bennelongia Pty Ltd. Since spring 2009 surveys have again been undertaken by Parks and Wildlife staff (Adrian Pinder, David Cale, Kirsty Quinlan and Anna Leung, assisted by John Lizamore, Sarah Davies, Don Cater, Don Thurgood, Michael Coote, Jen Higbid and Adam Turnbull). A total of 16 surveys have been undertaken since 2006. This work has also been incorporated into the annual South Coast Shorebird counts undertaken in February and coordinated by Greenskills Inc.

A map of the Warden wetland system, showing surveyed wetland suites, is provided in Figure 1. A similar map for the Gore-Quallilup wetlands is yet to be produced. Further information on the wetlands and wetland suites can be found in previous reports: Halse et al. (2007), Bennelongia (2008a b, 2009) and Pinder et al. (2010, 2012a b). This report provides a brief update incorporating data from the last six surveys (from spring 2012). We have focused on providing summary analyses of the data looking for major trends over time at the scale of whole systems (Warden and Gore-Quallilup). More

comprehensive analyses, including of individual wetlands and species, will be undertaken during 2015/16.

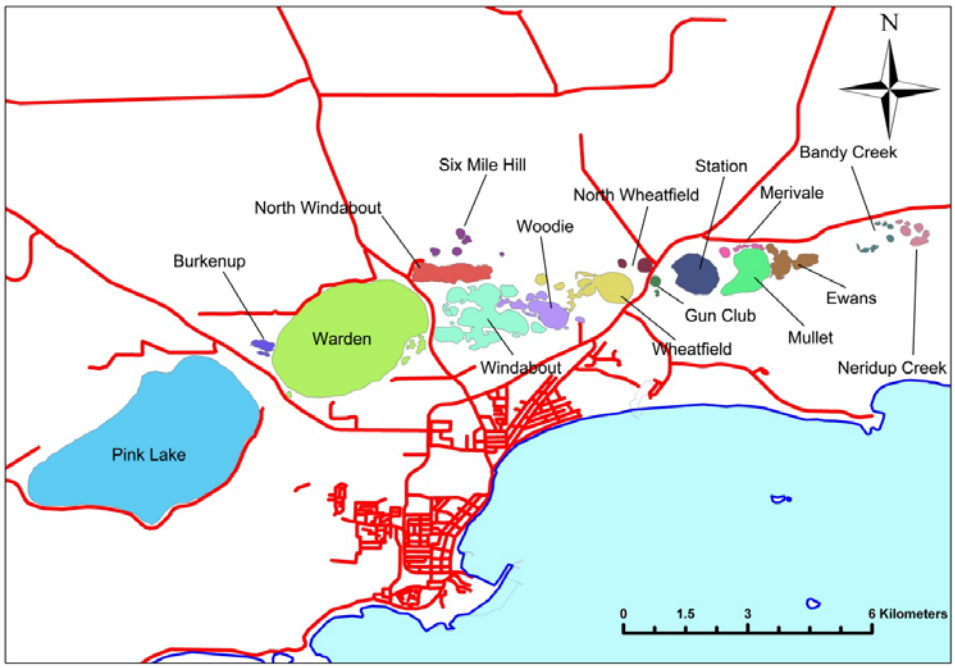

Figure 1. Wetland suites surveyed for waterbirds in the Warden system.

Methods for counts since Oct 2012 (see previous reports for earlier count methods)

Counts were made by one or two observers at all (or almost all) wetlands on each survey date, even when wetlands were dry (Appendix 1). Surveys were undertaken over 4 consecutive days. In the Warden wetlands the larger lakes supporting most of the birds (Ewans, Mullet, Station, Wheatfield, the North Wheatfield wetlands, Woody and Windabout) were always surveyed on one day, minimizing inaccuracies due to inter-wetland waterbird movement. This was achieved by one team surveying North Wheatfield, Ewans, Mullet and Station on foot, while a second team surveyed Wheatfield, Woody and Windabout by boat). The two North Wheatfield wetlands were always surveyed at the same time as Lake Wheatfield because birds from the former are easily disturbed and tend to move to the latter in large numbers. All wetlands in the Gore-Quallilup system were also surveyed on one day by two teams: one team surveying Lake Quallilup and the flow-through system and a second team surveying Lake Gore, the Dalyup channel and associated wetlands and the Carbul Suite (Lakes Carbul, Kubitch and Gidon). For some surveys, the Carbul Suite was surveyed on the day prior to other Gore-Quallilup wetlands. An attempt was made to count and identify all waterbirds on each wetland. Counts were made using a combination of binoculars and spotting scopes.

Aerial counts were undertaken between Oct 2006 and Feb 2012. See previous reports for aerial count methods.

Data analysis

Multivariate analyses were performed using the vegan package (Oksanen *et al.* 2013) run on R v3.1.2 within RStudio v 0.98.1103 (RStudio 2015) . Ordinations are non-metric multidimensional scaling (nMDS) using the Bray-Curtis dissimilarity index calculated using square-root abundance measures to reduce the otherwise stronger influence of high abundance species on community dissimilarity.

RESULTS

Warden versus Gore-Quallilup wetlands

Figure 2 is an nMDS ordination showing results of waterbird surveys for the Warden and Gore-Quallilup wetland systems. This shows that the two wetland systems have very different waterbird faunas irrespective of year or season, reflecting the different wetland habitats present in the two systems. Figure 3 contains abundance boxplots for species that tended to be abundant in one or both systems but had large differences in abundance between systems, using ground data from 2009 to 2015 for consistency (ground surveys not undertaken for Gore prior to 2006). Most species were more abundant, on average, in the Warden system than in the Gore-Quallilup system. Notable exceptions include Australian shelduck, hoary-headed grebe, darter and red-necked avocet, which tended to be more abundant in the Gore-Quallilup system. Eighteen species recorded in the Warden wetlands were not recorded in the Gore-Quallilup system while the reverse was true for only two species (white-bellied sea eagle and Pacific gull).

The Gore-Quallilup system, and particularly Lake Gore, is an important moulting site for waterfowl, especially the Australian shelduck, which occur in high numbers here in spring and tend to disperse over summer. Darters are also more common in the Gore system, especially when the flow-through system has sufficient depth. The dead trees in the flow-through provide abundant perching sites for this species and there is presumably abundant fish in this part of the system which is regularly connected to Lake Quallilup. Two of the larger shorebirds (red-necked avocets and black-winged stilts) also tend to be more common in the Gore-Quallilup system, primarily using Lake Gore, the wetland connected to the Dalyup River channel and the flow-through. Hoary-headed grebes tend to be particularly abundant on Lake Gore compared to elsewhere in either system. Thus, while the Warden system generally has higher species richness per survey (see Warden and Gore sections below) and a higher cumulative richness, the Gore-Quallilup system has some values for waterbirds not present in the Warden system so these systems should be considered as complementary for waterbird conservation.

It can also be seen from Figure 2 (and from Figures 9 and 15) that there is a more consistent difference in composition between seasons in the Warden wetlands than there is in the Gore-Quallilup wetlands.

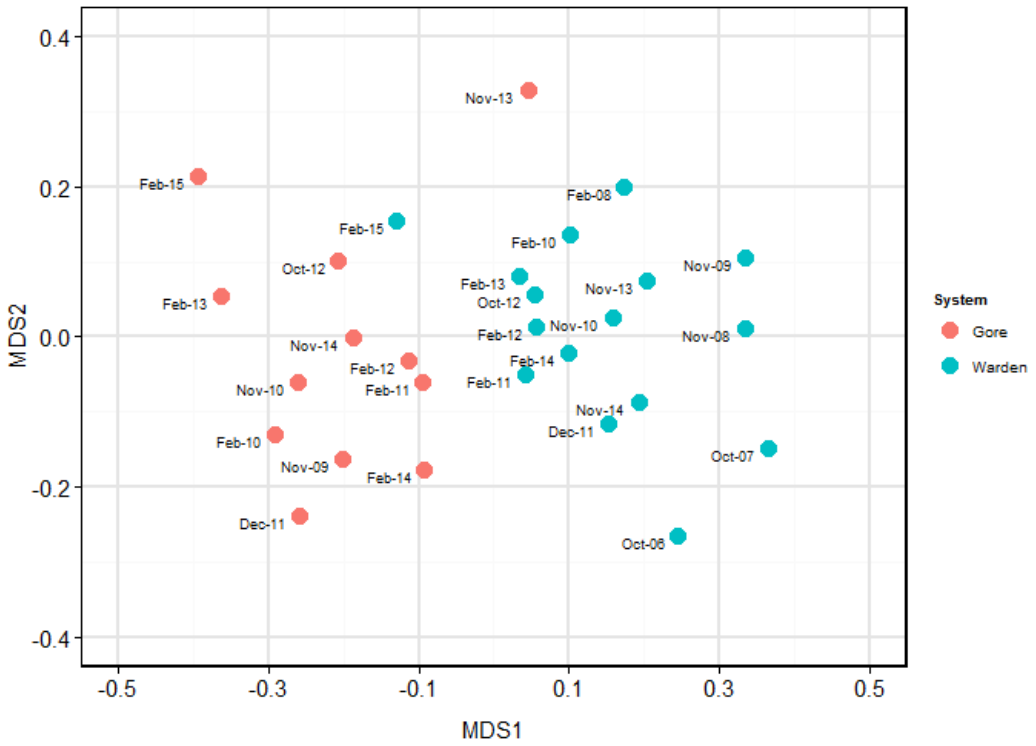

Figure 2. 2D nMDS ordination of waterbird survey results (ground counts) for the Warden and Gore wetland systems between Oct 2006 and Feb 2015 (data only from Nov 2009 for Gore). Stress = 0.17

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Figure 3. Boxplots showing abundances of selected waterbird species in the Warden and Gore-Quallilup wetland systems for ground surveys carried out between 2009 and 2015. Note that outlier abundances have been excluded from the plot but were used to calculate the box dimensions. Boxes are 25th to 75th percentiles, line within box is median and the whiskers are 1.5 x interquartile range.

Lake Warden system

Species richness and abundance

Total richness (from ground only or ground plus aerial counts) has mostly varied between 40 and 49 species (Figure 4). Fewer species were recorded in October 2006 and February 2015, although the 2006 counts were less extensive than subsequent ones. This lower richness in February 2015 reflects lower richness within most waterbird groups. The lower within group richness values in Feb 2015 were all within historical ranges (2006+), but for most other surveys low richness in one group has been compensated for by higher richness in another. Most notably, there were no great crested grebes, hardhead ducks, great cormorants, darters, and straw-necked ibis in Feb 2015. Average lake depth (0.71m) was lowest in Feb 2015 than during any other survey. Ewans Lake (at 0.35m) and Lake Warden (at 0.31m) were particularly shallow. Not surprisingly, most of these missing species are divers, so depth might have fallen below a threshold for these.

