

Baseline Waterbird Monitoring of Lake Hawdon North, 2022



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Report to the South Australian Government Department for Environment and Water

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Cover photo

Shallowly inundated mudflat habitat at Lake Hawdon North, north of Drain L (cell L-12), 8th November 2022 (photo Ben Taylor).

Disclaimer

This report was commissioned by the South Australian Government Department for Environment and Water. Although all efforts were made to ensure quality, it was based on the best information available at the time and no warranty express or implied is provided for any errors or omissions, nor in the event of its use for any other purposes or by any other parties.

Respect and Reconciliation

Aboriginal people are the First Peoples and Nations of South Australia. The Coorong, connected waters and surrounding lands have sustained unique First Nations cultures since time immemorial.

The *Healthy Coorong, Healthy Basin* program acknowledges the range of First Nations' rights, interests and obligations for the Coorong and connected waterways and the cultural connections that exist between Ngarrindjeri Nations and First Nations of the South East peoples across the region and seeks to support their equitable engagement.

Aboriginal peoples' spiritual, social, cultural and economic practices come from their lands and waters, and they continue to maintain their cultural heritage, economies, languages and laws which are of ongoing importance.

The Department for Environment and Water (DEW) works across the State with Aboriginal South Australians to conserve and sustain Country. Through this work we seek to improve the relationship between Aboriginal and non-Aboriginal Australians and build respect based on mutual understanding and acceptance of each other.

Acknowledgements

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Abbreviations

CSL	Coorong South Lagoon
DEM	Digital Elevation Model
HCHB	<i>Healthy Coorong, Healthy Basin</i> program
LHN	Lake Hawdon North
mAHD	meters Australia Height Datum (elevation relative to mean sea level)
OGW	On-Ground Works project (of the HCHB)
RBR	Regional Bird Refugia component (of the HCHB OGW)
WSEL	Water Surface Elevation

1. Introduction

1.1. Healthy Coorong, Healthy Basin

The Coorong, and Lakes Alexandrina and Albert Wetland is located at the terminus of the Murray-Darling Basin (MDB) System in South Australia. It is a system of shallow lakes, lagoons and wetlands covering over 140,000 hectares that is extremely diverse and an important refuge for migratory and non-migratory waterbirds in the Murray Darling Basin. In 1985 the Coorong, and Lakes Alexandrina and Albert Wetland was declared a Ramsar Wetland of International Importance, largely due to its role in supporting a diverse and abundant waterbird community. The site is also subject to a number of international migratory bird agreements including the Japan Australia Migratory Bird Agreement, the China Australia Migratory Bird Agreement and the Republic of Korea Migratory Bird Agreement and is an Icon Site of the Murray-Darling Basin Living Murray Initiative.

It is well documented (e.g. Brookes et al. 2018) that the Coorong and Lower Lakes has undergone ecological decline, which has been exacerbated by unsustainable water extractions in the MDB and the Millennium Drought. The *Healthy Coorong, Healthy Basin* (HCHB) program proposes to implement works to support the long-term health of the Coorong, with a focus on the Coorong South Lagoon (CSL). The program is being delivered by the South Australian Government Department for Environment and Water (DEW) and is jointly funded by the Australian and South Australian Governments.

The HCHB program will be achieved through six projects, including the On-Ground Works (OGW) project. The OGW project is proposing to implement on-ground works to support the mitigation of threats to key Coorong biota. The OGW project includes the Regional Bird Refugia (RBR) component, which aims to improve the availability and quality of habitat for seven target migratory and non-migratory shorebirds at priority wetlands in the Lower Lakes and South East of South Australia to provide regional refugia. The seven target shorebird species are:

- sharp-tailed sandpiper;
- curlew sandpiper;
- red-necked stint;
- common greenshank;
- banded stilt;
- red-necked avocet; and
- red-capped plover.

