Biodiversity and Conservation Science

Surveys of waterbirds using the Lake Warden and Lake Gore Ramsar sites in November 2020 and February 2021

Adrian Pinder[1], Fiona Felton[1], Michael Venarsky[1], David Cale[1] and Plaxy Barratt[2]

[1]Department of Biodiversity, Conservation and Attractions
[2] Birdlife Australia

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GOVERNMENT OF WESTERN AUSTRALIA
Department of Biodiversity, Conservation and Attractions
SOUTHCOAST NATURAL RESOURCE MANAGEMENT
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National Landcare Program

Department of Biodiversity, Conservation and Attractions

Locked Bag 104

Bentley Delivery Centre WA 6983

Phone: (08) 9219 9000

Fax: (08) 9334 0498

www.dbca.wa.gov.au

Questions regarding the use of this material should be directed to:

Program Leader
Ecosystem Science
Department of Biodiversity, Conservation and Attractions
Locked Bag 104
Bentley Delivery Centre WA 6983
Email: adrian.pinder@dbca.wa.gov.au

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Summary

- Ground-based surveys of waterbirds using the Warden and Gore wetland systems were undertaken in November 2020 and February 2021, continuing surveys of these systems commenced in 2006.
- The surveys were undertaken after two years of mostly below average rainfall. Depths of the Warden wetlands during autumn and winter 2020 were very low and while they increased to within ranges of previous years by spring (for most wetlands: Lake Warden remained shallower than for previous spring since 2006) it is possible these shallow depths earlier in the year, possibly in combination with availability of water elsewhere in Australia, influenced whether waterbirds remained in these systems. By contrast, depths in the Gore-Quallilup system were relatively high in Nov 2020. Over the dry 2020/21 summer wetland depths in both systems dropped considerably.
- The 3807 waterbirds using the Warden system in Nov 2020 was lower than for any of the previous ten spring surveys undertaken from 2006 onwards. Numbers of several species of duck, but most noticeably Shelduck, were particularly low, as was the count of Black Swan. Absence of Darter and Great Crested Grebe reflected the shallow depths. Numbers of larger endemic shorebirds were also low, though total number of smaller shorebirds was about average. Eurasian Coot were high in number, mostly on the central suite wetlands. Richness was also low with 38 species present across the Warden system: 4 lower than the 2006 to 2018 spring average. Two Black-tailed Godwits on Ewans Lake are the first records of this species for the current survey series. Overall, the assemblage present in Nov 2020 was more like that of some summer surveys than other spring surveys.
- In contrast to the very low abundance of waterbirds in the Warden system in Nov 2020, total abundance in Feb 2021 (11370) was well within the range recorded in those summer surveys without large numbers of Banded Stilt (all years except for 2015 and 2019). This was only the second time since 2006 that Banded Stilt, Red-necked Avocet and Black-winged Stilt have been absent. The count of 621 smaller shorebirds is also low compared to recent years (1003 to 1995 in 2012 to 2019). Hooded Plover numbers were down on most recent years, largely due to Lake Warden being almost dry. Chestnut Teal and Hoary-headed Grebes also tend to be most abundant on Lake Warden and their low numbers across the system may also be related to conditions at that lake this summer. As for spring, Eurasian Coot were more abundant than normal in this system, as were Pacific Black Duck and Yellow-billed Spoonbills. These may have benefitted from the shallower depths and abundant macrophyte and shallow wading zones in the central suite wetlands.
- With the addition of the Nov 2020 and Feb 2021 data, antecedent rainfall explains about half and one-third of the interannual variation in waterbird assemblages using the Warden wetlands.
- The Gore-Quallilup wetlands were quite well inundated in Nov 2020 and, compared to the Warden system, numbers of waterbirds (9987) were not as low in comparison to previous years. However, numbers of waterbirds in these wetlands were not sufficient to compensate for low numbers in the Warden system. The 4461 Shelduck on the Gore wetlands, which use these wetlands (especially Lake Gore) for moulting, was only slightly under the previous range for spring surveys. The 715 Little Black Cormorant

is the highest count for the 2006 to 2020 ground and/or aerial counts. Sharp-tailed Sandpipers were abundant (243, the previous high being 170 in 2014) but numbers of other migratory shorebirds were within previous ranges). Thirty-two species were observed, which is equal third highest richness (with 2009 and 2012). This was the first survey in which all five cormorant species were recorded and only the third time since 2009 that Eurasian Coot have been present.

- By Feb 2021 wetlands in the Gore-Quallilup system has dried considerably, with very shallow depths (and presumably high salinity) and Carbul and Gidon lakes were both dry. This drying was associated with the lowest total abundance (2800 birds) since summer ground counts commenced in 2010 and lower than any of the earlier aerial surveys. However, few individual species had counts that were lower than previous minima for the system. Rather, there were a large number of species with relatively low counts. Species with counts lower than for all previous summer surveys were Banded Stilt (8, previous average 858), Black-winged Stilt (23 compared to 97), Grey Teal (6 compared to 1208), Hardhead (8 compared to 438) and Musk Duck (1 compared to 282). Notable absences were Hooded Plover and Great Crested Grebe. The former are normally most abundant on the Carbul Lakes (especially Carbul and Kubich), even when Carbul is dry.
- Overall, the results of the 2020/21waterbird surveys reflects the generally lower than average depths in the wetlands following a period of lower than average rainfall. Assemblages tended to be on the edge of what has been observed since 2006.

Background

The surveys of waterbirds using wetlands within the Lake Warden and Gore-Quallilup wetland systems (Figure 1 and Figure 2) in November 2020 and February 2021 are the latest in a series of surveys that started in 2006, associated with the then Lake Warden Recovery Catchment, and that has been reported on previously, most recently by Pinder et al. (2019).

These surveys have aimed to comprehensively count waterbirds using the Lake Warden and Lake Gore wetland systems, including all wetlands within the Ramsar sites 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 reporting.

3. Guide and measure the effectiveness of management actions on waterbird populations.

In this report we present summaries of the data collected to date, incorporating the latest two surveys.

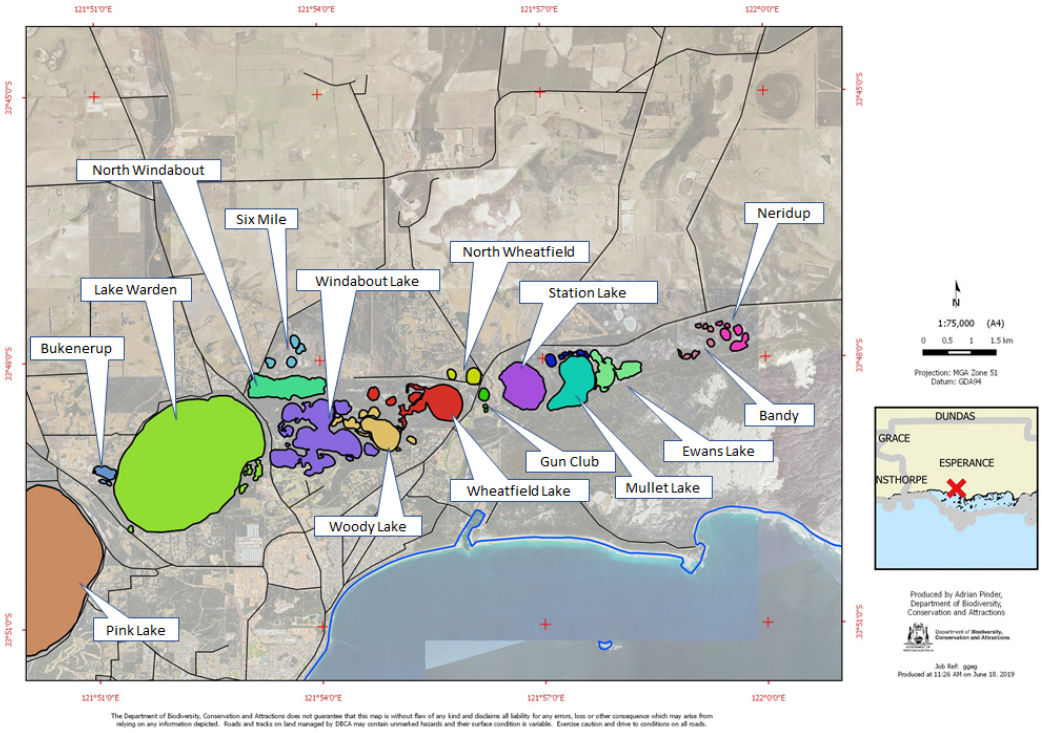

Figure 1. Map showing the Warden system. Colour of wetland polygons indicates suite.

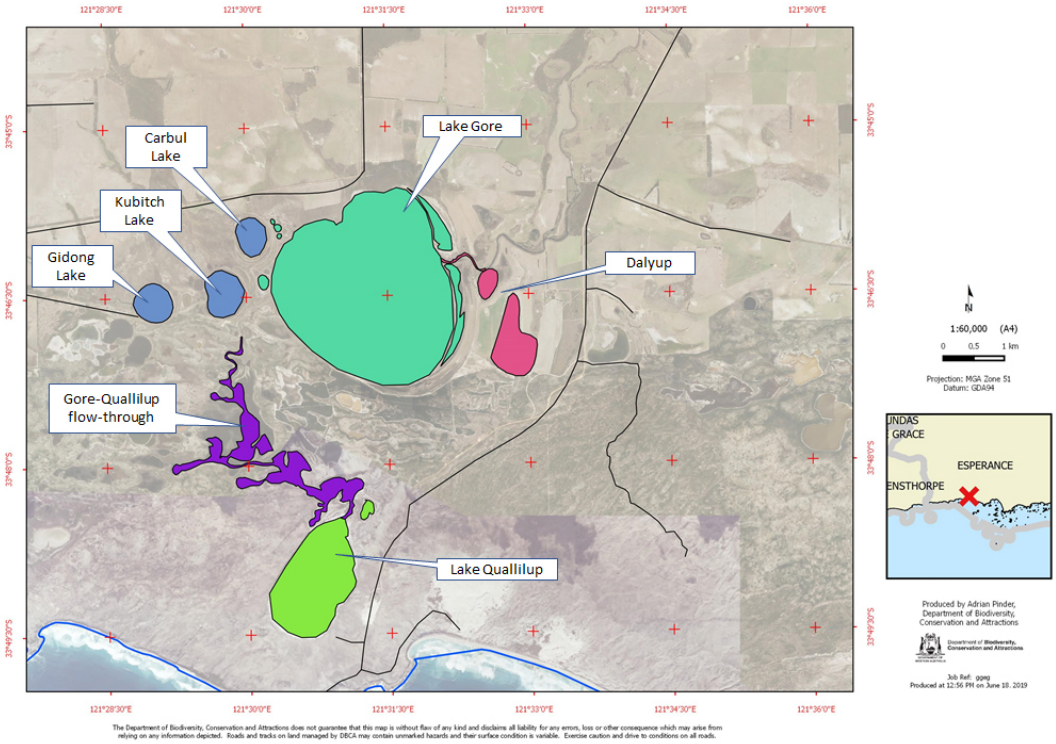

Figure 2. Map showing Gore-Quallilup system. Colour of wetland polygons indicates suite.

Methods

A survey of waterbirds using 65 wetland areas in the Lake Warden and Lake Gore-Quallilup wetland systems was undertaken between 16th and 19th November 2020 and 23rd to 25th February 2021 (
Table 1). The order, survey effort and methods were the same as for other recent surveys in these systems carried out by DBCA, except that Lake Warden was only surveyed by spotting from a number of points around the shore as the lake was very shallow and not supporting large numbers of waterbirds in either season. Pink Lake was incompletely surveyed in Nov 2020 and not surveyed at all in Feb 2021, but this lake has been excluded from all previous analyses.

Lake Wheatfield, Woodie Lake, Windabout Lake, Quallilup Lake and the Quallilup to Gore flowthrough were surveyed by boat. Other wetlands were surveyed on foot. All surveys involved two observers. Observers were Adrian Pinder, Fiona Felton and Mike Venarsky in both seasons, with David Cale in November and Plaxy Barratt from Birdlife Australia in February.

Weather for the November survey was fine, warm and clear with light winds. In February weather was fine, warm and clear but windy on most days.

Ordinations are performed on raw abundance data (rather than square root transformed data). While this means that high abundance species more strongly influence the ordinations than rare species, this is considered appropriate since high numbers of waterbirds are as important as the presence of particular species.

Table 1. Wetlands surveyed during Nov 2020 and Feb 2021.Dry wetlands were surveyed unless otherwise indicated.

SiteCode	Site name	Subsite	Spring 2020	Dry?	Summer 2021	Dry?
WRP001	Neridup Suite	A	16/11/2020		23/02/2021	
WRP001	Neridup Suite	B	16/11/2020		23/02/2021	dry
WRP001	Neridup Suite	C	16/11/2020		23/02/2021	dry
WRP001	Neridup Suite	D	16/11/2020		23/02/2021	dry
WRP001	Neridup Suite	E	16/11/2020		23/02/2021	dry
WRP002	Bandy Creek Suite	A	16/11/2020		23/02/2021	dry
WRP002	Bandy Creek Suite	B	16/11/2020		23/02/2021	
WRP002	Bandy Creek Suite	C	16/11/2020		23/02/2021	dry
WRP002	Bandy Creek Suite	D	16/11/2020		23/02/2021	dry
WRP002	Bandy Creek Suite	E	16/11/2020	dry	23/02/2021	dry
WRP003	Ewens Lake	A	17/11/2020		24/02/2021	
WRP004	Mullet Lake	A	17/11/2020		24/02/2021	
WRP005	Station Lake	A	17/11/2020		24/02/2021	dry
WRP005	Station Lake	B	17/11/2020		24/02/2021	
WRP005	Station Lake	C	17/11/2020		24/02/2021	dry
WRP006	Gun Club Suite	A	16/11/2020		23/02/2021	
WRP006	Gun Club Suite	B	16/11/2020		23/02/2021	dry
WRP007	Lake Wheatfield	A	17/11/2020		24/02/2021	
WRP007	Lake Wheatfield	BC	17/11/2020		24/02/2021	
WRP007	Lake Wheatfield	D	16/11/2020		not surveyed	
WRP007	Lake Wheatfield	E	16/11/2020		not surveyed	
WRP008	North Wheatfield Suite	A	17/11/2020		23/02/2021	
WRP008	North Wheatfield Suite	B	not surveyed		23/02/2021	dry
WRP008	North Wheatfield Suite	C	17/11/2020		23/02/2021	
WRP009	Woodie Lake Suite	A	17/11/2020		24/02/2021	
WRP009	Woodie Lake Suite	C	17/11/2020		24/02/2021	
WRP009	Woodie Lake Suite	D	17/11/2020		not surveyed	
WRP009	Woodie Lake Suite	E	19/11/2020		24/02/2021	
WRP009	Woodie Lake Suite	F	17/11/2020		24/02/2021	
WRP009	Woodie Lake Suite	G	19/11/2020		24/02/2021	dry
WRP010	Windabout Suite	A	17/11/2020		24/02/2021	
WRP010	Windabout Suite	B	17/11/2020		24/02/2021	
WRP010	Windabout Suite	C	not surveyed		not surveyed	
WRP010	Windabout Suite	D	17/11/2020		24/02/2021	
WRP010	Windabout Suite	E	17/11/2020		24/02/2021	
WRP010	Windabout Suite	F	17/11/2020		24/02/2021	dry
WRP011	North Windabout Suite	A	17/11/2020		24/02/2021	
WRP012	Six Mile Hill Suite	A	16/11/2020		23/02/2021	dry
WRP012	Six Mile Hill Suite	B	16/11/2020		23/02/2021	dry
WRP012	Six Mile Hill Suite	C	16/11/2020		23/02/2021	dry
WRP012	Six Mile Hill Suite	D	16/11/2020		23/02/2021	dry
WRP012	Six Mile Hill Suite	E	16/11/2020		23/02/2021	dry
WRP013	Lake Warden Suite	A	19/11/2020		23/02/2021	
WRP013	Lake Warden Suite	B	not surveyed		not surveyed	dry
WRP013	Lake Warden Suite	C	not surveyed		not surveyed	
WRP013	Lake Warden Suite	D	19/11/2020		23/02/2021	
WRP013	Lake Warden Suite	E	not surveyed		not surveyed	
WRP014	Burkenup Suite	A	19/11/2020		24/02/2021	dry
WRP015	Pink Lake	A	19/11/2020		not surveyed	
WRP016	Lake Gore Suite	A	18/11/2020		25/02/2021	
WRP016	Lake Gore Suite	B	18/11/2020		25/02/2021	dry
WRP016	Lake Gore Suite	C	18/11/2020		25/02/2021	dry
WRP016	Lake Gore Suite	D	18/11/2020		25/02/2021	
WRP016	Lake Gore Suite	E	18/11/2020		25/02/2021	dry
WRP016	Lake Gore Suite	F	18/11/2020		25/02/2021	
WRP017	Carbul Lakes	A	18/11/2020		25/02/2021	dry
WRP017	Carbul Lakes	B	19/11/2020		25/02/2021	
WRP017	Carbul Lakes	C	19/11/2020		25/02/2021	dry
WRP018	Dalyup Suite	A	18/11/2020		25/02/2021	
WRP018	Dalyup Suite	B	18/11/2020		25/02/2021	dry
WRP018	Dalyup Suite	C	18/11/2020		25/02/2021	dry
WRP019	Qualilup Lake	A	18/11/2020		25/02/2021	
WRP019	Qualilup Lake	B	18/11/2020		25/02/2021	dry
WRP020	Qualilup-Gore Flowthrough	A	18/11/2020		25/02/2021	
WRP021	Merrivale Suite	A	17/11/2020		24/02/2021	dry