By contrast, the highest richness values (48 and 49 species) were over the spring/summer period of 2013/14. As for the lowest richness values, higher richness was a combination of higher than average numbers of species within several groups, including 15 shorebirds (on both dates), 8 and 9 species of large wading birds (herons, egrets etc.) and 10 species of ducks/geese (on both dates). Depths were not unusually high or low given the time of year on these high richness dates.

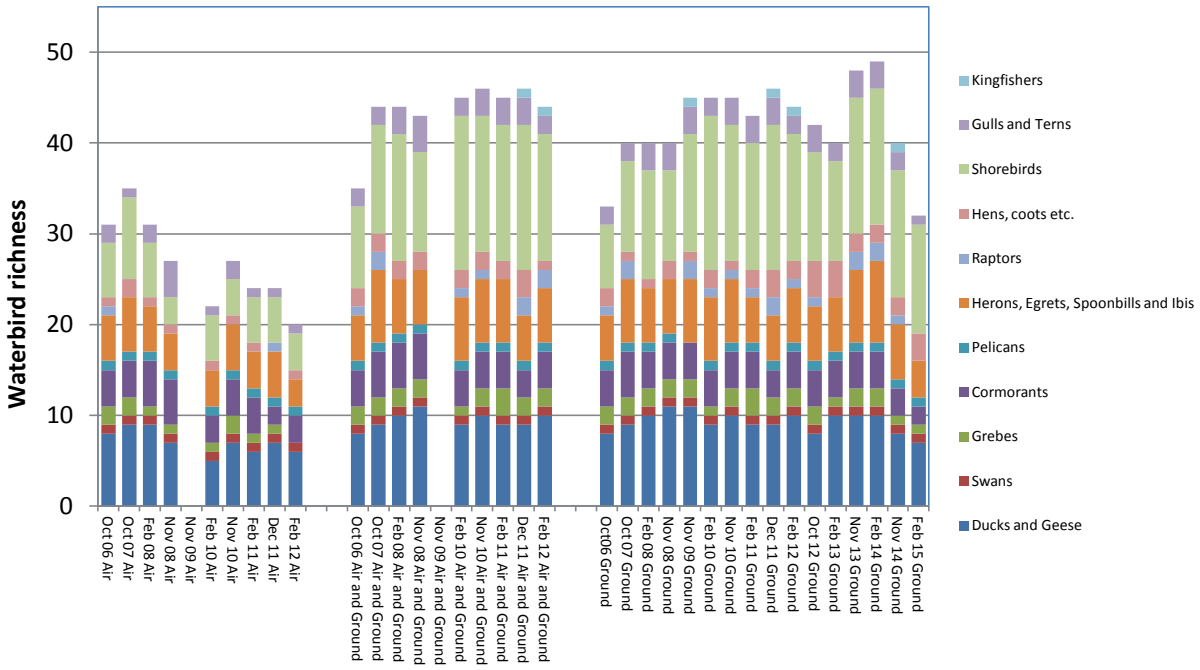

Figure 4. Richness of waterbirds by major taxonomic group within the Warden wetlands between 2006 and 2015, separated by survey method (air, air+ground and ground only).

Figure 3 and Figure 4 shows that there is no discernible relationship between wetland depths in the Warden system (averaged across all depth gauged wetlands) and either total waterbird richness or abundance within the Warden wetlands over the period 2007 to 2012.

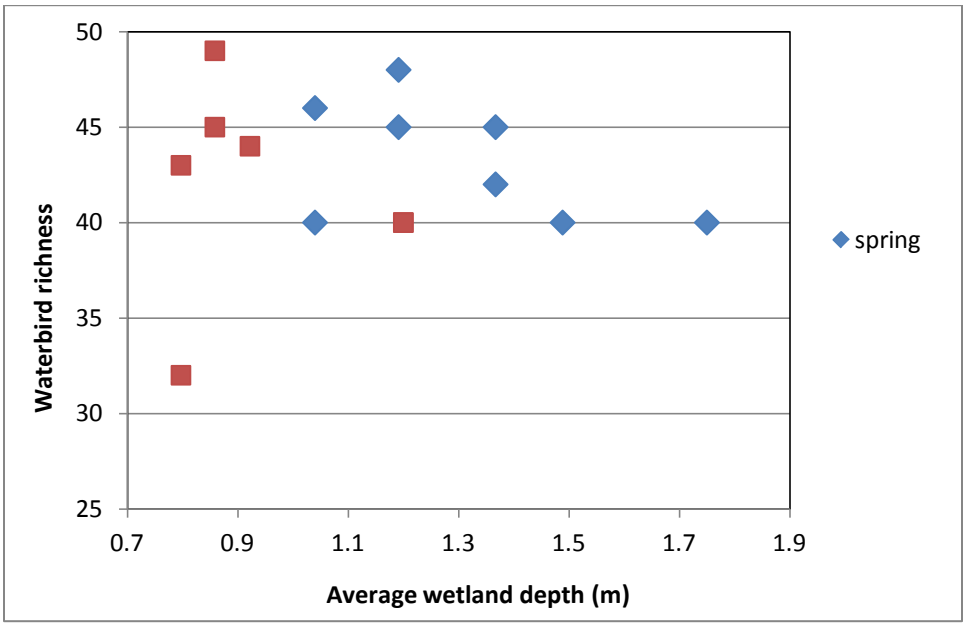

Figure 5. Average depth of gauged wetlands versus total abundance of waterbirds using the Warden system wetlands between Oct 2007 and Feb 2015.

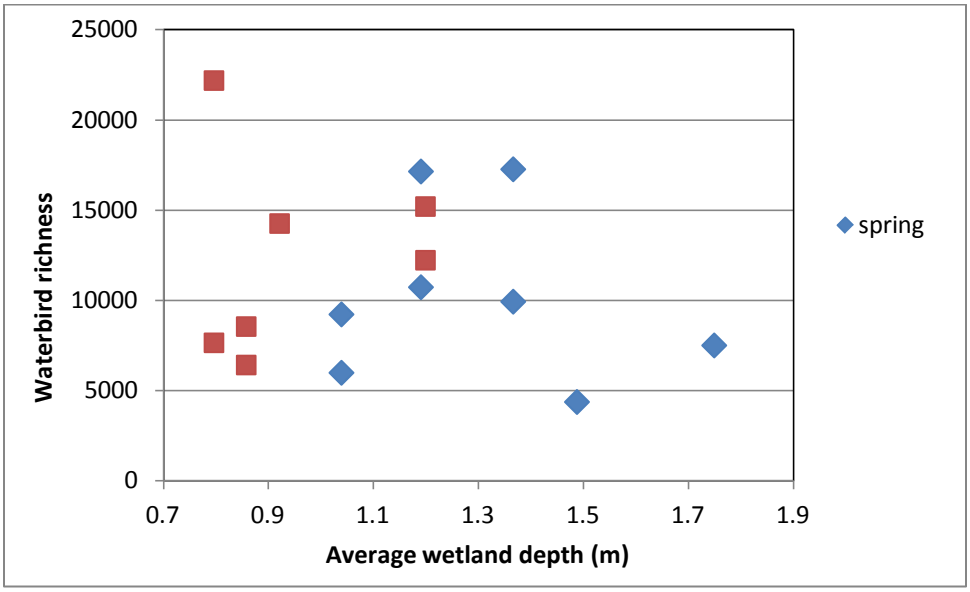

Figure 6. Average depth of gauged wetlands versus total abundance of waterbirds using the Warden system wetlands between Oct 2007 and Feb 2015.

Figure 5 presents abundance by major waterbird group in the Warden system between 2006 and 2015. This shows that while abundance varies greatly, from under 5000 birds to over 20000, there is not a

consistent trend of increasing or decreasing abundance over time. There is also no pattern of either season (spring versus summer) having higher abundance. High total abundance is usually associated with higher abundance of ducks and shorebirds in particular. The highest abundance was in February 2015 when 22170 birds were counted, including a record 4217 black swans and the second highest count of ducks (9679). Ducks and shorebirds generally predominate in the Warden wetlands, the latter especially so when total waterbird abundance is high and there are large numbers of the nomadic banded stilt (Oct 2007, Feb 2008, Oct 2012, Nov 2013 and Feb 2015).

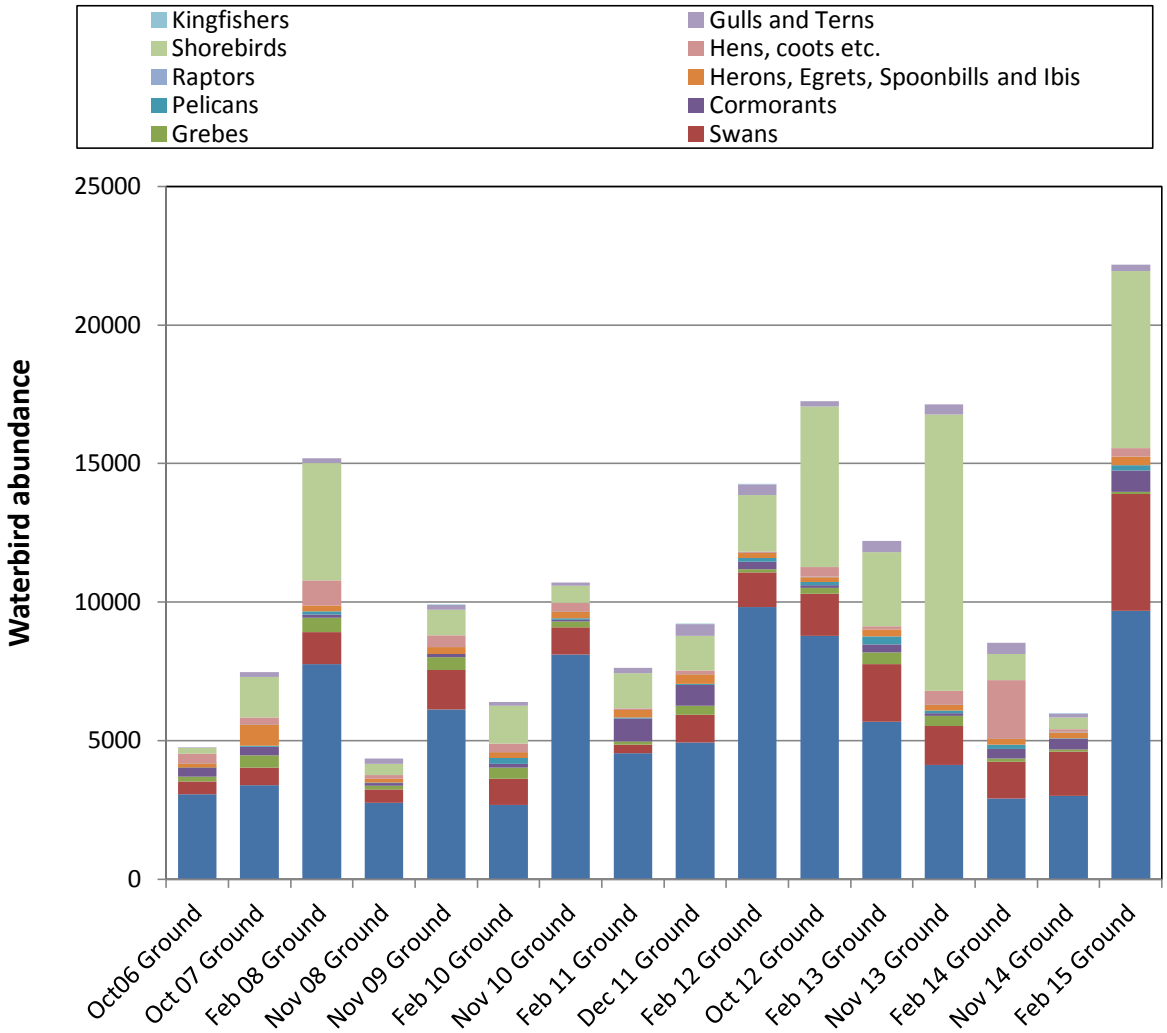

Figure 7. Abundance of waterbirds by major group using Warden system waterbirds between Oct 2006 and Feb 2015.