A multi criteria decision analysis (MCDA) was undertaken to evaluate the potential of 23 wetlands in the South East region to provide habitat for key species of waterbirds disadvantaged by deteriorating conditions in the southern Coorong (Hunt et al. 2019). Lake Hawdon North (LHN) was one of two South East wetlands receiving the highest MCDA score. A feasibility assessment completed in July 2020 (Taylor 2020) indicated the availability of habitat for the target species could be greatly increased by restoring hydrology and removing shrubland vegetation that has invaded in recent decades. This shrubland is unsuitable habitat for the target species and has established on former open mudflats (Taylor 2014) that would have provided ideal shorebird habitat. Assuming habitat for the target species consists of open mudflats inundated from 0 (damp) to 10 cm depth, Taylor (2020) found that restoration (shrubland removal combined with restored hydrology) could increase the carrying capacity of LHN for target species by 531%.

Following the 2020 feasibility assessment, further investigations have been undertaken examining various aspects of the proposed restoration including:

- detailed design of infrastructure;
- the ideal method to remove shrubland vegetation;
- approvals;
- Traditional Owner perspectives;
- stakeholder and broader community engagement; and
- downstream environmental water requirements.

The ecological objectives of the restoration of Lake Hawdon North have been defined as (Taylor et al. 2022):

- specifically within LHN, to:
 - Objective A. improve the availability and quality of foraging habitat (salt marsh/open mud flats) for the seven HCHB RBR target shorebird species, which are at risk from deteriorating conditions in the southern Coorong;
 - Objective B. increase the area of open mudflat/open water aquatic habitat, maintain the area of *Baumea arthropophylla* and *Gahnia filum* sedgeland and reduce the area of *Melaleuca halmaturorum* shrublands;
 - Objective C. do no harm, i.e. at the very least maintain identified existing ecological values, in particular the highly significant native fish community of the Lake Hawdon system, which includes diadromous species and covers both LHN and adjoining Lake Hawdon South Conservation Park;
- More broadly, to:
 - not adversely impact the health of the downstream Robe Lakes; and
 - provide additional complementary foraging habitat to act as a 'buffer' against worsening conditions in the CSL, particularly during drier periods when waterbirds rely heavily on coastal wetlands.

Nature Glenelg Trust, in collaboration with the Department for Environment and Water, have developed a baseline ecological monitoring program to enable the ecological outcomes of restoration to be measured and assessed against those project objectives specific to LHN. The elements of the monitoring program and their relationship to the ecological objectives of the restoration project are as follows:

Objective A

- Shorebirds and other waterbirds: quantify the abundance of the seven HCHB RBR target shorebird species and other waterbirds across LHN to establish a pre-restoration baseline and to guide future surveys.
- Shorebird food resources: quantify the diversity and abundance of macroinvertebrate food resources for shorebirds in the sediments of both Lake Hawdon North and Lake Hawdon South to establish a pre-restoration baseline and a comparison between the two sites.

Objective B

- Vegetation transects: establish transects that describe the pre-restoration vegetation of LHN and enable future changes arising through restoration to be observed and monitored.
- *Melaleuca halmaturorum* recruitment: continue previously established monitoring of the abundance and size distribution of this invasive native species to provide an indication of the

effectiveness of management, primarily grazing and hydrology, at preventing its proliferation within LHN.

Objective C

- Fish: undertake fish monitoring of existing and new monitoring locations throughout the Lake Hawdon system and compare results to previous data to provide a detailed understanding of the diversity, abundance and distribution of fish species and the demography of key threatened species.
- Bush Birds: improve understanding of the diversity and abundance of bush birds in the areas of *Melaleuca halmaturorum* shrubland proposed for clearance to provide a basis for the restoration project to minimise impacts to fauna.

In 2021 comprehensive baseline ecological monitoring was undertaken (Taylor et al. 2022) to document the status of Lake Hawdon North in its current, unrestored condition. This included a waterbird census of the entire wetland in early November 2021.

In early November 2022 a second baseline waterbird census of the whole of Lake Hawdon North was conducted to increase confidence of waterbird use of the wetland in its unrestored condition. The second baseline waterbird census is the subject of this report.