Antecedent rainfall

Figure 3 shows rainfall deciles for the 9 months Nov 2019 to Jul 2020, with the Esperance area receiving below average to very much below average rainfall for this period, along with the rest of the south west.

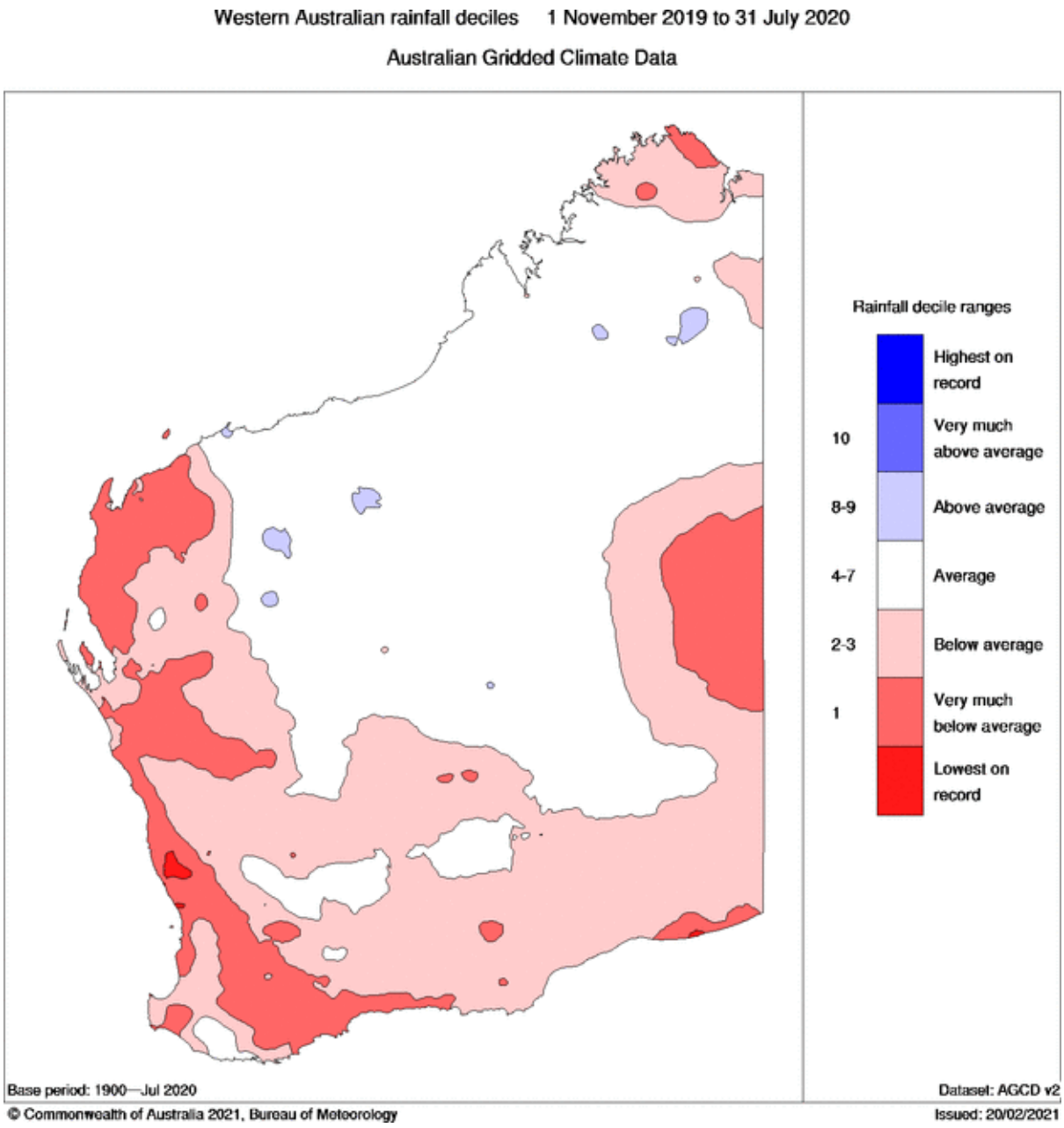

Figure 3. Rainfall deciles for Western Australia for the period 1 Nov 2019 to 31 July 2020.

By contrast, Figure 4 shows above average to very much above average rainfall in August 2020 in the Esperance area and hinterland and most of the south coast, but still below average rainfall in parts of the south-west and Wheatbelt, with average rainfall at best.

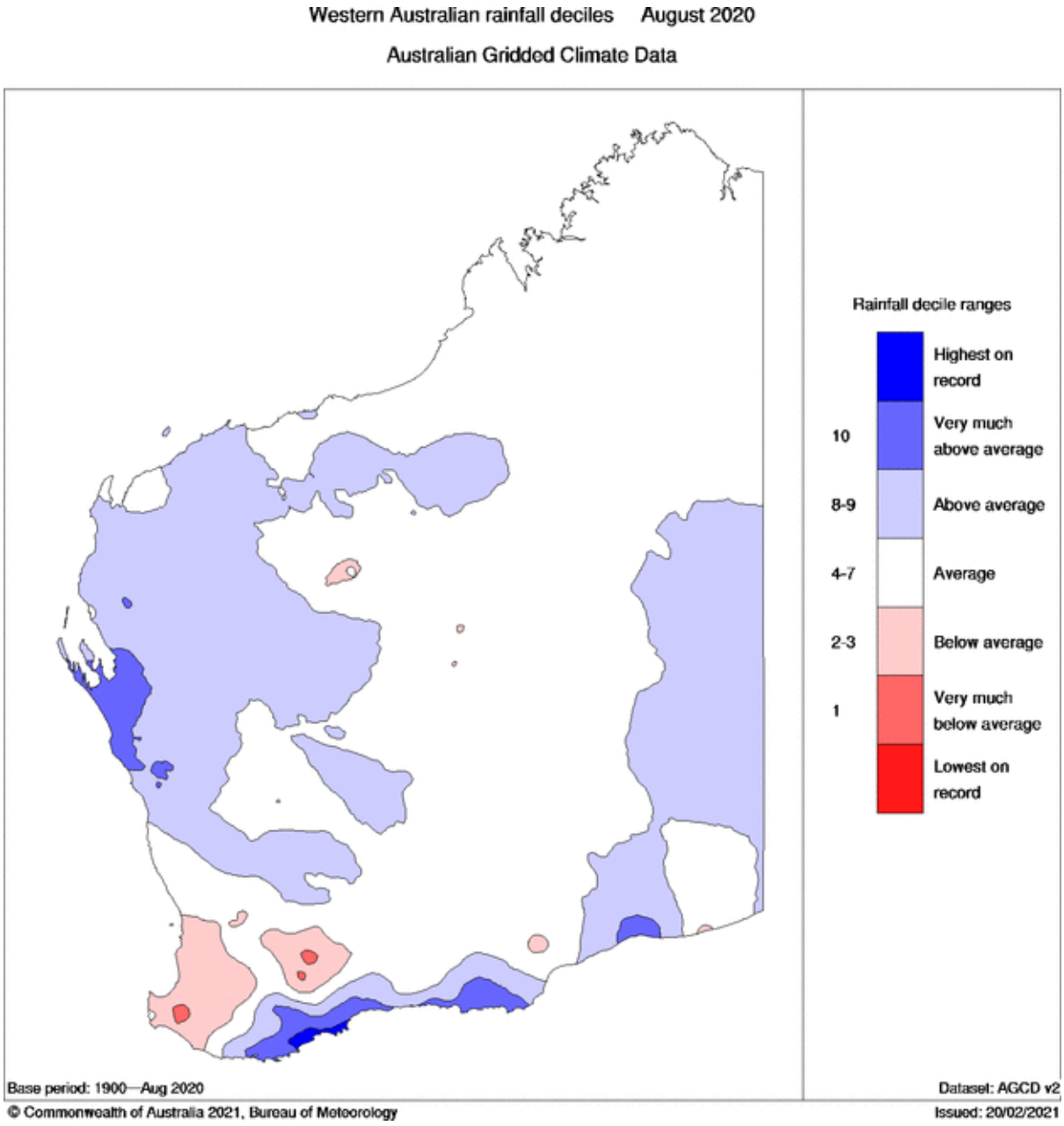

Figure 4. Rainfall deciles for Western Australia for August 2020

September and October 2020 saw a return to below average rainfall for the south coast and hinterland (Figure 5), although there was 86mm during November prior to the survey.

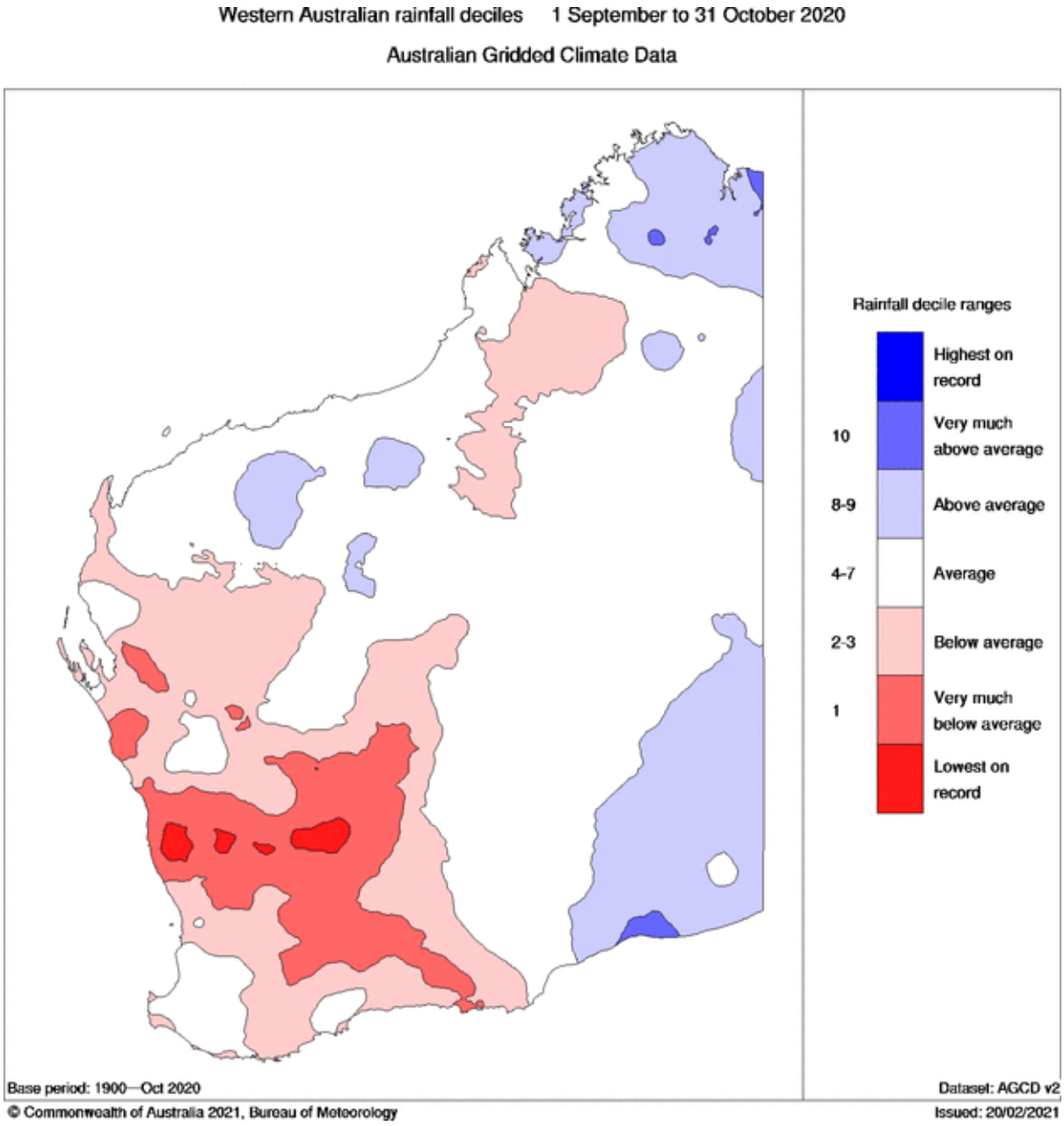

Figure 5. Rainfall deciles for Western Australia for the period 1 September to 31 October.

The Esperance coast received little rain between the Nov and Feb surveys (Figure 6).

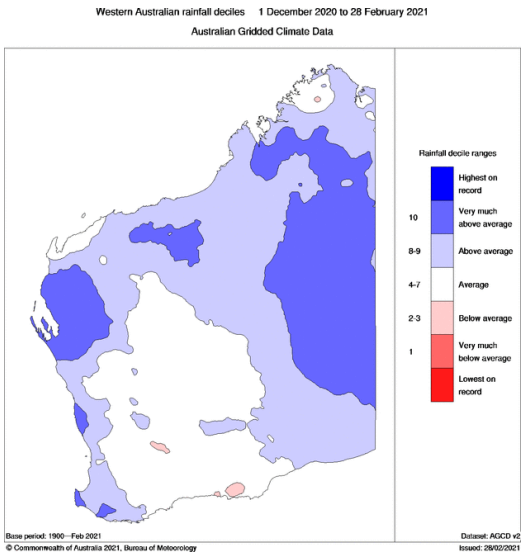

Figure 6. Rainfall deciles for Western Australia for the period 1 December 2020 to 31 Jan 2021.