Changes in abundance of waterbird groups are shown in Figure 8. This shows high variability in abundance within all groups over time, but little directional change. The number of grebes (mainly hoary-headed) seems to have been higher prior to 2010 and the highest numbers of seabirds and shorebirds have been since 2012. Changes in abundance of these and other waterbird groups are probably related to water depths in these wetlands as well as elsewhere in the region and the broader south-west, but this will be investigated in future analyses.

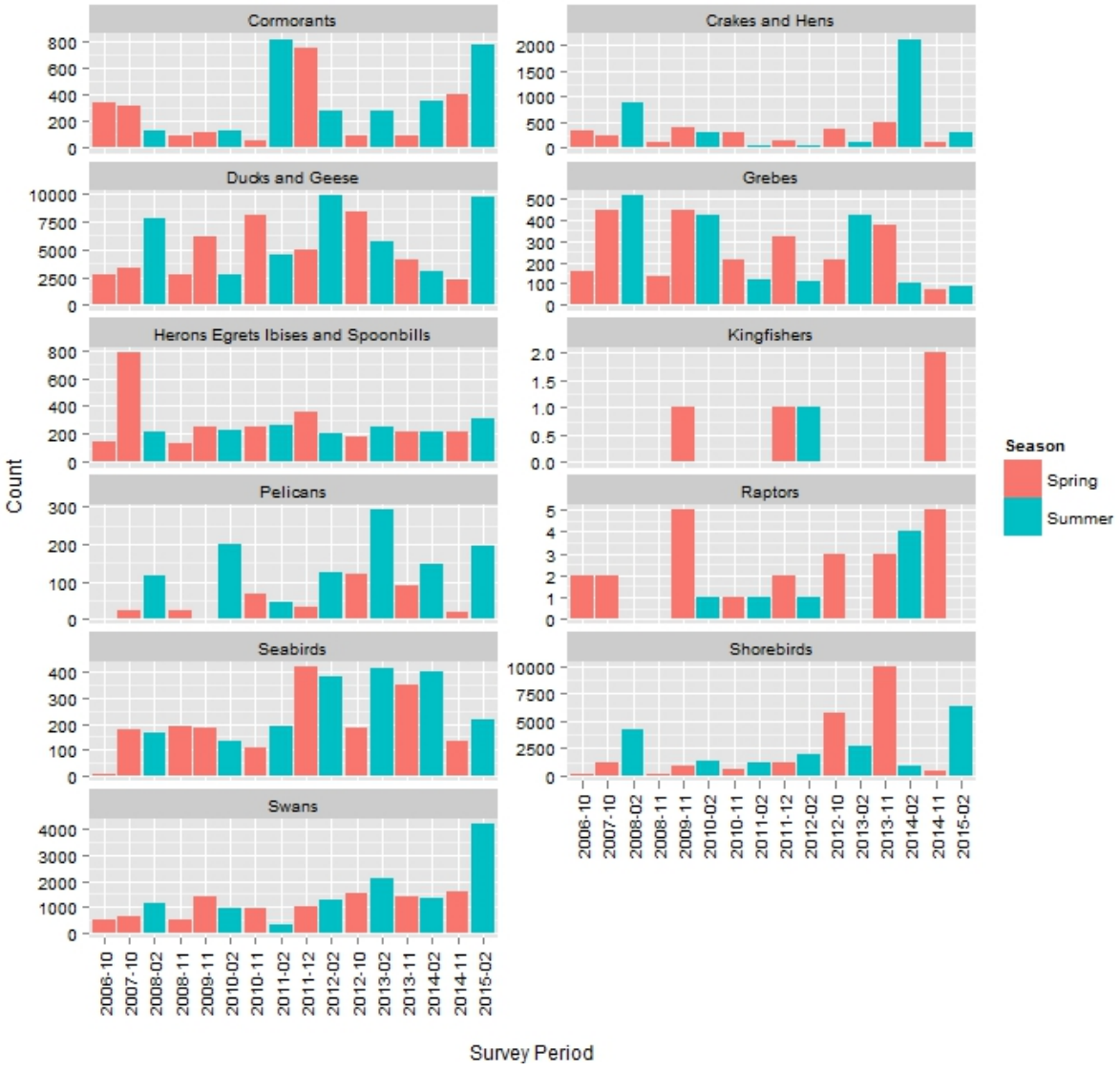

Figure 8. Changes in abundance of waterbirds by waterbird group between 2006 and 2015 in the Warden wetlands

Community composition

Waterbird community composition is generally different between spring and summer (Figure 8), with the exception that the Dec 2011 survey produced results more like a summer survey. Species that contributed most to distinguishing spring versus summer communities (from a 'simper' analysis) are listed in Table 1 with their mean spring and summer abundances and the statistical significance of the differences (t-tests) of these.

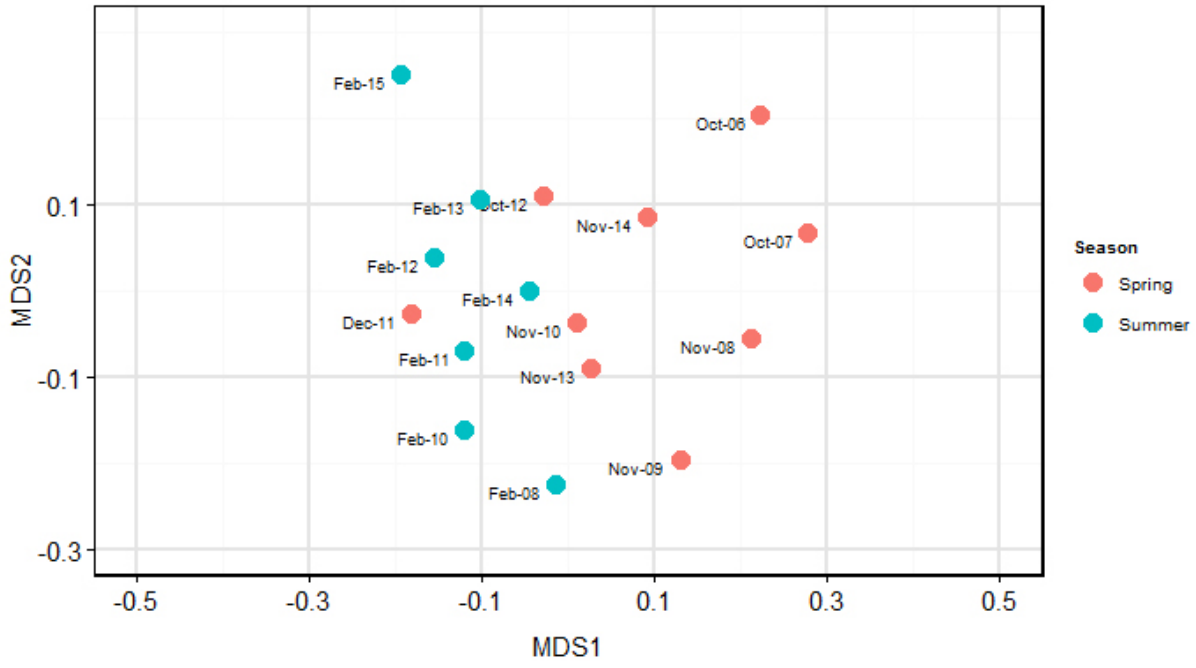

Figure 9. Non-metric multidimensional ordination of Warden system waterbird surveys colour coded by season. Stress = 0.16.

Table 1. Average abundances of species contributing most to distinguishing spring and summer surveys in the Warden wetland system based on a 'simper' analysis and results of Kolmogorov-Smirnov tests for significant differences in abundance between seasons.

	Average Count (± s.e.)		
Species	Spring	Summer	P value, Significance
banded stilt	1561 ± 996	1370 ± 672	0.866 n.s.
Australian shelduck	1915 ± 305	850 ± 272	0.015 *
grey teal	1475 ± 514	2744 ± 840	0.573 n.s.
Pacific black duck	529 ± 126	1358 ± 786	0.014 *
black swan	1061 ± 149	1614 ± 478	0.828 n.s.
red-necked stint	134 ± 77	592 ± 76	0.001 **
hoary-headed grebe	252 ± 45	239 ± 67	0.270 n.s.
hardhead	387 ± 159	32 ± 24	0.025 *
Eurasian coot	277 ± 47	541 ± 286	0.822 n.s.

There is some evidence that waterbird composition (based on square root abundance of species) across the Warden system is related to wetland depth. Figure 10 shows a non-metric multidimensional ordination with symbols representing surveys conducted in spring from 2007 to 2014 scaled according to the squared average depth of the seven gauged wetlands. This average depth is used as an indicator of changes in depth across the system between surveys. The average depth is squared to emphasize differences in depth between years. This analysis suggests that waterbird communities changed more during the period 2006 to 2008 than during most of 2019 to 2013 and that composition is related to depth. Thus, the deeper surveys of 2006 to 2009 are to the left of the plot while surveys undertaken in later years when average depths were shallower are towards the right of the plot. More quantitative analyses of depth-composition relationships (such as redundancy analysis) were hampered by the skewed distribution of the depth data and the small number of surveys.