2. Methods

The second baseline waterbird census was conducted over two days on 8th and 9th November 2022. Teams consisted of two members, with at least one experienced shorebird and waterbird surveyor in each team. Teams included representatives from NGT and Friends of Shorebirds SE (FoSSE). Team members were:

- Abel Zevenboom (FoSSE)
- Ben Taylor (NGT)
- Bryan Haywood (NGT)
- Cath Bell (FoSSE)
- Emma Blythman (FoSSE)
- Jeff Campbell (FoSSE)
- John Mullins (FoSSE)
- Kathy Collins (FoSSE)
- Ken Jones (FoSSE)
- Maureen Christie (FoSSE)
- Sarah Campbell (FoSSE)
- Tania Rajic (FoSSE)
- Tim Collins (FoSSE)
- Vicki Natt (FoSSE)

The survey area was assessed on foot, with vehicle access around the margins of the wetland arranged prior with adjoining landholders. Teams were equipped with binoculars and spotting scopes. Call identification was also used to detect some species.

The survey area consisted of the mapped extents (DEW “LANDSCAPE_Wetlands” layer) of LHN, comprising wetland polygons S0109028 and S0108576, as well as an adjacent wetland to the immediate

north, wetland S0108587 (Figure 1). This adjacent wetland was included in the survey area because it is hydraulically connected to LHN when the water surface elevation (WSEL) exceeds approximately 4.15 mAHd, which is within the proposed regulated WSEL range (3.60 – 4.30 mAHd) should the restoration of LHN proceed.

The survey area was overlaid with a grid of 220 square cells, each 400 × 400 m (16 ha) in size. Cells were aligned with Drain L to avoid the difficulties of cells straddling both sides of the drain. Cell boundaries were identifiable to surveyors on the ground using the AvenzaMaps® application on mobile phones, enabling bird counts per cell to be made. Areas within cells but outside of the target wetland polygons (i.e. adjoining paddocks) were outside of the survey area and were not counted. Drain L itself was counted as part of cells in the row D-15 to P-15.

Mudflat and open water habitats in each cell were assessed and all birds within these habitats counted. This included both inundated and damp mudflats. Parts of Lake Hawdon North that were determined *a priori* to be dry were not surveyed in 2022 as the 2021 census found waterbirds were absent from dry areas, with the exception of very small numbers of red-capped plover. Other habitat types were not systematically counted, however birds observed within these habitats (shrublands, grasslands (mostly dominated by introduced pasture grasses), *Gahnia filum* sedgelands, *Baumea arthropphylla* sedgelands) were opportunistically counted.

The depth of water in each cell was measured in an open location (where the DEM is more accurate compared to densely vegetated areas) and the location recorded. These data were used in combination with the DEM to map the overall extent of surface water within LHN at the time of the survey. Because the WSEL was not consistent across the survey area it was necessary to sub-divide the DEM within LHN and adjust the WSEL within sub-units, to align with field observations.

Weather conditions in Robe (15 km to the west of LHN) on 8th November were sunny with a maximum temperature of 29.1°C and 13 km/hr easterly winds at 3.00 pm. On 9th November conditions were overcast, maximum temperature 26.2°C with 39 km/hr nor-north west winds at 3.00 pm.