Rainfall at the Esperance weather station (BoM station 9789) during the 12 months prior to Nov 2020 was 464 mm[1] which is 11% below the average of 520 mm. The period Nov 2019 to July 2020 had consistently below average monthly rainfall totals (with a deficit of 145 mm) but August was very wet (164 mm compared to an average of 80 mm) and September and October were 45% and 25% lower than average respectively. Between the two surveys the Esperance station recorded 43.6 mm which would be lower than average (mean for Dec and Jan alone would be 45.5).

A similar pattern of rainfall was recorded at The Myrup and Esperance Aerodrome rainfall gauges. Rainfall at these stations (BoM stations 9584 and 9452) during the 12 months prior to the Nov 2020 survey was 466 mm and 480 mm, or 23% and 16% below average respectively. As for the Esperance station, August was the only above average month for rainfall at Myrup and Esperance Aerodrome, with 124 and 111 mm respectively (51% and 52% above average).

Figure 7 and Figure 8 show the cumulative deviation from monthly mean rainfall for the period Jan 2004 to October 2020 and Jan 2021 respectively, for three Bureau of Meteorology rainfall stations near Esperance, calculated by subtracting measured monthly rainfall from mean monthly rainfall (latter calculated from all dates available for the respective station). These graphs also show total waterbird abundance for all spring and summer surveys since 2006. This shows that the low waterbird abundance in Nov 2020 occurred after the largest and longest rainfall deficit since 2004 (a net deficit in rainfall for the period February 2017 to July 2020 of between 270 mm and 399 mm for the three stations). This deficit was steepest for the more coastal stations (Esperance and Myrup) and was especially steep for autumn and winter 2020 (e.g. 99 mm for the Esperance rainfall station). By Feb 2021 waterbird abundance had recovered to be within the range of previous surveys, perhaps reflecting even less water elsewhere in the south-west.

[1] Includes 14.5 mm for April 2020 modelled using linear regression from the Myrup (22.8 mm) and Esperance Aerodrome (21.2 mm) values for the same month. BoM data is not otherwise available for April 2020.

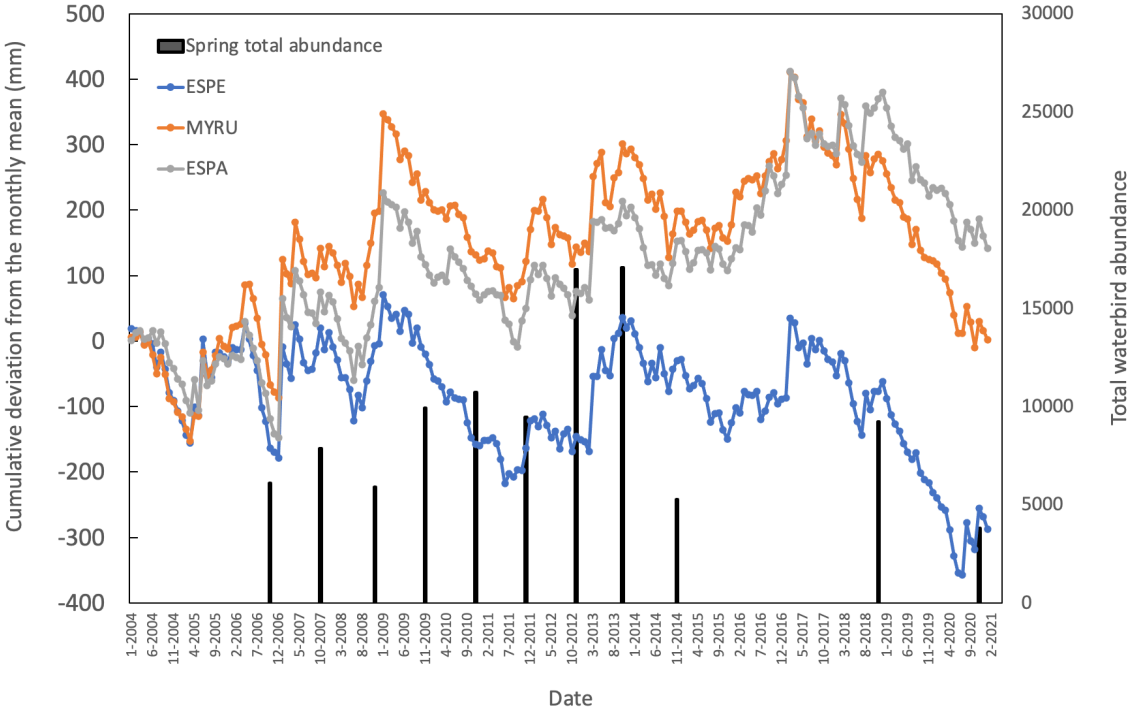

Figure 7. Cumulative deviation from monthly mean for the period Jan 2004 to Jan 2021, with columns representing total numbers of waterbirds counted for spring surveys since 2006.

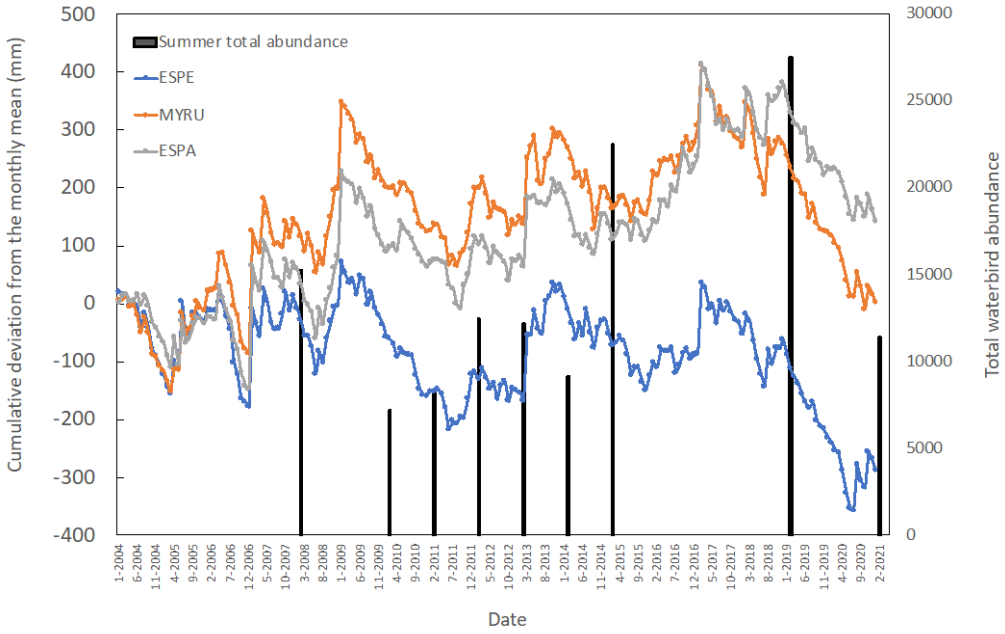

Figure 8. Cumulative deviation from monthly mean for the period Jan 2004 to Jan 2021, with columns representing total numbers of waterbirds counted for summer surveys since 2006.

Wetland depths

Average depth of the gauged Warden wetlands during the Nov 2020 survey was low at 1.2 m, but not as low it has been for some other spring surveys (e.g. 1.06 m in Dec 2011 and 1.12 m in Oct 2012). The difference in 2020 was the very low autumn and winter depths.

Figure 9 to Figure 11 show annual patterns in depths for three wetlands (Ewans, Wheatfield and Warden) for the period 2002 to 2020. These show that depths in Warden wetlands in 2020 were particularly low compared to most other years during at least autumn and winter.

In Ewans Lake, depth increased from the autumn low to be well within the usual range by spring. This pattern was most similar to depth changes in 2014 and 2019. Although depths were not monitored between Nov 2020 and Feb 2021, the Feb 2021 depth (0.42 m, red dot on Figure 9) suggests 2021 will have another shallow autumn in this lake unless there are significant rains.

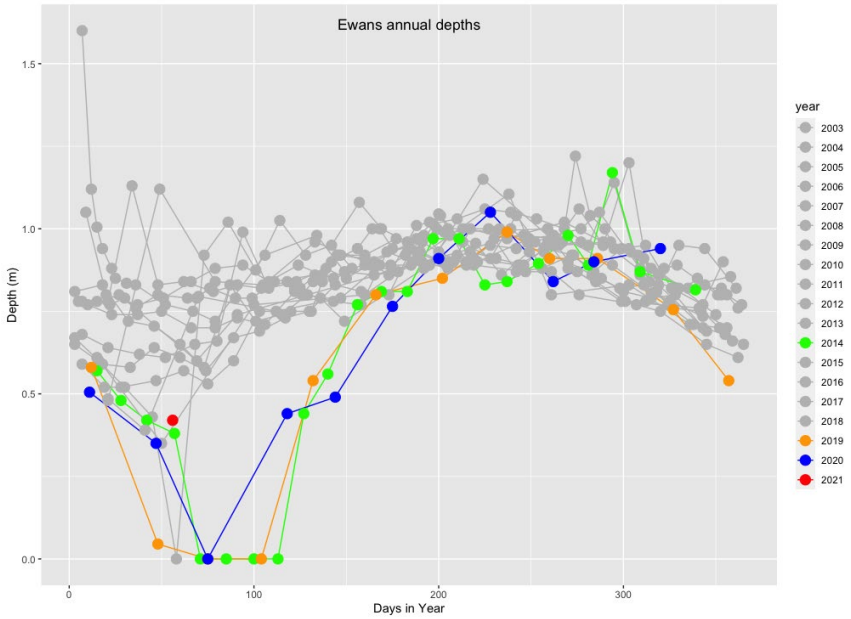

Figure 9. Annual depths of Ewans Lake between 2003 and 2021. Day 1 = 1 January. The 2020 line ends at the Nov survey. The red dot is the depth on Feb 26 2021.

As for Ewans Lake, autumn and early winter depths for 2020 in Lake Wheatfield were the lowest since 2002 and while depth increased in late winter/spring it remained low compared to most previous years. The Feb 2021 depth of 0.85 metres (red dot on Figure 10) was similarly low compared to most years since 2002 and represents low depths across the central suite wetlands.

In Lake Warden (Figure 11), depths were very low throughout the year, comparable only to 2015 and spring depths were the lowest on record since 2002. The Wheatfield pipeline was closed in late November 2019 and was not opened during 2020 in an effort to maintain flows

into Lake Warden from Windabout Lake. In Feb 2021, depth at Lake Warden was so shallow that the water line was beyond the inner-most depth gauge and depth was estimated to about 10cm.

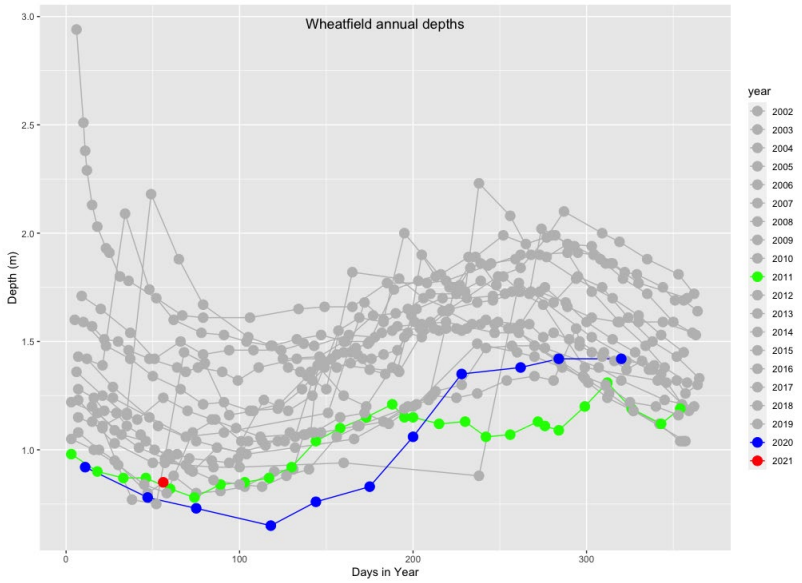

Figure 10. Annual depths of Lake Wheatfield between 2002 and Feb 2021. The 2020 line ends at the Nov survey. The red dot is depth in Feb 2021.

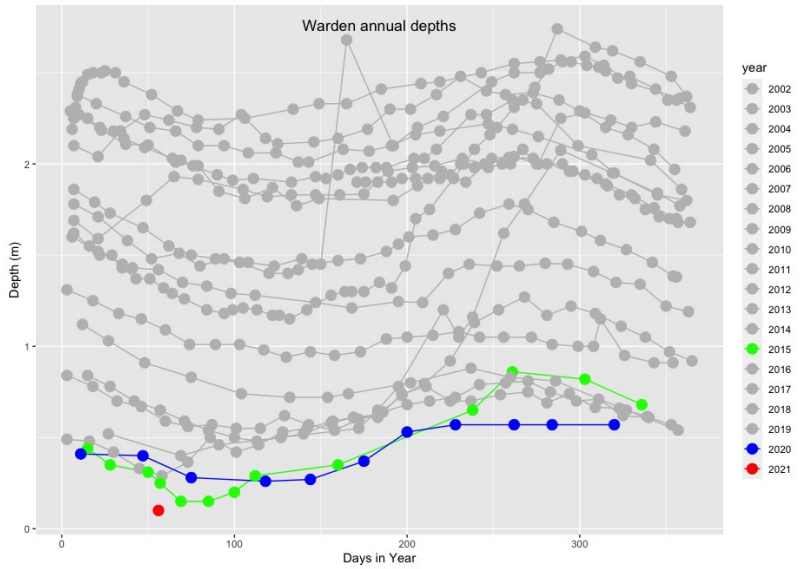

Figure 11. Annual depths of Lake Warden between 2002 and 2020. The 2020 line ends at the Nov survey.

Warden waterbirds

Richness in Nov 2020

The number of species using Warden wetlands in Nov 2020 (38) was lower than for all previous surveys except for the partial survey conducted in Oct 2006 (
Figure 12) and was 4 species lower than the 2006 to 2018 spring average of 42 species. Most absences are species that have also been absent during many previous surveys, but there was a larger number of such species than has been the case for most other surveys. The absence of Darters was notable, perhaps associated with relatively shallow depths. These are normally present in at least Lake Wheatfield, Windabout Lake and/or Lake Warden. Great Crested Grebe, another diving species, was absent for the first time in the 2006 to 2020 surveys. While never present in large numbers, there have always been counts of 1 to 31 in the system, although with greatest numbers in some of the earlier surveys. These have generally been in greatest numbers on Mullet Lake, Wheatfield Lake and Lake Warden. Another notable absence was Whiskered Terns which have been present during most previous surveys, especially on Windabout Lake and Lake Warden. Twelve shorebird species were observed which is not unusually low for the Warden system. The two Black-tailed Godwits on Ewans Lake are the first records of this species for the current survey series.