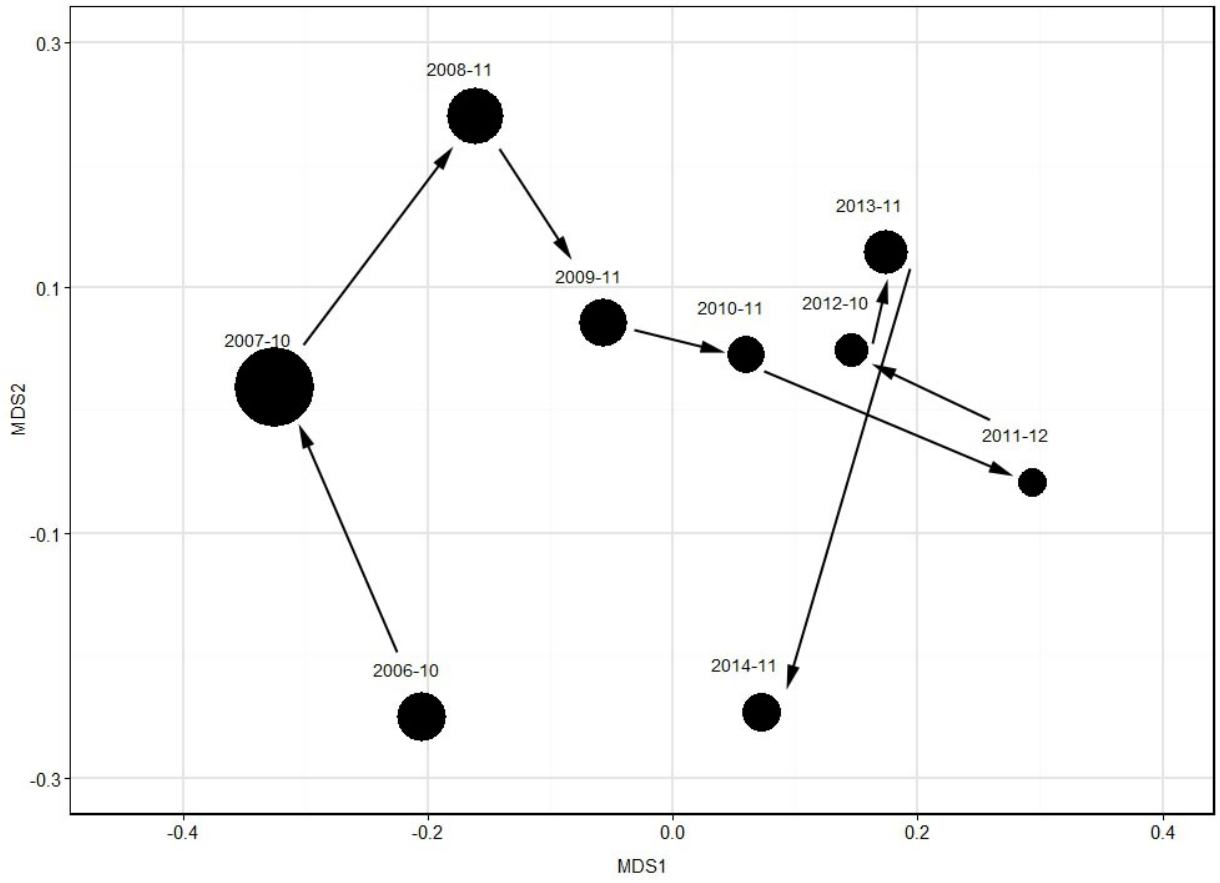

Figure 10. A non-metric multidimensional ordination of Warden waterbird communities from spring surveys between 2006 and 2014, with survey symbols scaled by average range standardised depth^2 across gauged wetlands. Stress = 0.12.

A similar ordination for summer surveys is shown in Figure 11, but note that sizes of symbols between this and Figure 10 are not comparable. In this plot, deepest average depth was in 2008 and this survey is

locate towards the bottom left of Figure 11. Depths were intermediate between 2010 and 2012 and in 2014 and these surveys were position towards the top of the ordination, whereas surveys undertaken when average depths were lower are towards the bottom of the plot (shallowest years to the right). A second pattern is a drift in composition from the left to the right of plot over time. This drift in waterbird composition during summer is more pronounced than that observed for the spring surveys.

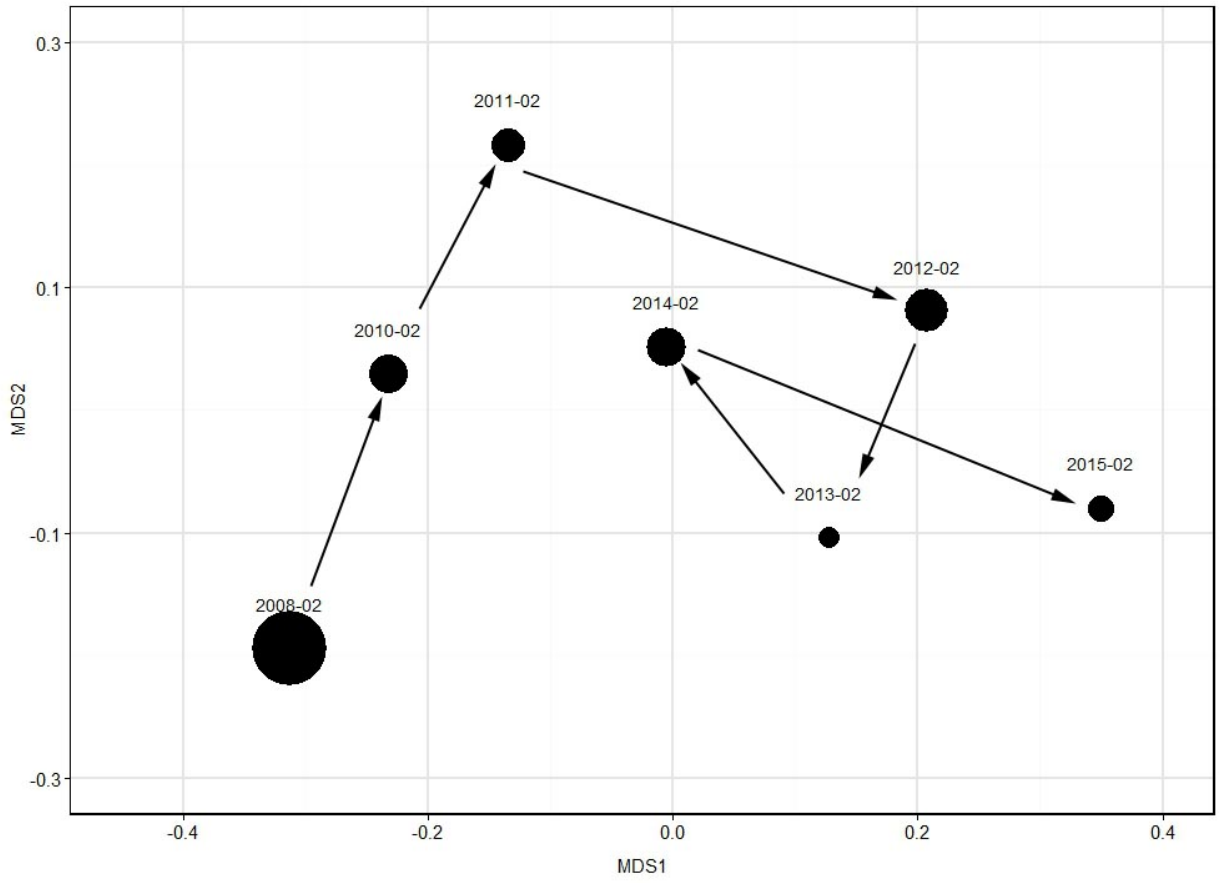

Figure 11. A non-metric multidimensional ordination of Warden waterbird communities from summer surveys between 2006 and 2014, with survey symbols scaled by average range standardised depth^2 across gauged wetlands. Stress = 0.07.

The above two graphs show waterbird community composition in relation to average depth, but through the 2006 to 2015 period changes in depth were more pronounced in some wetlands than in others, so further analysis of individual wetlands is required.

Gore-Quallilup system

Species richness and abundance

Figure 12 shows waterbird species richness for surveys conducted on the Gore-Quallilup wetlands between 2006 and 2015. Total richness (from ground only or ground plus aerial counts) has varied between 27 and 38 species. There does not appear to be a trend in richness over time. Higher than usual numbers of shorebird species was the main contributor to the higher total richness in Feb 2012 while in Nov 2013 the high richness was a combination of more ducks, shorebirds and seabirds.

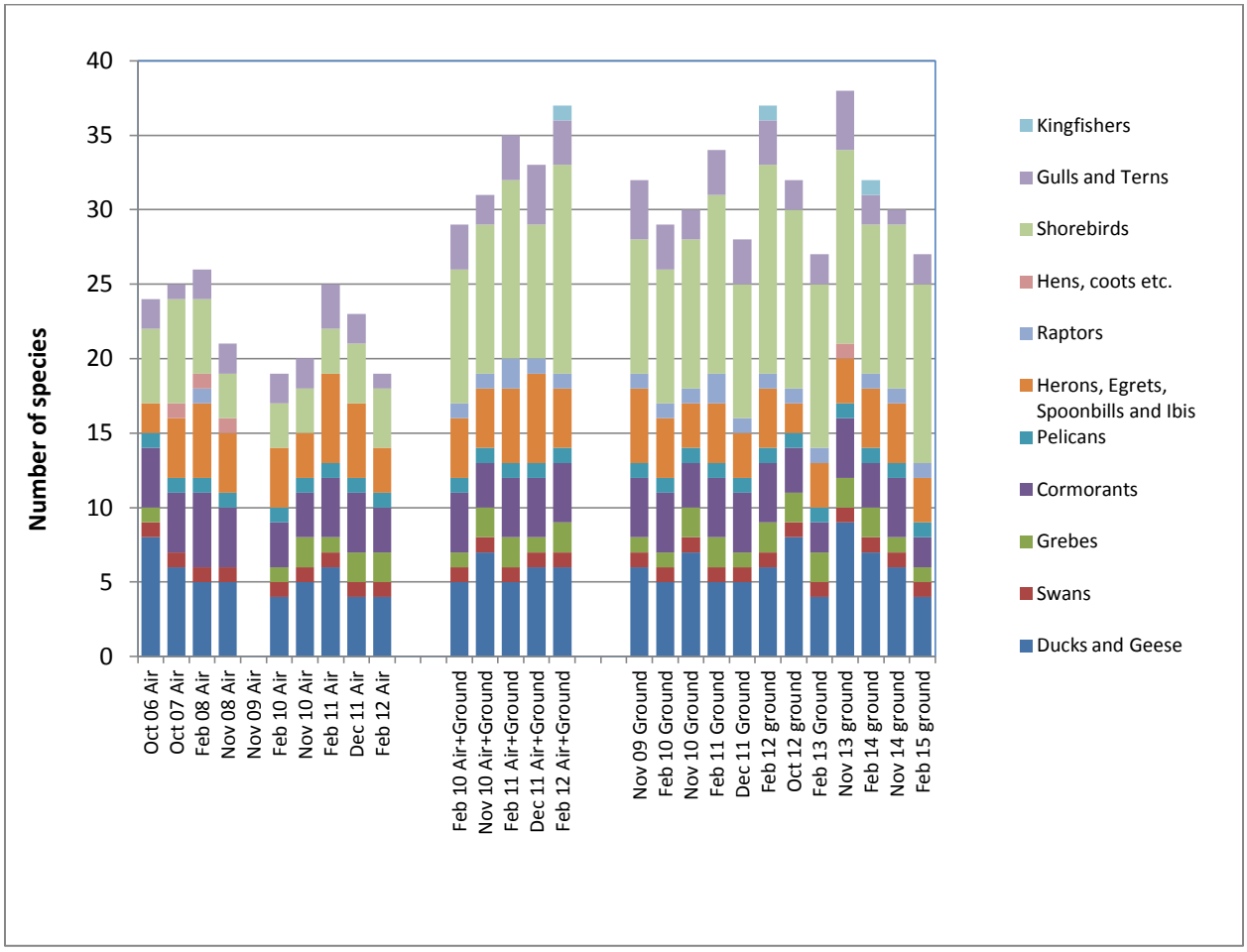

Figure 12. Waterbird species richness for Gore-Quallilup wetlands 2006 to 2015, from aerial surveys, ground surveys and combined.