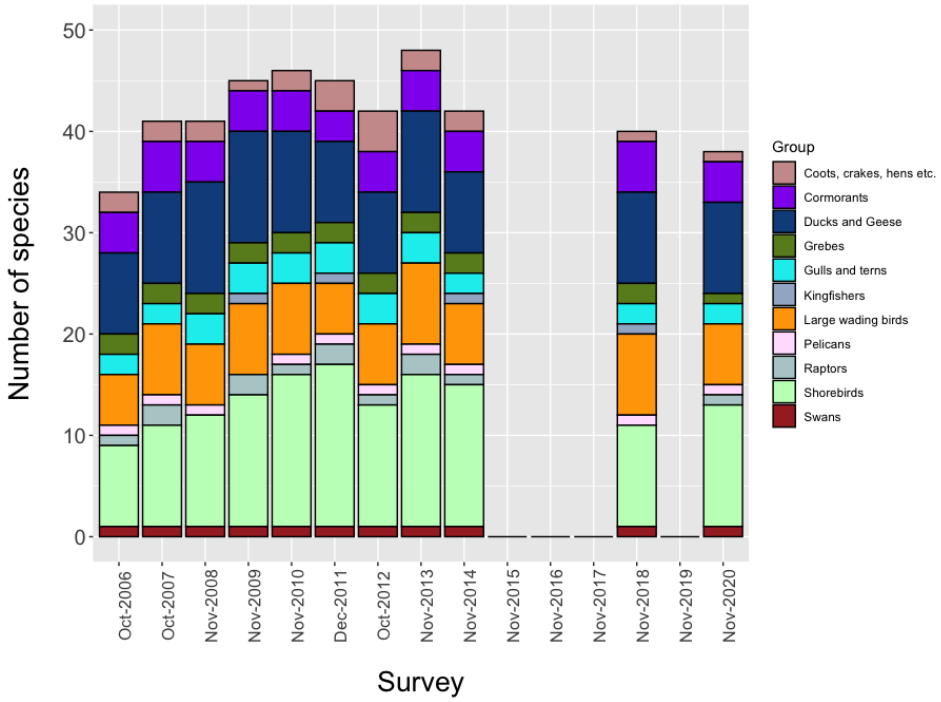

Figure 12. Number of species recorded during spring surveys of the Warden wetland system between 2006 and 2020.

Abundance in Nov 2020

The 3807 waterbirds using the Warden wetlands during the Nov 2020 survey is the lowest count for the 2006 to 2020 period (Figure 13). Numbers of several species of duck were

particularly low. The 370 Australian Shelduck was a very low count compared to counts of >1000 for 2006 to 2013 surveys, although counts in recent years have also been under 1000 (998 in 2014 and 800 in 2018). The count of 452 Black Swan is the lowest on record. The average count for this species is 1152 (2006 to 2019). Numbers of Chestnut Teal (65) were only about half the next previous low count (121) in 2008 and much lower than the 2006 to 2018 average of 333. Grey Teal numbers (749) were also much lower than the 2006 to 2018 average (1610). Only 14 Hardhead were observed, compared to a 2006 to 2018 average of 413. Only one Straw-necked Ibis was recorded, compared to a 2006 to 2018 average of 153.

Banded Stilt vary greatly in number in the Warden system and when in large numbers (sometimes several thousand) mostly congregate on Lake Warden. This year Lake Warden was particularly shallow which meant that salinity was too high for shorebird invertebrate food resources and only a single Banded Stilt was observed across the Warden system. Red-necked Avocet (17 in 2020) were low in number for the same reason. Several weeks prior to the Nov 2020 survey large numbers of Banded Stilt were present on Pink Lake (R Cail pers. comm) but were not observed during the partial survey of this lake in Nov 2020. Numbers of most migratory shorebirds were not unusual, except for relatively low numbers of Common Greenshank (5 compared to an average count of 71 for 2006 to 2018) and the presence of two Black-tailed Godwits.

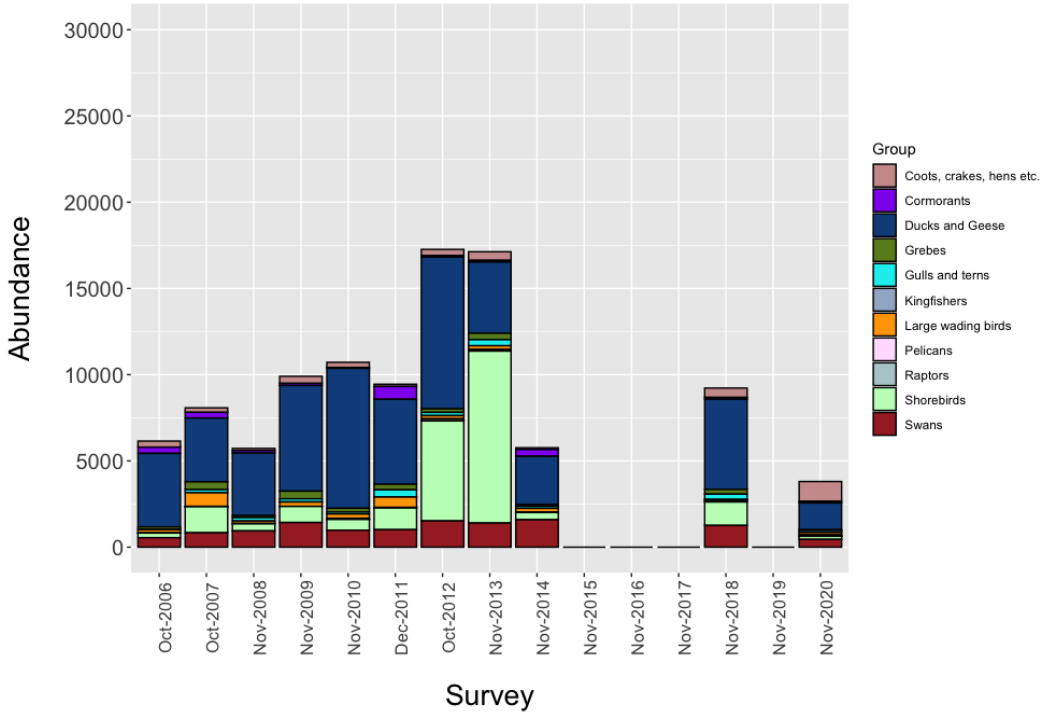

Figure 13. Abundances of waterbirds using the Warden system during spring surveys conducted between 2006 and 2020. Note that no surveys were undertaken in 2015 to 2017 and 2019.

The only species that was notably abundant was Eurasian Coot (1151 compared to a 2006 to 2018 average of 304), mostly on the central suite wetlands.

The low abundance of waterbirds on the Warden system in Nov 2020 means that the 'missing' birds were elsewhere, and this may be related to the low depths in the Warden wetlands earlier

in the year (Figure 9 to Figure 11) and/or to better habitat elsewhere, plus the low depth and high salinity at Lake Warden. Rainfall was consistently low across the south-west during 2020 (Figure 3 to Figure 5) so it would not be expected that waterbirds were using significantly better wetland areas elsewhere in the south-west, but there were significant rains in large parts of south-eastern Australia and some inland wetlands received significant amounts of water. The latter includes Lake Carnegie where an estimated 275000 waterbirds were present in June 2020, including an estimate of 118000 Grey Teal, although total numbers of Grey Teal (2571) using the Warden and Gore system combined was not much below average (3294 for the 2009 to 2018 ground counts).

Composition in Nov 2020

Figure 14 is an ordination of waterbird communities using Warden wetlands during spring between 2006 and 2020, with each survey represented by a symbol coloured and scaled by average depths in the gauged Warden wetlands. The Nov 2020 survey is positioned well to the right of all other surveys, suggesting waterbird composition during the survey was atypical. This may reflect the different hydrological regime in some wetlands compared to most other years in which surveys have been carried out, characterised by unusually low depths during autumn and early winter (Figure 9, Figure 10 and Figure 11). Nonetheless, the Nov 2020 fits with a pattern of composition associated with depth during the surveys, declining from deeper periods to the left of the plot (paler larger symbols) to shallower conditions to the bottom right during the surveys (darker smaller symbols).

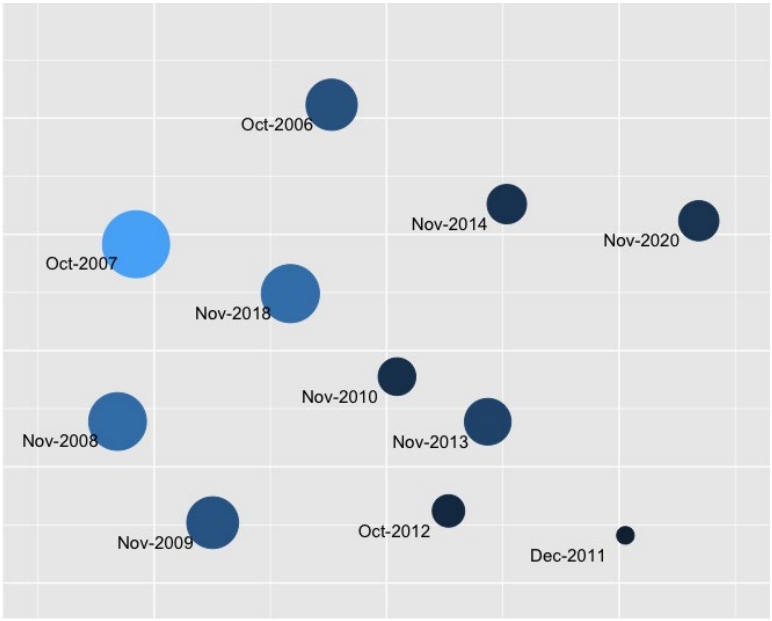

Figure 14. An nMDS ordination of waterbird communities using Warden wetlands during spring from 2006 to 2020. Stress = 0.14.

Richness in Feb 2021

Only 35 species were present in Feb 2021 (Figure 15). This is the second lowest richness for the 2006+ summer surveys; the lowest being 32 species in Feb 2015. Otherwise, richness has

been 40 to 46 species. Notable absences are the three larger non-migratory shorebirds species (Black-winged Stilt, Red-necked Avocet and Banded Stilt) and Pink-eared Duck. Some rare occurrences are a Wood Sandpiper on one of the Neridup wetlands and six Black-tailed Godwits on Wheatfield Lake. The only previous 2006+ records of Wood Sandpipers are from Feb and Nov 2008 and Feb 2012. Previous records of Black-tailed Godwit are 2 individuals on Ewans Lake in Nov 2020. Small numbers of Great Crested Grebe (3) and Darter (1) returned to the Warden wetlands after their notable absence in November.

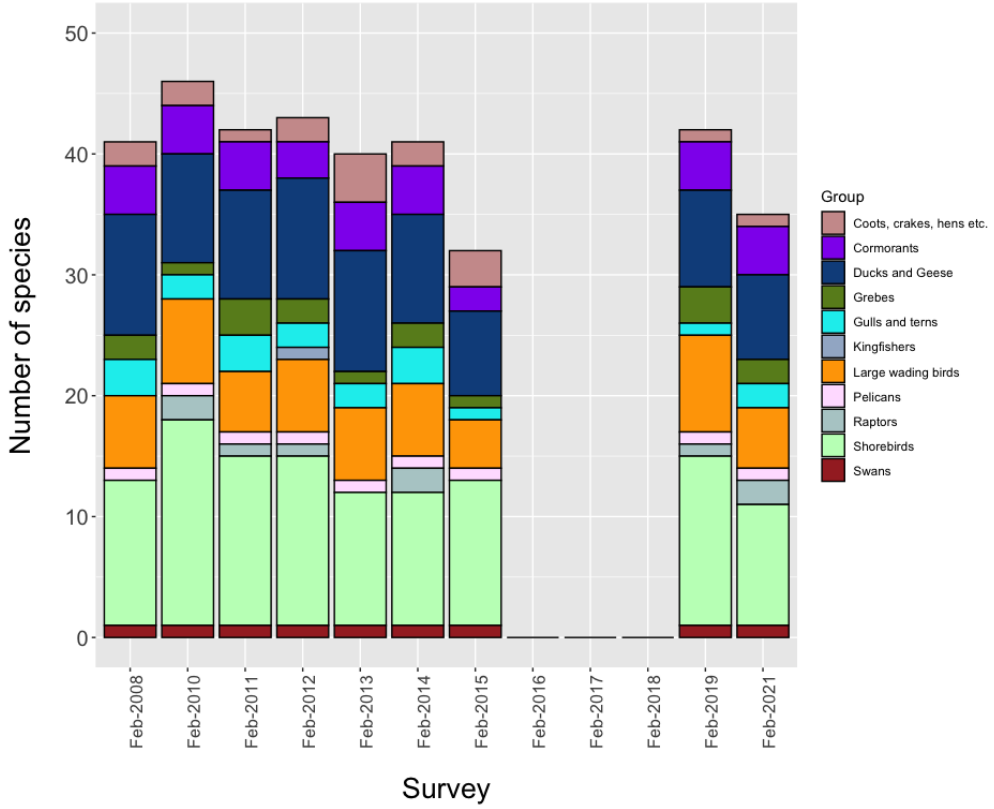

Figure 15. Number of species recorded during summer surveys of the Warden wetland system between 2008 and 2021. No summer surveys were undertaken between 2016 and 2018.

Abundance in Feb 2021

In contrast to the very low abundance of waterbirds in the Warden system in Nov 2020, total abundance in Feb 2021 (11370) was well within the range recorded in those summer surveys without large numbers of Banded Stilt (all years except for 2015 and 2019). This was only the second time since 2006 that Banded Stilt, Red-necked Avocet and Black-winged Stilt have been absent. A large part of the explanation for the first two of these species is that Lake Warden was nearly dry. However, the count of 621 smaller shorebirds is also low compared to recent years (1003 to 1995 in 2012 to 2019) but only slightly lower than the 637 to 783 for summer counts 2006, 2008 and 2010. Number of red-necked stints (420), Hooded Plover (24) and Sharp-tailed Sandpipers (11) were especially low compared to recent years.

Most non-shorebird species were present in numbers within ranges observed since 2006. Exceptions were Chestnut Teal (46) and Hoary-headed Grebe (3). Chestnut Teal normally have highest abundance on Lake Warden and Windabout Lake and Hoary-headed Grebe are also

normally in highest abundance on Lake Warden. That Lake Warden was nearly dry largely explains the low numbers of these two species.

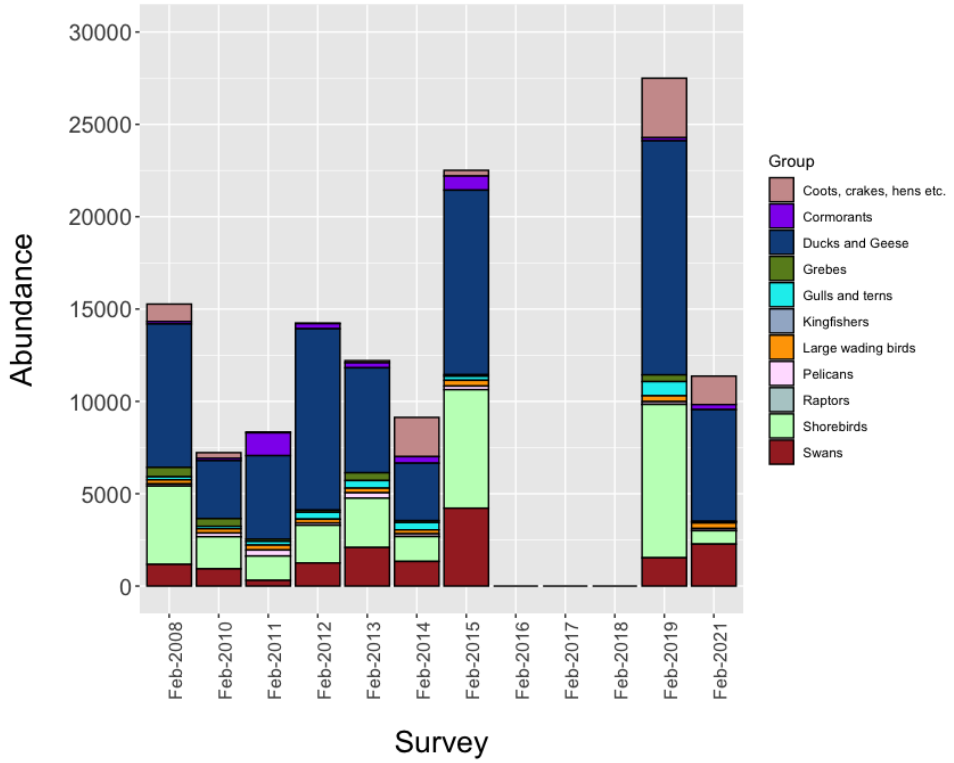

Figure 16. Abundances of waterbirds using the Warden system during summer surveys conducted between 2006 and 2020. Note that no summer surveys were undertaken between 2016 and 2019.

By contrast the number of Pacific Black Duck (3190) is the highest count for the 2006+ surveys (previous range 188 to 2676), as is the count of Yellow-billed Spoonbills (140 compared to a previous range of 62 to 120, mostly <80). Eurasian Coot are usually low in number in the Warden System and the 1543 in Nov 2020 is the third highest count. The shallow water depths in the central suite would have provided greater feeding habitat for the coot, spoonbills and Pacific Black Duck than would be the case when these wetlands are deeper but may not have suited the diving species like grebes, especially as the dense macrophyte occupied much of the water column across the central suite.

Composition in Feb 2021

Figure 17 is an ordination of waterbird communities using Warden wetlands during summer between 2008 and 2021, with colour and size of the survey symbols scaled by average depths in the gauged Warden wetlands. As was the case up to 2019 (Pinder *et al.*, 2019), there is little relationship between wetland depth and waterbirds in summer compared to spring. Nonetheless, the summer 2021 depths were the lowest for the 2008+ summer surveys and the positioning of the symbol representing the Feb 2021 waterbird composition, away from all other summer surveys, may reflect this.

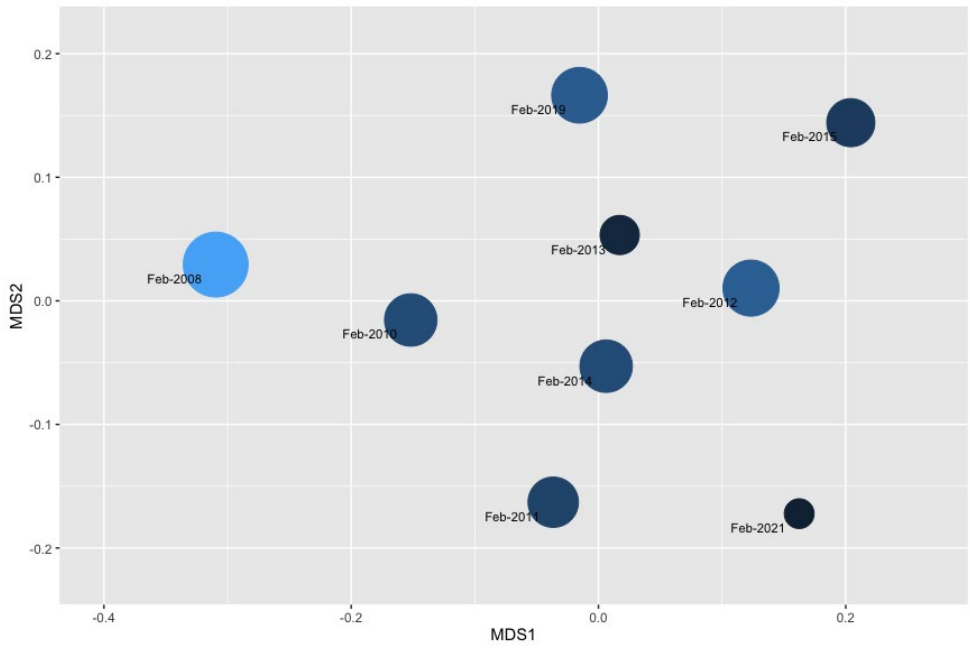

Figure 17. An nMDS ordination of waterbird communities using Warden wetlands during spring from 2008 to 2021. Stress = 0.10.

Influence of rainfall and depth on Warden system waterbird assemblages

Pinder et al. (2019) investigated the influence of antecedent rainfall and depth at the time of the survey on waterbird assemblages. A bio-env analysis explained about a third of variation in assemblage composition in 2006 to 2018 surveys using antecedent rainfall. Addition of the Nov 2020 data extended the gradient of both antecedent rainfall and assemblage composition, with the effect of increasing the explanatory power of antecedent rainfall to about 0.48 (correlation between waterbird assemblage composition and 12 month cumulative deviation from monthly mean for the Myrup and Esperance rainfall stations, $p<0.05$). Adding in the number of days in which the Wheatfield to Bandy Creek pipeline was open in the three months prior to the surveys increased explanatory power to 0.56 (using just the number of days the pipeline was open plus the 12 month cumulative deviation from monthly mean for Myrup). On its own, the number of days the pipeline was open prior to the survey was correlated with assemblage composition ($r^2 = 0.37$, $p<0.01$). Variation timing of the spring surveys was uncorrelated with assemblage composition.

The best model for bio-env analysis of the 2008 to 2019 summer surveys (with or without pipeline days available for selection) consisted of just the 6 month CDMs for the Esperance Aerodrome and Myrup weather stations, with a correlation (r^2) of 0.30 ($p<0.05$). Addition of the Feb 2021 data produced a model with the same rainfall variables but with an increased mantel correlation of 0.37 $p<0.05$). The summer waterbird communities thus seem to be more influenced by CDMs over shorter terms (6 rather than 12 month CDM). This may reflect the importance of rates of drying of the wetlands between the spring and summer surveys. Neither

timing of the summer surveys, nor the number of days that the pipeline was open were correlated with assemblage composition.

Species for which the Warden wetlands support >1% of the global population

Chestnut Teal

Figure 18 shows the total numbers of Chestnut Teal recorded during surveys undertaken from 2006 to 2021. Numbers of this species are highly variable from year to year making comment about trends difficult. Between 2007/8 and 2012/13 the number of this species using the system increased between spring and late summer. Since 2013/14 this has not been the case. The 2020/21 surveys were by far the lowest counts of this species, although this follows a count of >900 in Nov 2018: the highest spring count for this survey series and so there is not a trend of reducing Chestnut Teal numbers.

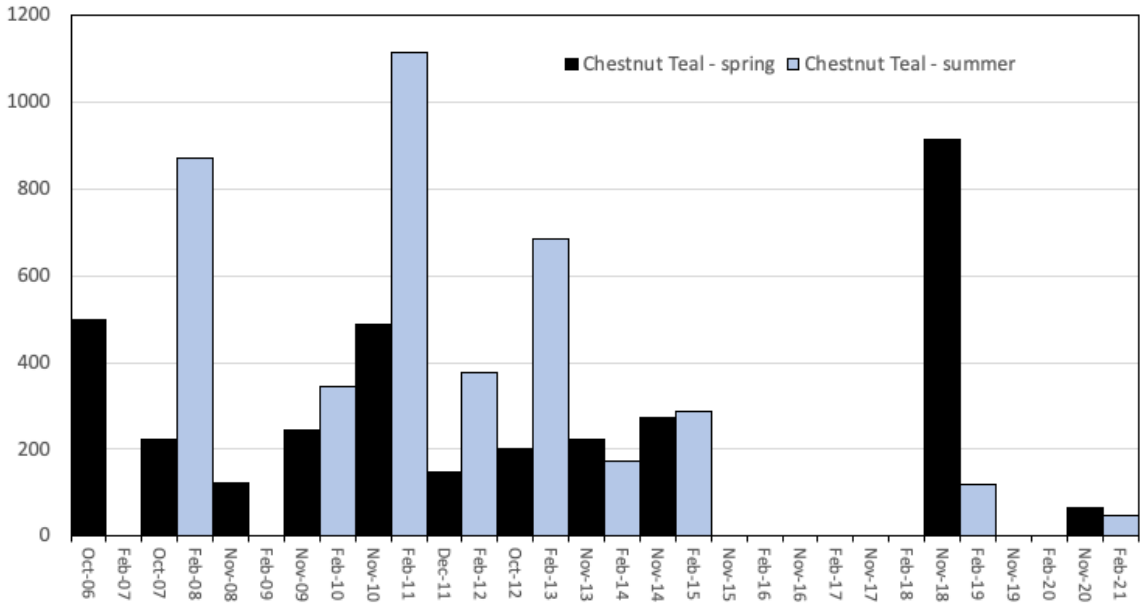

Figure 18. Abundance of Chestnut Teal across the Warden wetlands during surveys undertaken between Oct 2006 and Feb 2021. Blue stars indicate periods where no survey was undertaken.

Hooded Plovers

Figure 19 shows number of Hooded Plovers across the Warden system during spring and summer surveys since 2006. The large increase in numbers after 2009 is an effect of decreasing inundation of Lake Warden after shorebird habitat increased, in large part due to operation of the Wheatfield to Bandy Creek pipeline and reduced overflows from Windabout.

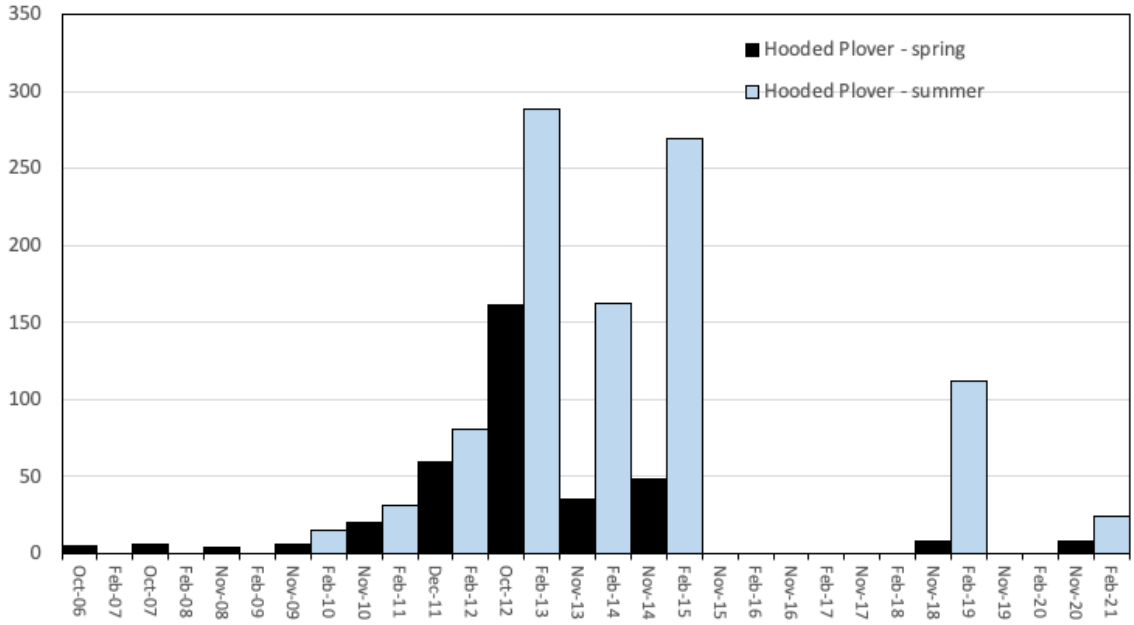

Figure 19. Abundance of Hooded Plover across the Lake Warden system during surveys undertaken between Oct 2006 and Feb 2021. Blue stars indicate periods where no survey was undertaken.

Figure 20 shows how abundance of Hooded plovers on Lake Warden has varied with depth, over four time periods. During the early 1980s depths between 0.6 and 1.0 metres supported the largest numbers of Hooded Plovers. Between 2006 and 2009 depths were much higher, greatly reducing shorebird habitats and Hooded Plovers were absent. After 2009 depths were lower and shorebird habitat greater and Hooded Plovers returned. Lake Warden was shallow during the Nov 2020 and Feb 2021 surveys (red circles on Figure 20) and Hooded Plovers were low in number or absent, as they frequently were during the 1980s at such depths. Reasons for this are not clear as Hooded Plovers do not feed in the water so the presumed high salinity of the lake would not be a proximal problem, though it could have led to fewer aquatic animals being stranded as the water receded. It could also be that there was insufficient discharge of freshwater from the seepages around the north-east corner of the lake where this species is usually most abundant.

The other main lake to support Hooded Plovers is Station Lake in the eastern suite. Here abundance is less strongly related to depth and there is generally plenty of Hooded Plover habitat across the spring/summer depth range, but with highest counts at depths < 0.4 m. Figure 21 shows that numbers of Hooded Plovers using Station Lake during the Oct to Feb period have not changed since the 1980s, except that spring depths are sometimes now higher than 0.7 m and Hooded Plovers are then absent. Figure 19 and Figure 20 show that thresholds of wetland depth influencing Hooded Plovers are not uniform across wetlands.

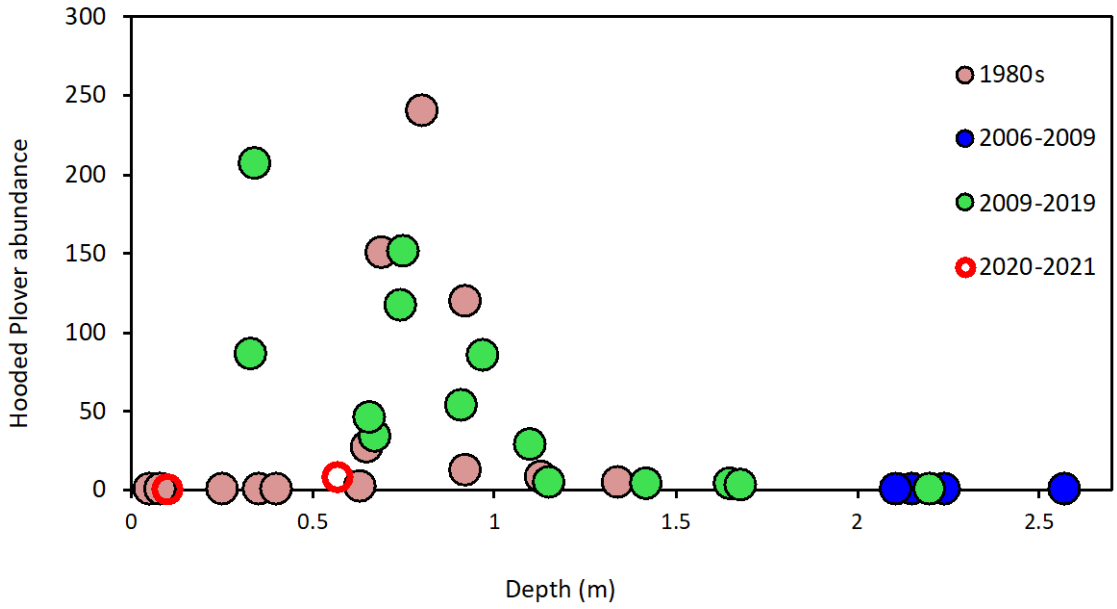

Figure 20. Abundance of Hooded Plovers at Lake Warden during spring and summer surveys undertaken in the 1980s and during the 2006+ surveys split into three periods.