Figure 13 shows total waterbird abundance from ground counts between 2009 and 2015. Earlier counts were from the air and not shown here. Total waterbird abundance in the Gore-Quallilup wetlands has varied from year to year, but with no consistent trend over time. Total abundance has ranged from 4331 to 15094, but normally depths are within the 6000 to 10000 range. The high abundance in spring 2012

was a combination of the highest recorded numbers of ducks (primarily shelduck and grey teal) and shorebirds (particularly banded stilt on Carbul and Kubitch lakes and red-necked avocet on the flow-through system). Aerial counts in Oct 2007 and Feb 2008 (both about 14500) were almost as high as those in Oct 2012. The Oct 2007 aerial count was dominated by ducks (>11000, almost all shelduck), with few shorebirds (though smaller shorebirds are hard to survey from the air) whereas in Feb 2008 the number of ducks was much lower but nearly 4000 banded stilts were recorded.

While species richness on the Gore-Quallilup wetlands in Feb 2015 wasn't much lower (at 27 species) than average, the community was much simpler, with very few large wading birds (herons, ibis stec.), grebes and cormorants. Shorebirds made up a larger proportion of total abundance than for any previous survey since 2006.

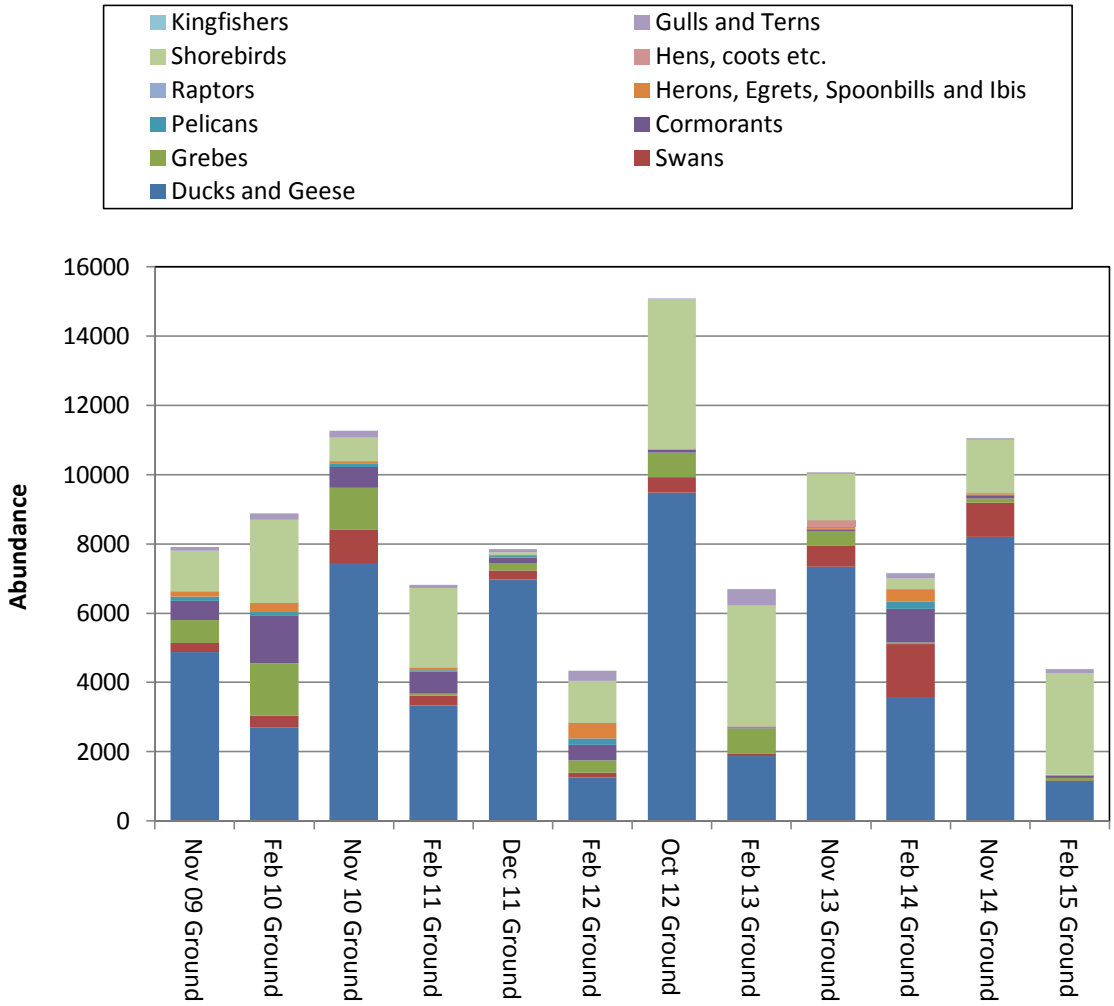

Figure 13. Abundance of waterbirds using the Gore-Quallilup wetlands 2009 to 2015. Pre 2009 surveys were aerial counts.

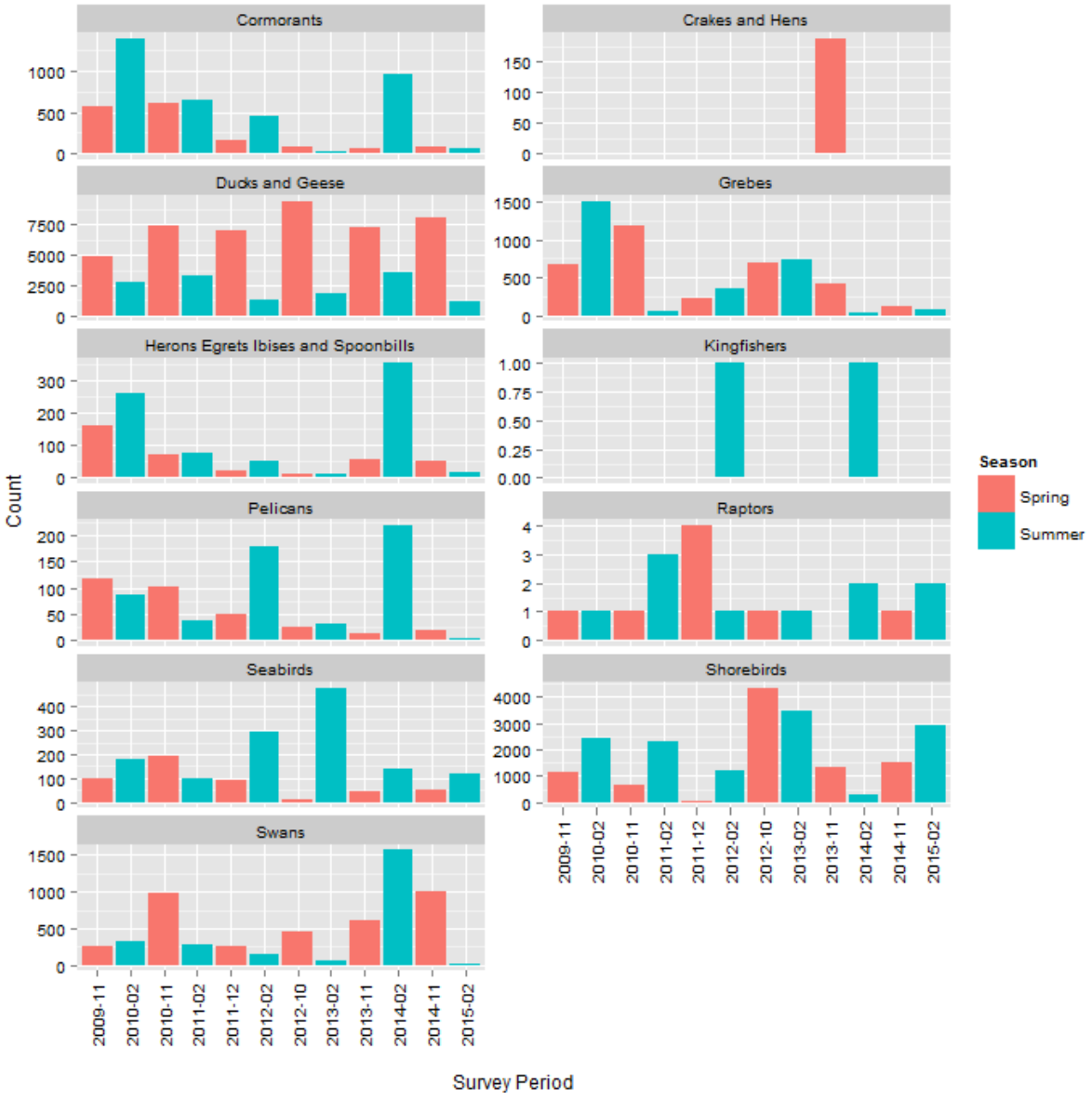

Figure 14. Changes in abundance within waterbird groups between 2006 and 2015 in the Warden wetlands

Changes in abundance of waterbird groups between 2009 and 2015 are shown in Figure 14. The number of cormorants and grebes was higher between 2009 and 2011 when depths were higher. Abundances of other groups has been variable but no obvious trends over time. Spring surveys always record higher numbers of ducks than summer surveys, reflecting the use of Lake Gore (especially) by large numbers of moulting shelduck in spring and their dispersal over summer. No such seasonal pattern was evident in the Warden system data.

Composition

An ordination of waterbird ground survey results for the Gore-Quallilup wetlands between 2009 and 2015 is shown in Figure 15. Unlike in the Warden system, there is no clear consistent difference in composition between spring and summer communities. There is also no indication of inter-annual directional change. For the summer surveys there was a gradual drift in species composition between 2010 and 2015 with the exception that the Feb 2014 composition was very different and off that trend. The November 2013 community was also quite different to other spring surveys.

A 'bio-env' analyses revealed that just 13 species accounted for 91% of variation in community composition between surveys. The abundance of these species are shown in Figure 16. One clear pattern here is the greater abundance of shelduck in spring compared to summer. The cormorants (darters and little black cormorants) were more abundant in earlier surveys when wetlands were deeper). Most other species vary in abundance but show no clear pattern through time, as per the ordination based on all species.

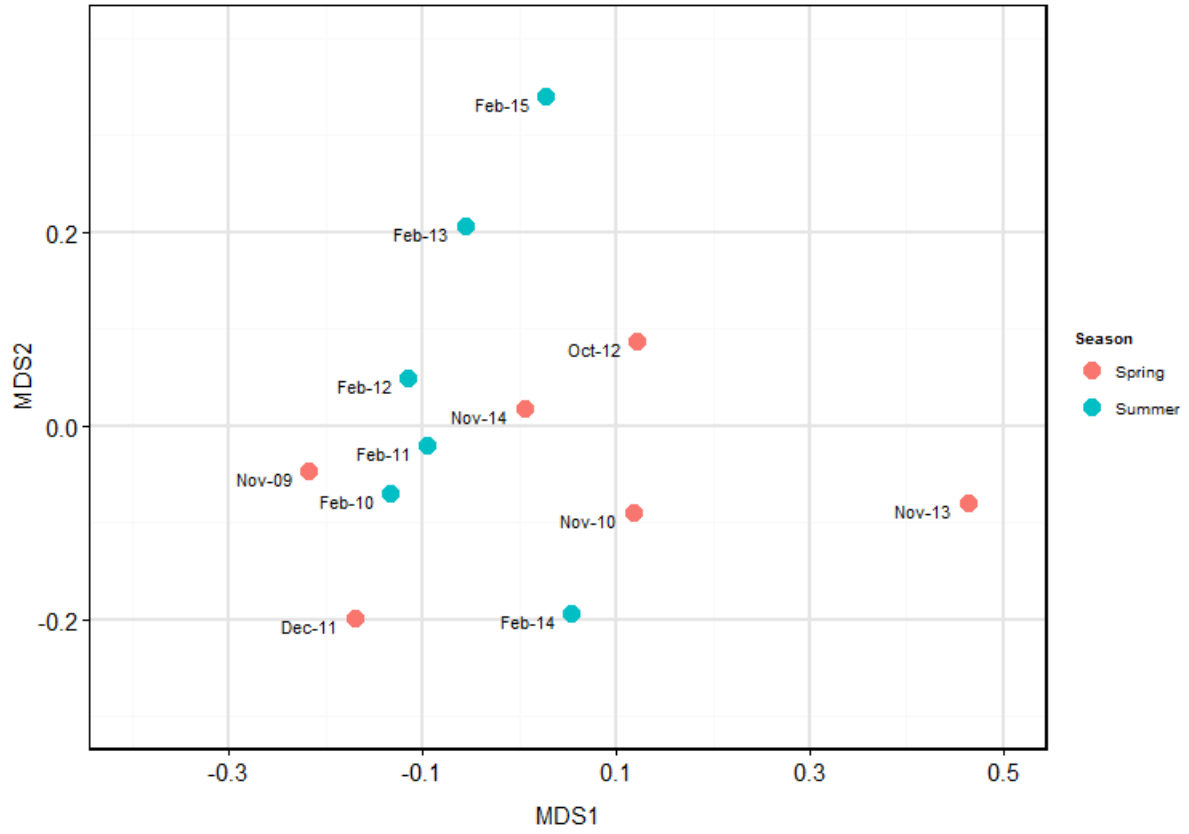

Figure 15. Two dimensional ordination (nMDS) of waterbird ground surveys (square-root abundance) conducted in the Gore-Quallilup wetland system 2009 to 2015. Stress=0.12.

Figure 16. Abundances of selected waterbirds using the Gore-Quallilup wetlands from 2009 to 2015.

As in the Warden system, there is some evidence that waterbird composition across the Gore-Quallilup system is related to depth. Figure 17 is an ordination of waterbird communities of the Gore-Quallilup wetlands between 2010 and 2014 (depth data was not collected at some wetlands prior to 2010). This plot has symbols representing surveys scaled to be proportional to squared average depth in 4 wetlands (Lake Gore, Lake Quallilup, Lake Carbul and Lake Kubitch). This has the survey during the deepest year (2013) to the left of the plot, the surveys with intermediate depths (2010 and 2012) in the centre of the plot and the shallowest depths (2011 and 2014) to the right/upper right of the plot, indicating that composition is influenced by depth.. The same analysis for summer data shows a similar pattern (Figure 18).

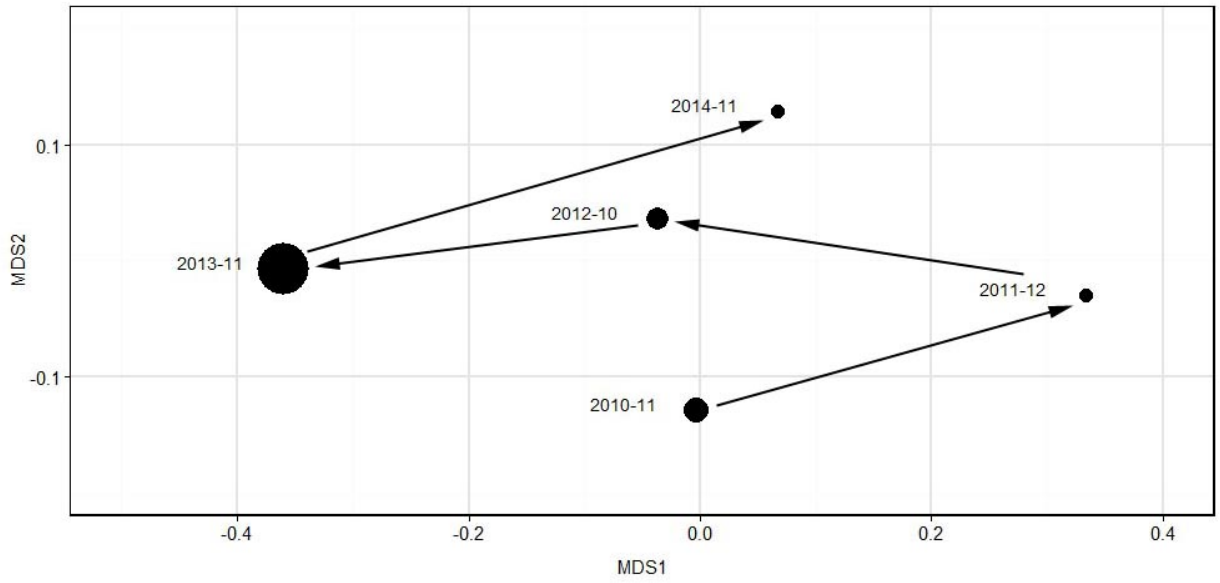

Figure 17. A non-metric multidimensional ordination of Gore-Quallilup waterbird communities from spring surveys between 2010 and 2014, with survey symbols scaled by average range standardised depth^2 across gauged wetlands. Stress = 0.12.

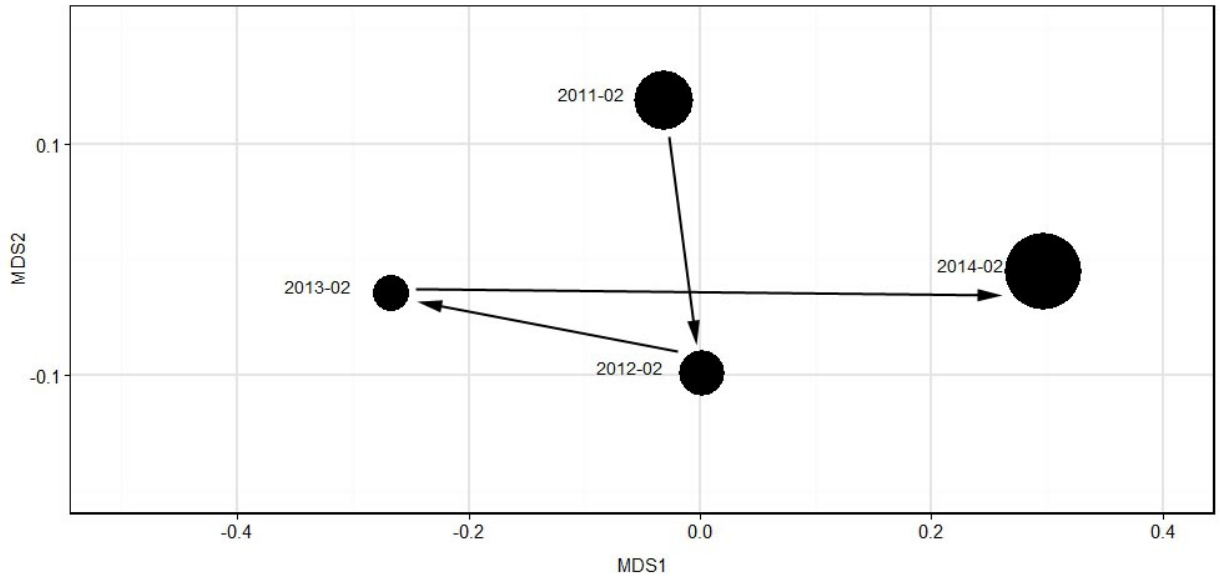

Figure 18. A non-metric multidimensional ordination of Gore-Quallilup waterbird communities from summer surveys between 2011 and 2014 (no depths recorded for 2015), with survey symbols scaled by average range standardised depth^2 across gauged wetlands. Stress = 0.0.

Summary

The main conclusions from these preiliminary analyses are:

1. The Warden and Gore-Quallilup systems support different waterbird communities.
2. In the Warden system spring and summer communities are different whereas this was not so much the case in the Gore-Quallilup wetlands.
3. Abundance of waterbirds in both systems is highly variable but there is no trend in abundance over time. Species richness is quite stable (40 to 50 species) in the Warden system over time except that richness dropped to 32 species in February 2015. Richness in the Gore-Quallilup system is more variable, but also shows no trend over time.
4. There is no evidence that species richness or total waterbird abundance is related to depths across the system (with the proviso that analyses at individual lakes have not been completed), but composition of waterbird communities (abundances of individual species in combination) at the level of the whole system (Warden and Gore-Quallilup) does seem to be influenced by depth. Abundances of some individual species are also clearly related to depth.

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RStudio (2015) *RStudio: Integrated development environment for R (Version 0.98.1103)*.