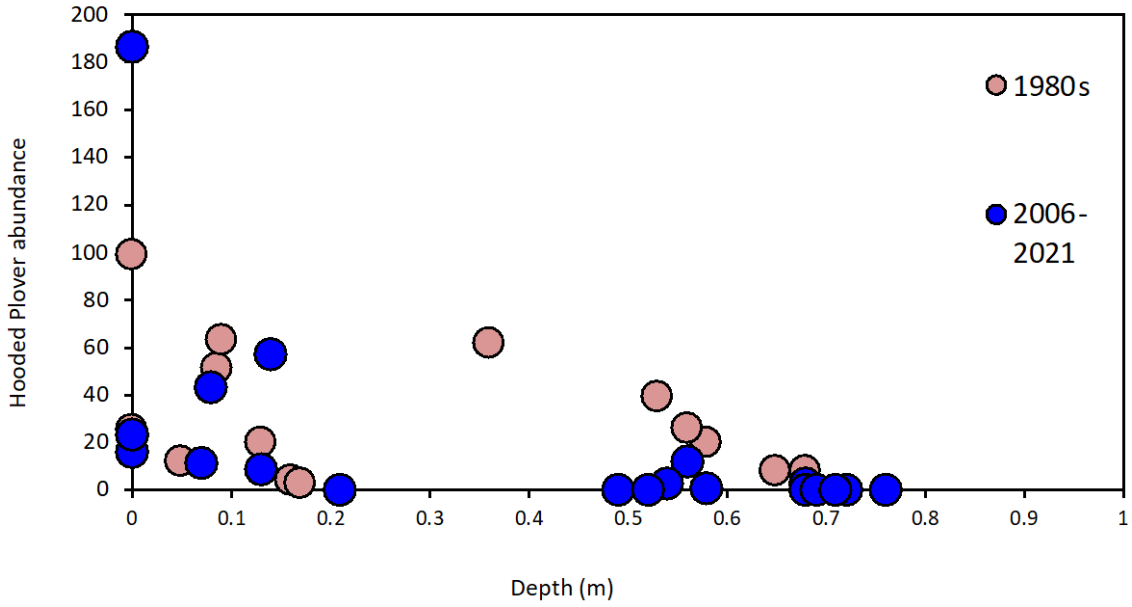

Figure 21. Abundance of Hooded Plovers at Station Lake during spring and summer surveys undertaken in the 1980s and during the 2006+ surveys.

Gore waterbirds

Lake Depths

Lake Gore and the associated wetlands were relatively deep (1.28 m at Lake Gore during the Nov 2020 survey) compared to many other surveys since 2006, although we do not have good

depth time series for these wetlands other than Lake Gore. Depth during the Feb 2021 survey was 0.65 m.

Richness in Nov 2020

Unlike the Warden system, waterbird richness in the Gore system was not lower than average in Nov 2020 (Figure 22). This was the first survey in which five cormorant species were recorded and only the third time since 2009 that Eurasian Coot have been present.

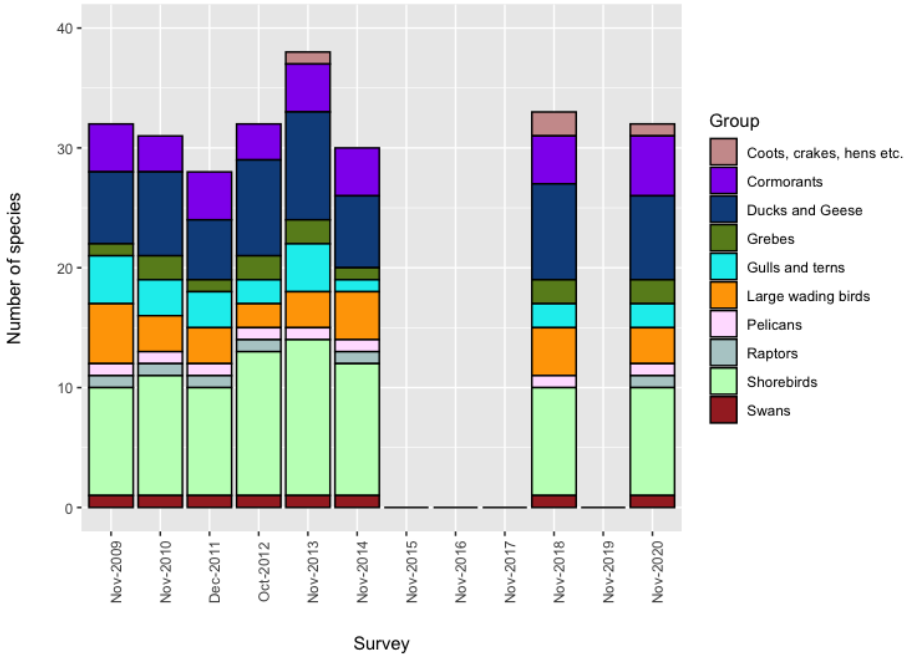

Figure 22. Number of species recorded during spring surveys of the Gore wetland system between 2009 and 2020.

Abundances in Nov 2020

Abundance of waterbirds in the Gore system was also not unusual, with the count of 9987 being not much below the average of 11642 and within the range of previous surveys (Figure 23). Lake Gore is known as an important site for moulting Australian Shelduck. The 4461 counted in the Gore system included 2157 on Lake Gore plus 1552 on the Carbul Lakes. This total is somewhat less than is normally present in this system in spring (4649 to 7346, average 6221). The 715 Little Black Cormorant is the highest count for the 2009 to 2020 surveys. This species was abundant on Lake Gore and the Gore-Quallilup flow-through in 2009 (492) and 2010 (524) when water levels were high, and this species was breeding in the flow-through. Some of the earlier aerial surveys (Surveys from 2011 to 2018 were undertaken when depths in the flow-through, especially, were lower and breeding declined or ceased. Depths in the flow-through were once again quite high in 2020 and this was associated with a return to larger numbers of Little Black Cormorant in the flow-through, albeit not nesting. Counts for most shorebirds were within previous ranges, despite the greater depths and consequently narrower shore zones (at least for the Gore and Carbul suites). Numbers of Sharp-tailed Sandpipers were quite high at 243; the previous high being 170 in 2014. These were all on the flow-through which had greater areas of shallow feeding zone. There are normally at least a few hundred Banded Stilt in the Gore system (maximum 3113 in Oct 2012), especially on the Carbul Lakes, but none were present in 2020.

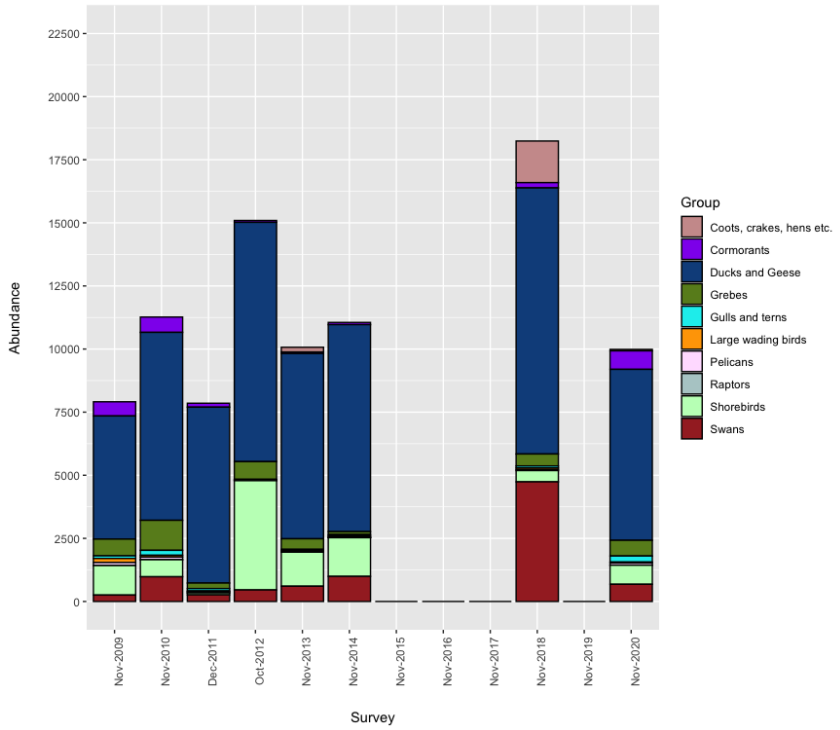

Figure 23. Abundances of waterbirds using the Gore system during spring ground-based surveys conducted between 2010 and 2020. Note that no surveys were undertaken in 2015 to 2017 and 2019.

Abundances of waterbirds using the Gore system did not compensate for the low abundances in the Warden system, so it is not just that birds that would ordinarily use Warden wetlands had moved to the Gore system. Between the two systems the total count of 13794[2] is not high.

Composition in Nov 2020

Figure 24 is an ordination of waterbird community composition based on spring ground counts from 2009 to 2020. This indicates that the assemblage of waterbirds using the Gore-Quallilup wetlands in 2020 was not particularly different to that present during other surveys since 2009. Pinder et al. (2019) noted that the Nov 2018 Gore-Quallilup waterbird assemblage was well outside the previous range of compositions (in the right of the ordination plot), but the 2020 assemblage has come back to being similar to some other survey periods.

[2] Excluding six birds from Pink Lake.

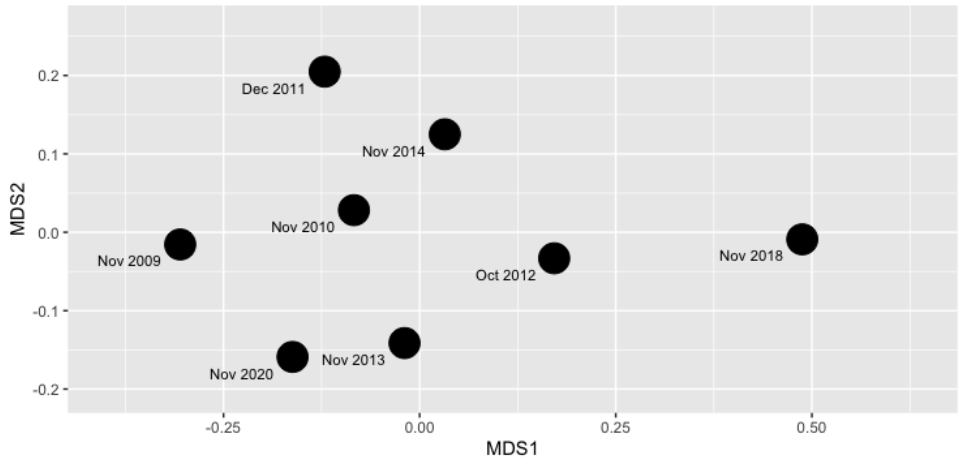

Figure 24. nMDS ordination of waterbird communities present during spring surveys of Gore-Quallilup wetlands conducted between 2009 and 2020 (ground counts). Stress = 0.04.

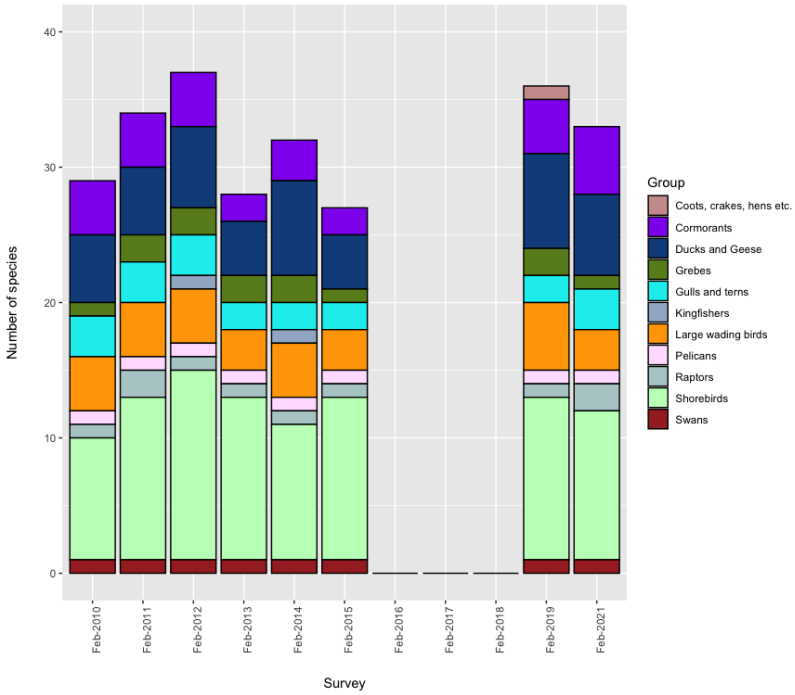

Figure 25. Number of species recorded during summer ground-based surveys of the Gore-Quallilup wetland system between 2010 and 2021.

Richness in Feb 2021

Thirty three waterbird species were present in the Gore-Quallilup system in Feb 2021, an equal second highest richness with Feb 2011. Notable absences are Hooded Plover and Great Crested Grebe. The former is normally most abundant on the Carbul Lakes (especially Carbul

and Kubich), even when Carbul is dry. Absence of Great Crested Grebes would be due to the low depth of Lake Gore. All 33 species had been recorded in this system previously.

Abundances in Feb 2021

The 2800 waterbirds present within the Gore-Quallilup system in Feb 2021 was an exceptionally low count (Figure 26). However, few of the counts of individual species were minima for the species in the 2010+ counts. Rather, there were many species with relatively lower counts than average. For example, there were only 385 Australian Shelduck compared to a previous count range of 256 to 4337 (average 1669) and only 43 Sharp-tailed Sandpipers compared to a previous range of 29 to 226 (average 96). Species with counts lower than for all previous summer surveys are Banded Stilt (8, previous average 858), Black-winged Stilt (23, 97), Grey Teal (6, 1208), Hardhead (8, 438) and Musk Duck (1, 282). The three duck species are normally in greatest numbers on Lake Gore, but this was very shallow and probably too saline to support large numbers. Banded Stilt are normally in greatest numbers on the Carbul wetlands (Carbul, Kubich and Gidon). Their absence may not have anything to do with these lakes per se (although Carbul and Gidon were dry) as much as an absence of these species in the Esperance area over the 2019-20 season. The black-winged stilt is normally in greatest numbers on Lake Gore and the Gore-Quallilup flow-through.

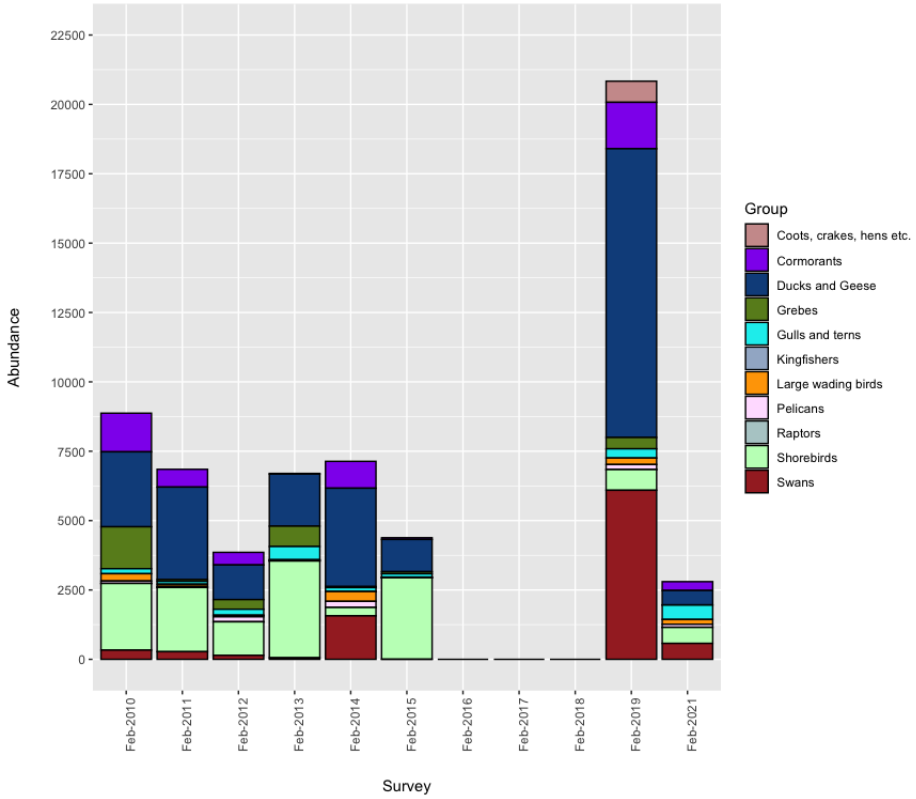

Figure 26. Abundances of waterbirds using the Gore system during summer ground-count surveys conducted between 2010 and 2021. Note that no surveys were undertaken in 2016, 2017 and 2018.