Appendix 1

Wetlands and dates surveyed for waterbirds in the Warden and Gore systems

Wetland Suite Name	Wetland Suite Code	Wetland	Location	Nov-09	Feb-10	Nov-10	Feb-11	Dec-11	Feb-12	Oct-12	Feb-13
Neridup Suite	WRP001	A	basins	19/11/2009	DRY 22/02/2010	15/11/2010	14/02/2011	12/12/2011	13/02/2012	22/10/2012	11-Feb-13
		B	medium sized central eastern lake	19/11/2009	DRY 22/02/2010	15/11/2010	DRY 14/02/2011	12/12/2011	DRY 13/02/2012	22/10/2012	DRY 11/02/2013
		C	medium sized central western lake	19/11/2009	DRY 22/02/2010	15/11/2010	DRY 14/02/2011	12/12/2011	DRY 13/02/2012	22/10/2012	DRY 11/02/2013
		D	small lake just above WRP001C	19/11/2009	DRY 22/02/2010	15/11/2010	DRY 14/02/2011	DRY 12/12/2011	DRY 13/02/2012	22/10/2012	DRY 11/02/2013
		E	small northern-most lake	19/11/2009	DRY 22/02/2010	DRY 15/11/2010	DRY 14/02/2011	DRY 12/12/2011	DRY 13/02/2012	22/10/2012	DRY 11/02/2013
Bandy Creek Suite	WRP002	A	south-eastern lake	19/11/2009	DRY 22/02/2010	15/11/2010	DRY 14/02/2011	12/12/2011	13/02/2012	22/10/2012	11-Feb-13
		B	adjacent areas	19/11/2009	22/02/2010	15/11/2010	14/02/2011	12/12/2011	13/02/2012	22/10/2012	11-Feb-13
		C	eastern lake closest to track	19/11/2009	DRY 22/02/2010	DRY 15/11/2010	DRY 14/02/2011	12/12/2011	DRY 13/02/2012	22/10/2012	DRY 11/02/2013
		D	lake between C and D	19/11/2009	DRY 22/02/2010	DRY 15/11/2010	DRY 14/02/2011	DRY 12/12/2011	DRY 13/02/2012	22/10/2012	DRY 11/02/2013
		E	north-western most lake close to Merivale Road	19/11/2009	DRY 22/02/2010	DRY 15/11/2010	DRY 14/02/2011	DRY 12/12/2011	DRY 13/02/2012	22/10/2012	DRY 11/02/2013
Ewens Lake	WRP003	A	north and north-west of Ewans that are connected to Ewans, but didn't get into the southern-	19/11/2009	22/02/2010 and 23/02/2010	15/11/2010	14/02/2011	12/12/2011	15/02/2012	23/10/2012	12/02/2013
Mullet Lake	WRP004	A	lake	19/11/2009	23/02/2010	15/11/2010	14/02/2011	12/12/2011	15/02/2012	23/10/2012	12/02/2013
Station Lake	WRP005	A	flats to south of main lake	20/22/2009	DRY 23/02/2010	15/11/2010	DRY 14/02/2011	12/12/2011	15/02/2012	23/10/2012	Dry 12/02/2013
		B	main lake	20/22/2009	DRY 23/02/2010	15/11/2010	14/02/2011	12/12/2011	15/02/2012	23/10/2012	Dry 12/02/2013
		C	lake	20/22/2009	DRY 23/02/2010	15/11/2010	14/02/2011	12/12/2011	15/02/2012	23/10/2012	Dry 12/02/2013
Merivale Suite	WRP021 (ex 5B)	A	Wetlands around north of Mullet Lake	not surveyed	not surveyed	not surveyed	not surveyed	12/12/2011	15/02/2012	23/10/2012	Dry 12/02/2013
Gun Club wetlands	WRP006	A	main lake opposite Lake Road (north of Gun Club)		DRY 22/02/2010	16/11/2010	DRY 14/02/2011	12/12/2011	DRY 15/02/2012	24/10/2012	Dry 12/02/2013
		B	hour-glass shaped on eastern edge of Gun Club	19/11/2009	DRY 22/02/2010	16/11/2010	DRY 14/02/2011	12/12/2011	DRY 15/02/2012	23/10/2012	Dry 12/02/2013
Wheatfield Suite	WRP007	A	Woodie Lake	20/11/2009	23/02/2010	17/11/2010	15/02/2011	13/12/2011	15/02/2012	23/10/2012	12/02/2013
		B/C	eastern section of the Wheatfield to Woodie channel and the Coweramup Inflow	20/11/2009	DRY 23/02/2010	17/11/2010	DRY (except for channel) 15/02/2011	13/12/2011	DRY 15/02/2012	23/10/2012	Dry 12/02/2013
		D	main channel	20/11/2009	23/02/2010	17/11/2010	DRY 15/02/2011	13/12/2011	15/02/2012	24/10/2012	Dry 12/02/2013
		E	007D near Lake Road	20/11/2009	DRY 23/02/2010	17/11/2010	DRY 15/02/2011	13/12/2011	15/02/2012	23/10/2012	
North Wheatfield Suite	WRP008	A	western	20/11/2009	DRY 24/02/2010	16/11/2010	14/02/2011	13/12/2011	14/02/2012	23/10/2012	12/02/2013
		B	central	20/11/2009	DRY 24/02/2010	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed
		C	eastern	20/11/2009	DRY 24/02/2010	16/11/2010	14/02/2011	13/12/2011	14/02/2012	23/10/2012	12/02/2013
Woodie Suite	WRP009	A	main lake	20/11/2009	23/02/2010	17/11/2010	15/02/2011	13/12/2011	15/02/2012	23/10/2012	12/02/2013
		B	very small wetland just near western edge of main lake	20/11/2009	DRY 23/02/2010	17/11/2010	DRY 15/02/2011	13/12/2011	DRY 15/02/2012	23/10/2012	12/02/2013
		C	spectacle' lake north of Woodie	20/11/2009	DRY 23/02/2010	17/11/2010	DRY 15/02/2011	13/12/2011	15/02/2012	23/10/2012	Dry 12/02/2013
		D	Woodie to Windabout channel	20/11/2009	23/02/2010	17/11/2010	15/02/2011	13/12/2011	15/02/2012	23/10/2012	12/02/2013
		E	small wetland opposite boat lauch area	20/11/2009	23/02/2010	17/11/2010	DRY 15/02/2011	13/12/2011	DRY 15/02/2012	23/10/2012	Dry 12/02/2013
		F	long wetland between Woodie and Windabout	20/11/2009	23/02/2010	17/11/2010	15/02/2011	13/12/2011	DRY 15/02/2012	23/10/2012	Dry 12/02/2013
		G	wetland at end of Windabout Way	20/11/2009	23/02/2010	17/11/2010	DRY 15/02/2011	13/12/2011	DRY 15/02/2012	23/10/2012	Dry 12/02/2013
Windabout Suite	WRP010	A	main lake	20/11/2009	23/02/2010	17/11/2010	15/02/2011	13/12/2011	15/02/2012	23/10/2012	12/02/2013
		B	main body	20/11/2009	23/02/2010	17/11/2010	15/02/2011	13/12/2011	15/02/2012	23/10/2012	12/02/2013
		C	east bay	20/11/2009	23/02/2010	17/11/2010	15/02/2011	13/12/2011	15/02/2012	23/10/2012	12/02/2013
		D	small wetland north of south-west bay	20/11/2009	DRY 23/02/2010	17/11/2010	15/02/2011	13/12/2011	DRY 15/02/2012	23/10/2012	Dry 12/02/2013
		E	west bay	20/11/2009	23/02/2010	17/11/2010	15/02/2011	13/12/2011	15/02/2012	23/10/2012	12/02/2013
		F	bay	20/11/2009	23/02/2010	17/11/2010	15/02/2011	13/12/2011	15/02/2012	23/10/2012	12/02/2013
North Windabout Suite	WRP011	A	series of interconnected wetlands between Lake Road	20/11/2009	24/02/2010	17/11/2010	DRY 15/02/2011	13/12/2011	DRY 14/02/2012	24/10/2012	Dry 12/02/2013
Six Mile Hill Suite	WRP012	A	south-east	21/11/2009	DRY Aerial only	16/11/2010	DRY 15/02/2011	13/12/2011	DRY 14/02/2012	24/10/2012	Dry 12/02/2013
		B	south-west	21/11/2009	DRY Aerial only	16/11/2010	DRY 15/02/2011	13/12/2011	DRY 14/02/2012	24/10/2012	Dry 12/02/2013

Wetlands and dates surveyed for waterbirds in the Warden and Gore systems

Wetland Suite Name	Wetland Suite Code	Wetland	Location	Nov-09	Feb-10	Nov-10	Feb-11	Dec-11	Feb-12	Oct-12	Feb-13
		C	south-central	21/11/2009	DRY Aerial only	16/11/2010	DRY 15/02/2011	13/12/2011	DRY 14/02/2012	24/10/2012	Dry 12/02/2013
		D	southern wetland of central pair	21/11/2009	DRY Aerial only	16/11/2010	DRY 15/02/2011	13/12/2011	DRY 14/02/2012	24/10/2012	Dry 12/02/2013
		E	northern wetland of central pair	21/11/2009	DRY Aerial only	16/11/2010	DRY 15/02/2011	13/12/2011	DRY 14/02/2012	24/10/2012	Dry 12/02/2013
		F	northern wetland	not surveyed	DRY Aerial only	not surveyed	not surveyed	not surveyed	not surveyed	24/10/2012	Dry 12/02/2013
Lake Warden Suite	WRP013	A	main lake	21/11/2009	24/02/2010	18/11/2010	16/02/2011	14/12/2011	14/02/2012	24/10/2012	13/02/2013
		B	wetlands on south-eastern edge	21/11/2009	24/02/2010	18/11/2010	16/02/2011	not surveyed	not surveyed	not surveyed	Dry 13/02/2013
		C	of boat ramp track	21/11/2009	24/02/2010	18/11/2010	15/02/2011	14/12/2011	14/02/2012	24/10/2012	Dry 13/02/2013
		D	wetlands on south-eastern edge	21/11/2009	24/02/2010	not surveyed	not surveyed	14/12/2011	14/02/2012	not surveyed	Dry 13/02/2013
		E	western edge of lake	not surveyed	24/02/2010	18/11/2010	16/02/2011	not surveyed	not surveyed	DRY 24/10/2012	13/02/2013
Burkenup Suite	WRP014	A	west of rail-line only, including	21/11/2009	24/02/2010	18/11/2010	16/02/2011	14/12/2011	14/02/2012	24/10/2013	Dry 13/02/2013
Pink Lake	WRP015	A	main lake	21/11/2009	DRY Aerial only	18/11/2010	16/02/2011	14/12/2011	15/02/2012	24/10/2013	13/02/2013
Lake Gore Suite including Dalyup channel and wetland to south of channel	WRP016	A	Main Lake	22/11/2009	25/02/2010	19/11/2010	17/02/2011	15/12/2011	16/02/2012	25/10/2012	14/02/2013
		B	Eastern peripherals behind dune	22/11/2009	25/02/2010	19/11/2010	17/02/2011	15/12/2011	16/02/2012	25/10/2012	14/02/2013
		C	North Western satellite lake 1 (northern lake east of Carbul	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed
		D	North Western satellite lake 2 (middle lake east of Carbul	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed
		E	North Western satellite lake 3 (southern lake east of Carbul	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed
		F	North Western satellite lake 4 (lake between Lake Gore, Carbul Lake and Kubitch Lake)	22/11/2009	25/02/2010	19/11/2010	17/02/2011	15/12/2011	16/02/2012	25/10/2012	14/02/2013
Carbul Lakes	WRP017	A	Carbul Lake	22/11/2009	DRY 25/02/2010	19/11/2010	16/02/2011	15/12/2011	DRY 16/02/2012	25/10/2012	Dry 14/02/2013
		B	Kubitch Lake	22/11/2009	DRY 25/02/2010	19/11/2010	16/02/2011	15/12/2011	16/02/2012	25/10/2012	Dry 14/02/2013
		C	Gidong Lake	Aerial only	DRY Aerial only	Aerial only	16/02/2011	15/12/2011	16/02/2012	25/10/2012	14/02/2013
Dalyup Channel and associated wetlands	WRP018	A	Dalyup Channel	22/11/2009	25/02/2010	19/11/2010	16/02/2011	15/12/2011	16/02/2012	25/10/2012	14/02/2013
		B	Wetland connected to south of	22/11/2009	25/02/2010	19/11/2010	16/02/2011	15/12/2011	16/02/2012	25/10/2012	14/02/2013
		C	Large L-shaped wetland south-	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed	not surveyed
Quallilup Lake	WRP019	A	main lake	22/11/2009	25/02/2010	19/11/2010	17/02/2011	15/12/2011	16/02/2012	25/10/2012	14/02/2013
		B	satellite wetland on north-	not surveyed	25/02/2010	19/11/2010	17/02/2011	15/12/2011	16/02/2012	25/10/2012	14/02/2013
Kubitch to Quallilup flow-through	WRP020	A	From Quallilup north through wetland complex as far as	22/11/2009	25/02/2010	19/11/2010	17/02/2011	15/12/2011	16/02/2012	25/10/2012	14/02/2013