Composition in Feb 2021

Figure 27 is an ordination of waterbird community composition based on summer ground counts from 2009 to 2020. The two most recent surveys (Feb 2019 and Feb 2021, far left and top right respectively) documented assemblages quite different from those present in the 2010 to 2015 period, but also very different from each other.

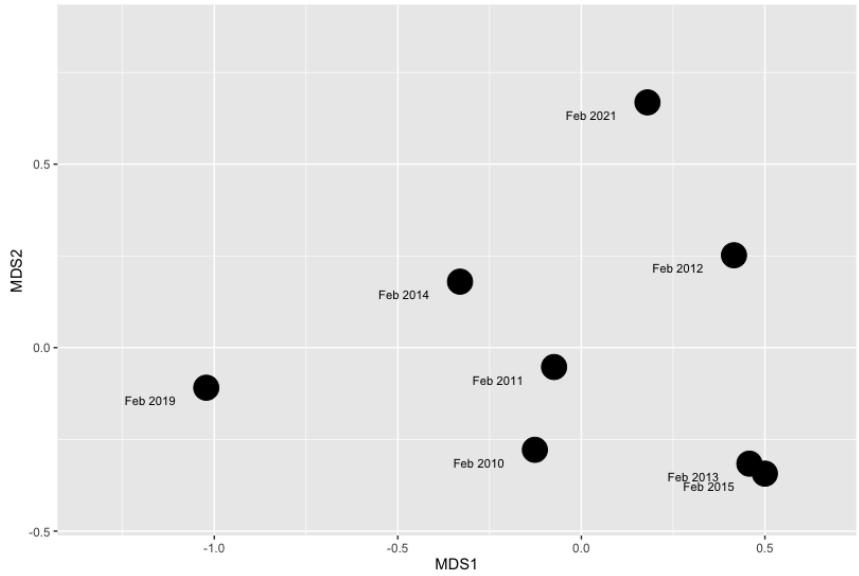

Figure 27. nMDS ordination of waterbird communities present during summer surveys of Gore-Quallilup wetlands conducted between 2010 and 2021 (ground counts). Stress = 0.06.

Warden and Gore combined waterbirds

Abundances in Nov 2020

Combining ground count data across both systems, the Nov 2020 count was the lowest for spring surveys on record so far, even allowing for the inflation large numbers of Banded Stilt in 2012 and 2013 (because they are nomadic and highly variable in numbers). The number of shorebirds was especially low at 935, of which only 1 was a Banded Stilt. The number of Eurasian Coot was the second highest count at 1210. The low total count demonstrates that the low Warden system count was not countered by a relatively high count on the Gore system, so waterbirds had left for other systems.

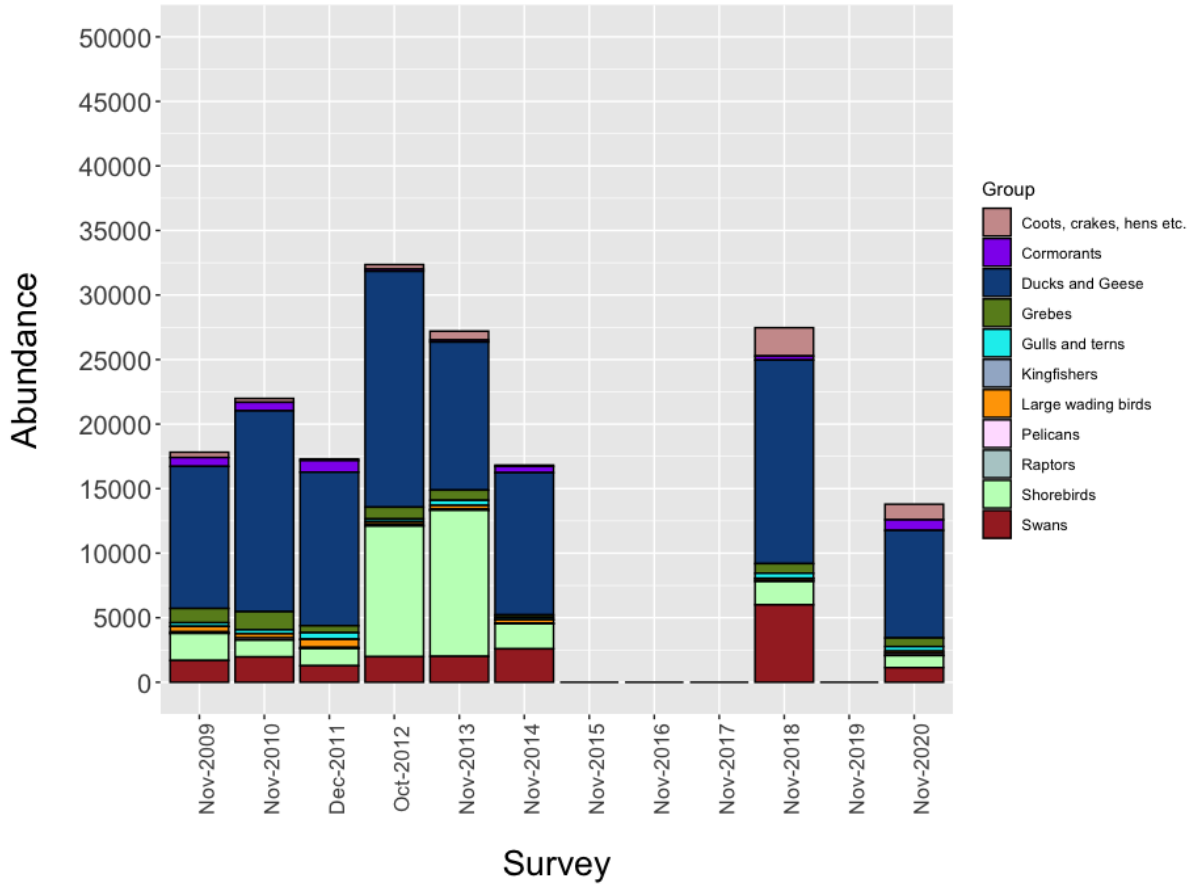

Figure 28. Abundances of waterbirds by major group across both the Warden and Gore-Quallilup systems for ground counts conducted during spring between 2009 and 2020.

Abundances in Feb 2021

The 14170 waterbirds across both systems was also the lowest since 2010, but only slightly lower than some other summer counts. If counts of banded stilt are ignored, then the Feb 2021count of 14162 is similar to counts of 14492 and 13962 in Feb 2010 and Feb 2011 respectively.

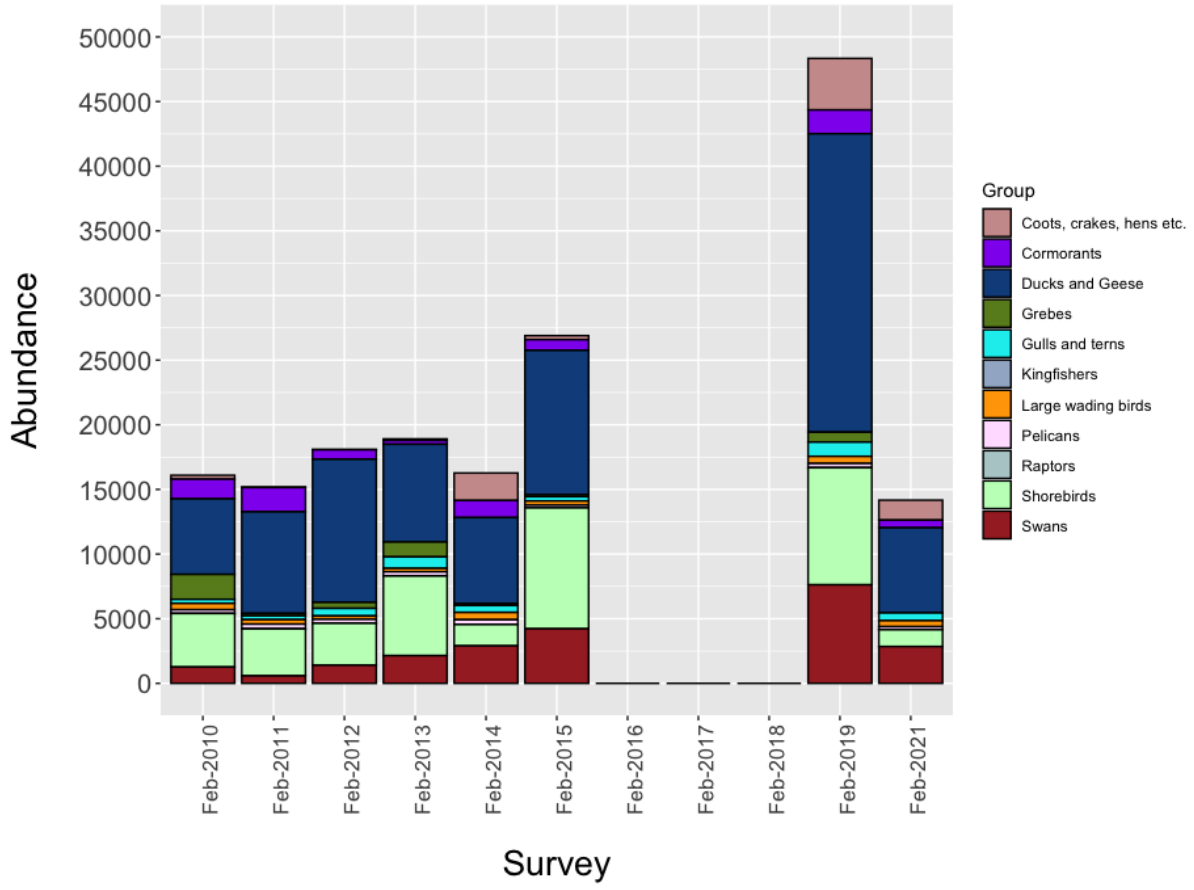

Figure 29. Abundances of waterbirds by major group across both the Warden and Gore-Quallilup systems for ground counts conducted in February between 2010 and 2021.

Assemblage composition Nov 2020

Figure 30 shows an ordination of waterbird communities for both systems combined, by season, for the 2009 to 2021 ground-based surveys. The 2006 to 2008 data are excluded because ground counts were not undertaken on the Gore system prior to Nov 2009. This shows that the combined waterbird assemblage present in Nov 2020 (represented by the lower right blue symbol) was quite different to other spring periods since 2009 and closer to some of the summer communities. The Feb 2021 survey was closest in composition to Nov 2020 suggesting that the 2020-21 year was different to previous years.

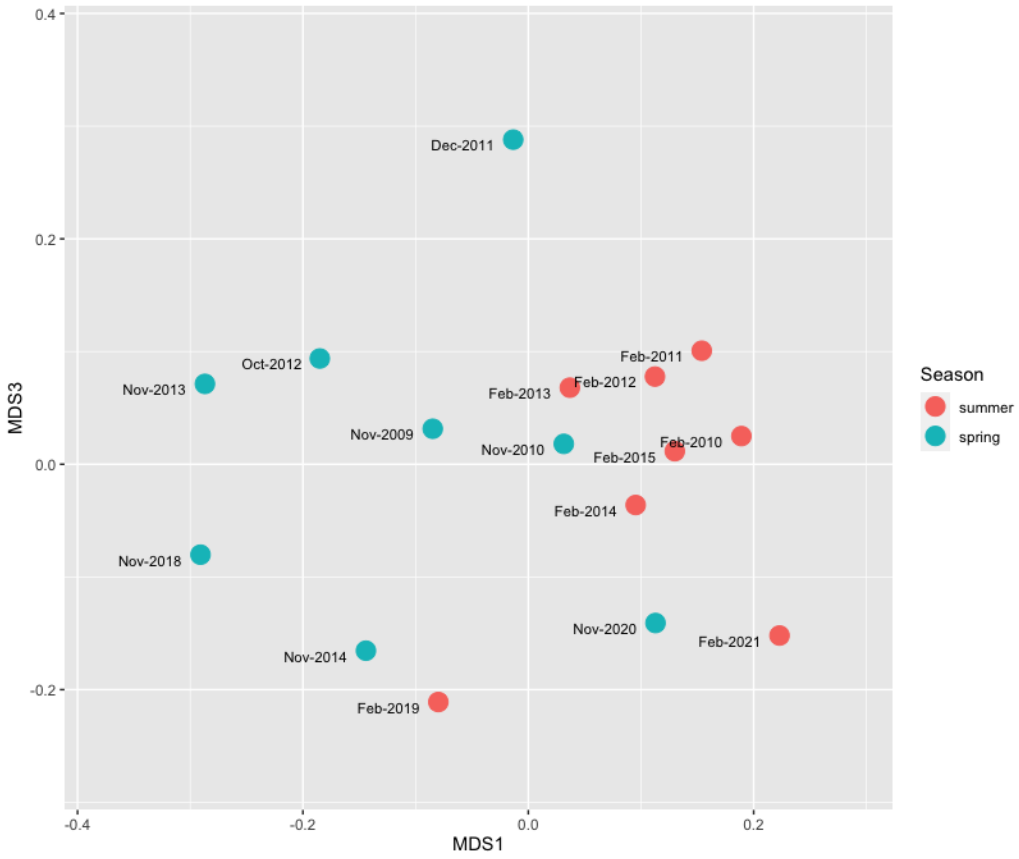

Figure 30. Axes 1 and 2 of a three-dimensional ordination (stress = 0.13) of all ground count waterbird data across the Warden and Gore systems, by season from Nov 2009 to Feb 2021.

Figure 31 shows the same data in an ordination with communities separated by both system (Warden and Gore) and season (spring and summer). This indicates that the November 2020 assemblage in the Gore system (blue open arrow) was not different to several previous spring surveys of the same wetlands (as also shown in Figure 24). By contrast, the November 2020 assemblage in the Warden system (red open arrow) was more like some of the summer assemblages recorded in the Warden system. The February 2021 assemblage in the Gore system was quite different to other summer surveys in this system. The February 2021 assemblage in the Warden system was not so dissimilar to a number of other summer surveys in the same system. Despite the significant variation in waterbird assemblages recorded since 2009 the Warden and Gore assemblages remain distinct and so the two systems are not supporting the same waterbird values.