Wetlands and dates surveyed for waterbirds in the Warden and Gore systems

Wetland Suite Name	Wetland Suite Code	Wetland	Location	Nov-13	Feb-14	Nov-14	Feb-15
Neridup Suite	WRP001	A	basins	25/11/2013	DRY 3/02/2014	10/11/2014	DRY 9/02/2015
		B	medium sized central eastern lake	25/11/2013	DRY 3/02/2014	10/11/2014	09/02/2015
		C	medium sized central western lake	25/11/2013	DRY 3/02/2014	10/11/2014	DRY 9/02/2015
		D	small lake just above WRP001C	DRY 25/11/2013	DRY 3/02/2014	10/11/2014	DRY 9/02/2015
		E	small northern-most lake	25/11/2013	DRY 3/02/2014	10/11/2014	DRY 9/02/2015
Bandy Creek Suite	WRP002	A	south-eastern lake	25/11/2013	DRY 3/02/2014	10/11/2014	DRY 9/02/2015
		B	adjacent areas	25/11/2013	03/02/2014	10/11/2014	DRY 9/02/2015
		C	eastern lake closest to track	25/11/2013	DRY 3/02/2014	10/11/2014	DRY 9/02/2015
		D	lake between C and D	25/11/2013	DRY 3/02/2014	10/11/2014	DRY 9/02/2015
		E	north-western most lake close to Merivale Road	25/11/2013	DRY 3/02/2014	11/11/2014	DRY 9/02/2015
Ewens Lake	WRP003	A	north and north-west of Ewans that are connected to Ewans, but didn't get into the southern-	26/11/2013	04/02/2014	11/11/2014	11/02/2015
Mullet Lake	WRP004	A	lake	26/11/2013	04/02/2014	11/11/2014	11/02/2015
Station Lake	WRP005	A	flats to south of main lake	26/11/2013	04/02/2014	11/11/2014	11/02/2015
		B	main lake	26/11/2013	04/02/2014	11/11/2014	11/02/2015
		C	lake	26/11/2013	04/02/2014	11/11/2014	11/02/2015
Merivale Suite	WRP021 (ex 5B)	A	Wetlands around north of Mullet Lake	26/11/2013	DRY 4/02/2014	11/11/2014	DRY 11/02/2015
Gun Club wetlands	WRP006	A	main lake opposite Lake Road (north of Gun Club)	26/11/2013	03/02/2014	10/11/2014	09/02/2015
		B	hour-glass shaped on eastern edge of Gun Club	26/11/2013	03/02/2014	10/11/2014	DRY 9/02/2015
Wheatfield Suite	WRP007	A	Woodie Lake	26/11/2013	04/02/2014	11/11/2014	11/02/2015
		B/C	eastern section of the Wheatfield to Woodie channel and the Coweramup Inflow	26/11/2013	DRY 4/02/2014	11/11/2014	11/02/2015
		D	main channel	26/11/2013	04/02/2014	11/11/2014	not surveyed
		E	007D near Lake Road	26/11/2013	DRY 4/02/2014	12/11/2014	not surveyed
North Wheatfield Suite	WRP008	A	western	26/11/2013	04/02/2014	11/11/2014	9/02/2015 and 11/02/2015
		B	central	not surveyed	not surveyed	not surveyed	not surveyed
		C	eastern	26/11/2013	05/02/2014	11/11/2014	9/02/2015 and 11/02/2015
Woodie Suite	WRP009	A	main lake	26/11/2013	04/02/2014	11/11/2014	11/02/2015
		B	very small wetland just near western edge of main lake	26/11/2013	04/02/2014	11/11/2014	DRY 11/02/2015
		C	spectacle' lake north of Woodie	26/11/2013	04/02/2014	11/11/2014	11/02/2015
		D	Woodie to Windabout channel	26/11/2013	04/02/2014	11/11/2014	11/02/2015
		E	small wetland opposite boat lauch area	26/11/2013	04/02/2014	11/11/2014	DRY not surveyed
		F	long wetland between Woodie and Windabout	26/11/2013	04/02/2014	11/11/2014	DRY 11/02/2015
		G	wetland at end of Windabout Way	26/11/2013	DRY 4/02/2014	11/11/2014	DRY not surveyed
Windabout Suite	WRP010	A	main lake	26/11/2013	04/02/2014	11/11/2014	11/02/2015
		B	main body	26/11/2013	04/02/2014	11/11/2014	11/02/2015
		C	east bay	26/11/2013	04/02/2014	11/11/2014	DRY 11/02/2015
		D	small wetland north of south-west bay	26/11/2013	04/02/2014	11/11/2014	DRY 11/02/2015
		E	west bay	26/11/2013	04/02/2014	11/11/2014	11/02/2015
		F	bay	26/11/2013	04/02/2014	11/11/2014	DRY 11/02/2015
North Windabout Suite	WRP011	A	series of interconnected wetlands between Lake Road	27/11/2013	05/02/2014	11/11/2014	DRY 9/02/2015
Six Mile Hill Suite	WRP012	A	south-east	26/11/2013	DRY 4/02/2014	12/11/2014	DRY 9/02/2015
		B	south-west	26/11/2013	DRY 4/02/2014	DRY 12/11/2014	DRY 9/02/2015

Wetlands and dates surveyed for waterbirds in the Warden and Gore systems

Wetland Suite Name	Wetland Suite Code	Wetland	Location	Nov-13	Feb-14	Nov-14	Feb-15
		C	south-central	26/11/2013	04/02/2014	12/11/2014	DRY 9/02/2015
		D	southern wetland of central pair	26/11/2013	04/02/2014	12/11/2014	DRY 9/02/2015
		E	northern wetland of central pair	26/11/2013	04/02/2014	DRY 12/11/2014	DRY 9/02/2015
		F	northern wetland	26/11/2013	04/02/2014	not surveyed	not surveyed
Lake Warden Suite	WRP013	A	main lake	27/11/2013	05/02/2014	12/11/2014	10/02/2015
		B	wetlands on south-eastern edge	27/11/2013	05/02/2014	not surveyed	not surveyed
		C	of boat ramp track	27/11/2013	05/02/2014	12/11/2014	DRY 10/02/2015
		D	wetlands on south-eastern edge	27/11/2013	05/02/2014	not surveyed	not surveyed
		E	western edge of lake	27/11/2013	not surveyed	DRY 12/11/2014	DRY 10/02/2015
Burkenup Suite	WRP014	A	west of rail-line only, including	27/11/2013	DRY 5/02/2014	12/11/2014	DRY 10/02/2015
Pink Lake	WRP015	A	main lake	27/11/2013	05/02/2014	12/11/2014	10/02/2015
Lake Gore Suite including Dalyup channel and wetland to south of channel	WRP016	A	Main Lake	28/11/2013	06/02/2014	13/11/2014	12/02/2015
		B	Eastern peripherals behind dunes	28/11/2013	06/02/2014	13/11/2014	DRY 12/02/2015
		C	North Western satellite lake 1 (southern lake east of Carbul	27/11/2013	not surveyed	13/11/2014	DRY 10/02/2015
		D	North Western satellite lake 2 (middle lake east of Carbul	27/11/2013	not surveyed	13/11/2014	10/02/2015
		E	North Western satellite lake 3 (southern lake east of Carbul	27/11/2013	not surveyed	13/11/2014	DRY 10/02/2015
		F	North Western satellite lake 4 (lake between Lake Gore, Carbul Lake and Kubitch Lake)	28/11/2013	06/02/2014	13/11/2014	DRY 10/02/2015
Carbul Lakes	WRP017	A	Carbul Lake	28/11/2013	06/02/2014	13/11/2014	DRY 10/02/2015
		B	Kubitch Lake	28/11/2013	06/02/2014	13/11/2014	10/02/2015
		C	Gidong Lake	28/11/2013	06/02/2014	13/11/2014	10/02/2015
Dalyup Channel and associated wetlands	WRP018	A	Dalyup Channel	28/11/2013	06/02/2014	13/11/2014	12/02/2015
		B	Wetland connected to south of	28/11/2013	06/02/2014	13/11/2014	DRY 12/02/2015
		C	Large L-shaped wetland south-	28/11/2013	not surveyed	not surveyed	not surveyed
Quallilup Lake	WRP019	A	main lake	28/11/2013	06/02/2014	13/11/2014	12/02/2015
		B	satellite wetland on north-	28/11/2013	06/02/2014	13/11/2014	12/02/2015
Kubitch to Quallilup flow-through	WRP020	A	From Quallilup north through wetland complex as far as	28/11/2013	06/02/2014	13/11/2014	12/02/2015