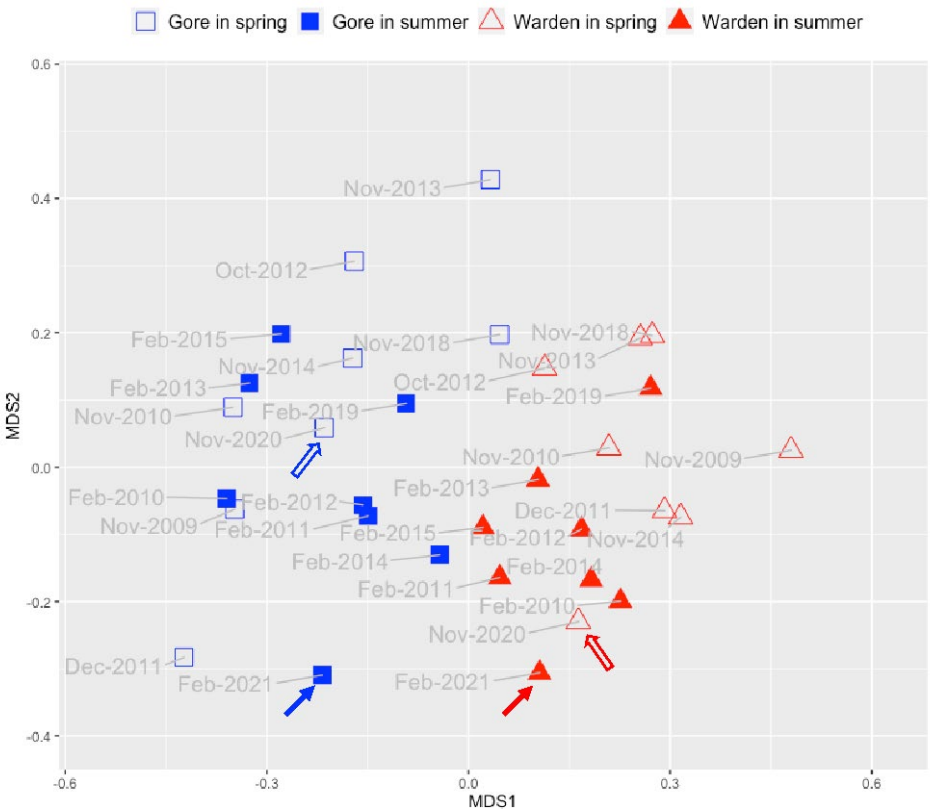

Figure 31. Axes 1 and 2 of a three-dimensional ordination (stress = 0.13) of all waterbird data separated by season and system.

References

Pinder AM, Clarke A, Winchcombe YC, Cale DJ & Coote M (2019). *Surveys of waterbirds using the Lake Warden and Lake Gore Ramsar sites in November 2018 and February 2019, with exploratory analyses of the 2006 to 2019 dataset*. Department of Biodiversity, Conservation and Attractions, Perth , Western Australia.

						Coots	Ducks and														Swans	Grebes		Herons,						Pelicans	Cormora					Raptors		Shorebir														Seabirds				
Suite name	Wetland	Date	No birds - wetland dry	No birds - wetland with water	Not surveyed	Eurasian Coot	Australasian Shoveler	Australian Shelduck	Chestnut Teal	Freckled Duck	Grey Teal	Hardhead	Musk Duck	Pacific Black Duck	Pink-eared Duck	Black Swan	Great Crested Grebe	Hoary-headed Grebe	Australian White Ibis	Cattle Egret	Great Egret	Straw-necked Ibis	White-faced Heron	Yellow-billed Spoonbill	Australian Pelican	Darter	Great Cormorant	Little Black Cormorant	Little Pied Cormorant	Pied Cormorant	Swamp Harrier	White-bellied Sea-eagle	Banded Stilt	Bar-tailed Godwit	Black-fronted Dotterel	Black-tailed Godwit	Black-winged Stilt	Common Greenshank	Common Sandpiper	Hooded Plover	Masked Lapwing (southern)	Red-capped Plover	Red-necked Avocet	Red-necked Stint	Sharp-tailed Sandpiper	Unidentified wader	Wood Sandpiper	Caspian Tern	Crested Tern	Pacific Gull	Silver Gull	Unidentified Tern
Neridup	WRP001A	16/11/2020																				3																																
Neridup	WRP001B	16/11/2020																																																		
Neridup	WRP001C	16/11/2020																					1		1																												
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Neridup	WRP001E	16/11/2020																					3																	2												
Bandy Creek	WRP002A	16/11/2020							1							2							8																														
Bandy Creek	WRP002B	16/11/2020												14		5									4			1													1				10							
Bandy Creek	WRP002C	16/11/2020																					2																														
Bandy Creek	WRP002D	16/11/2020							1																																											
Bandy Creek	WRP002E	16/11/2020	Y																																																	
Ewans	WRP003A	17/11/2020							203	14		281			13		196		2			4			27					1					2						6				14						3	
Mullet	WRP004A	17/11/2020				2	11		45	13				46			118		4				1		5																							2			1	
Station Lake	WRP005A	17/11/2020																				1																														
Station Lake	WRP005B	17/11/2020							69			30			4		118		4						2																												
Station Lake	WRP005C	17/11/2020																																											10		45	3				
Merivale	WRP021A	17/11/2020							1						4		7					1	4																													
Gun Club	WRP006A	16/11/2020				9							1		1		1		1																																	
Gun Club	WRP006B	16/11/2020																					1																		2											
Wheatfield	WRP007A	17/11/2020				986			1	10		149	1	21	28				2	2		26		13	10	4		34												1										18	
Wheatfield	WRP007BC	17/11/2020										4			2							3		2																												
Wheatfield	WRP007D	16/11/2020																					1					1																							
Wheatfield	WRP007E	16/11/2020		Y																																															
North Wheatfield	WRP008A	17/11/2020				71		2	4	2	97	11	6	78	6	2		4				1						7																					6	
North Wheatfield	WRP008B	17/11/2020																															2																
North Wheatfield	WRP008C	17/11/2020				47			4		45	1	14	55		2		1	9						30	6	24					2															35	
Woody	WRP009A	17/11/2020						2	1		19			26				5					3		1		2		1																				14	
Woody	WRP009C	17/11/2020		Y																																															
Woody	WRP009D	17/11/2020							2														7																											6	
Woody	WRP009E	19/11/2020		Y																																														
Woody	WRP009F	17/11/2020																																											2						
Woody	WRP009G	19/11/2020																																				1		1										
Windabout	WRP010A	17/11/2020				36			11		124			27		1		26				1	14		6			11				1				2		3				4				2		18	7
Windabout	WRP010B	17/11/2020																					1																												
Windabout	WRP010C	17/11/2020			Y																																													
Windabout	WRP010E	17/11/2020							4												1		4																1											
Windabout	WRP010F	17/11/2020							2																												3		4					7					
North Wibdabout	WRP011A	17/11/2020		Y																																														
Six Mile	WRP012A	16/11/2020																				2	3	5					1																						
Six Mile	WRP012B	16/11/2020		Y																																														
Six Mile	WRP012C	16/11/2020																				1															4				7									
Six Mile	WRP012D	16/11/2020													1																																			
Six Mile	WRP012E	16/11/2020		Y																																														
Warden	WRP013A	19/11/2020							45																															2		19	13	2						
Warden	WRP013B	19/11/2020			Y																																												
Warden	WRP013C	19/11/2020	Y																																															
Warden	WRP013D	19/11/2020			Y																																												
Bukenerup	WRP014A	19/11/2020		Y																																													
Pink	WRP015A	19/11/2020							4																																			2						
Gore	WRP016A	18/11/2020						2157			75		333			231	8	609			7		1		61			90									11		1				3						171	32
Gore	WRP016B	18/11/2020						86			96					11																												6		27				2	
Gore	WRP016C	18/11/2020		Y																																													
Gore	WRP016D	18/11/2020				4		22			8		1	1	3			2										4									5												
Gore	WRP016E	18/11/2020					3	72			0							1																																
Gore	WRP016F	18/11/2020						5			8																																		3						
Carbul	WRP017A	18/11/2020					7	456			459					34																																		
Carbul	WRP017B	19/11/2020				55		808			176					360							1	2													20													
Carbul	WRP017C	19/11/2020						286	84		574				3	45					1				0											3	2												
Dalyup	WRP018A	18/11/2020											4								4				3		2	2									1	2											28	
Dalyup	WRP018B	18/11/2020																			3		2		4											13	3					1							

						Coots	Ducks and														Swans	Grebes		Herons,						Pelicans	Cormora					Raptors		Shorebird																Seabirds				
Suite name	Wetland	Date	No birds - wetland dry	No birds - wetland with water	Not surveyed	Eurasian Coot	Australasian Shoveler	Australian Shelduck	Chestnut Teal	Freckled Duck	Grey Teal	Hardhead	Musk Duck	Pacific Black Duck	Pink-eared Duck	Black Swan	Great Crested Grebe	Hoary-headed Grebe	Australian White Ibis	Cattle Egret	Great Egret	Straw-necked Ibis	White-faced Heron	Yellow-billed Spoonbill	Australian Pelican	Darter	Great Cormorant	Little Black Cormorant	Little Pied Cormorant	Pied Cormorant	Swamp Harrier	White-bellied Sea-eagle	Banded Stilt	Bar-tailed Godwit	Black-fronted Dotterel	Black-tailed Godwit	Black-winged Stilt	Common Greenshank	Common Sandpiper	Hooded Plover	Masked Lapwing (southern)	Red-capped Plover	Red-necked Avocet	Red-necked Stint	Sharp-tailed Sandpiper	Unidentified wader	Wood Sandpiper	Caspian Tern	Crested Tern	Pacific Gull	Silver Gull	Unidentified Tern
Dalyup	WRP018C	18/11/2020	Y																																																			
Quallilup	WRP019A	18/11/2020							22		4			3									2		2	2	1	10									2												1	4	
Quallilup	WRP019B	18/11/2020			Y																																														
Qualilup flowthrough	WRP020A	18/11/2020						569	24		422			2				1			6		8	1	16	5	6	609		1		1		5		62	15	3		2	12	282	29	243				1	1	
Neridup	WRP001A	23/02/2021																																			1				7		2								
Neridup	WRP001B	23/02/2021	Y																																															
Neridup	WRP001C	23/02/2021	Y																																															
Neridup	WRP001D	23/02/2021	Y																																															
Neridup	WRP001E	23/02/2021	Y																																															
Bandy Creek	WRP002A	23/02/2021	Y																																															
Bandy Creek	WRP002B	23/02/2021						1													1		5																			1										
Bandy Creek	WRP002C	23/02/2021	Y																																															
Bandy Creek	WRP002D	23/02/2021	Y																																															
Bandy Creek	WRP002E	23/02/2021	Y																																															
Ewans	WRP003A	24/02/2021																				1	1															1				98		182								
Mullet	WRP004A	24/02/2021						182					16			510							4		27							1					8	5			1		236				1		4	
Station	WRP005A	24/02/2021	Y																																															
Station	WRP005B	24/02/2021																																					23		14							1				
Station	WRP005C	24/02/2021	Y																																															
Merivale	WRP021A	24/02/2021	Y																																															
Gun Club	WRP006A	23/02/2021																	8				1		1												14				2										
Gun Club	WRP006B	23/02/2021	Y																																															
Wheatfield	WRP007A	24/02/2021				1093	9		28		498	3	204	412		138	3	1	9		38		5	38	60		15	200	2					18	6	9	4		6			4						11	
Wheatfield	WRP007BC	24/02/2021																			1		3											8																
Wheatfield	WRP007D	24/02/2021			Y																																													
Wheatfield	WRP007E	24/02/2021			Y																																													
North Wheatfield	WRP008A	23/02/2021				4	6	21	2		184	1		1180				1	4		2		1	48	1	1		19	8							1	1													
North Wheatfield	WRP008B	23/02/2021	Y																																															
North Wheatfield	WRP008C	23/02/2021														5		1	1		1	2	2	54	3											20				8				7						
Woody	WRP009A	24/02/2021				370					2		22	14					3		8		2		2			6	1							2				2									6	
Woody	WRP009C	24/02/2021																					1																												
Woody	WRP009D	24/02/2021			Y																																												
Woody	WRP009E	24/02/2021			Y																																												
Woody	WRP009F	24/02/2021																																			1														
Woody	WRP009G	24/02/2021	Y																																															
Windabout	WRP010A	24/02/2021				76	13	861	16		794	1		1584		1620			1		6		3		26			6	15							2				26						5		50	
Windabout	WRP010B	24/02/2021			Y																																												
Windabout	WRP010C	24/02/2021			Y																																												
Windabout	WRP010D	24/02/2021			Y																																												
Windabout	WRP010E	24/02/2021																					0														2													
Windabout	WRP010F	24/02/2021	Y																																															
North Windabout	WRP011A	24/02/2021																																					1												
Six Mile	WRP012A	23/02/2021	Y																																															
Six Mile	WRP012B	23/02/2021																													1																			
Six Mile	WRP012C	23/02/2021	Y																																															
Six Mile	WRP012D	23/02/2021	Y																																															
Six Mile	WRP012E	23/02/2021	Y																																															
Warden	WRP013A	23/02/2021																			1	42																													
Warden	WRP013B	23/02/2021	Y																																															
Warden	WRP013C	23/02/2021			Y																																													
Warden	WRP013D	23/02/2021			Y																																													
Warden	WRP013E	23/02/2021			Y																																													
Bukenerup	WRP014A	24/02/2021	Y																																															
Pink	WRP015A	25/02/2021			Y																																													
Gore	WRP016A	25/02/2021						272					1			18					1													8							5	180	232						2	
Gore	WRP016B	25/02/2021	Y																																															
Gore	WRP016C	25/02/2021	Y																																															
Gore	WRP016D	25/02/2021		Y																																														
Gore	WRP016E	25/02/2021	Y																																															

						Coots	Ducks and										Swans	Grebes		Herons,					Pelicans	Cormora					Raptors		Shorebir													Seabirds				
Suite name	Wetland	Date	No birds - wetland dry	No birds - wetland with water	Not surveyed	Eurasian Coot	Australasian Shoveler	Australian Shelduck	Chestnut Teal	Freckled Duck	Grey Teal	Hardhead	Musk Duck	Pacific Black Duck	Pink-eared Duck	Black Swan	Great Crested Grebe	Hoary-headed Grebe	Australian White Ibis	Cattle Egret	Great Egret	Straw-necked Ibis	White-faced Heron	Yellow-billed Spoonbill	Australian Pelican	Darter	Great Cormorant	Little Black Cormorant	Little Pied Cormorant	Pied Cormorant	Swamp Harrier	White-bellied Sea-eagle	Banded Stilt	Bar-tailed Godwit	Black-fronted Dotterel	Black-tailed Godwit	Black-winged Stilt	Common Greenshank	Common Sandpiper	Hooded Plover	Masked Lapwing (southern)	Red-capped Plover	Red-necked Avocet	Red-necked Stint	Sharp-tailed Sandpiper	Unidentified wader	Wood Sandpiper	Caspian Tern	Crested Tern	Pacific Gull	Silver Gull	Unidentified Tern
Carbul	WRP017A	25/02/2021	Y																																															
Carbul	WRP017B	25/02/2021					4	113			4					557												2																						
Carbul	WRP017C	25/02/2021	Y																																														
Dalyup	WRP018A	25/02/2021																4					2								1							5	1											
Dalyup	WRP018B	25/02/2021	Y																																														
Dalyup	WRP018C	25/02/2021	Y																																														
Quallilup	WRP019A	25/02/2021							2												46		2		2	13	0	140				2																18	1		451	
Quallilup	WRP019B	25/02/2021																																			1														
Quallilup flowthrough	WRP020A	25/02/2021							116		2			5				4	2		30		90		108	16	28	96	2	22				5	3		23	47	4		12	2	5		43			10			35	