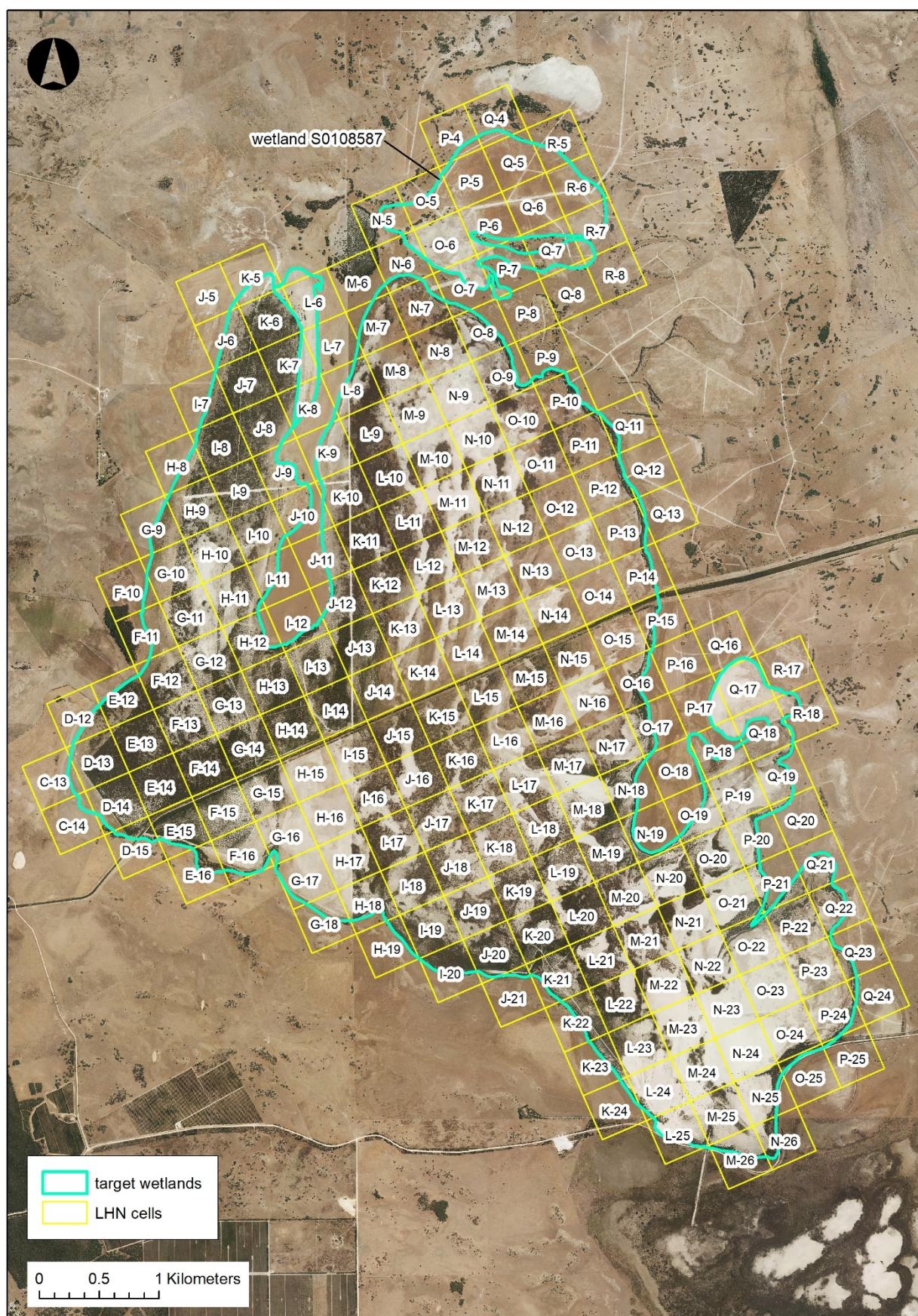


Figure 1. Survey area (target wetlands) and overlying grid of 220 cells.

3. Results

Water Levels and Flow Rates

The measurements of water depth in each cell obtained in the field were compared with the 2m regional DEM to map the extent of inundation at the time of survey (Figure 2). Of the 220 cells within the survey area, 97 were partially or completely inundated at the time of the survey. This was a considerably larger inundated area than was the case for the 2021 survey (Figure 3, 76 cells partially or completely inundated). Notably, despite the lentic nature of inundated areas (with the exception of Drain L) at the time of the survey, there was a marked difference in WSEL across the survey area. In wetland S0108587 to the north of LHN, WSEL was approximately 4.18 mAHD, while in some cells south of Drain L WSEL was approximately 3.80 mAHD. The western side of Lake Hawdon North, where the bed elevation is as low as 3.60 mAHD, was dry.

Drain L itself was inundated with a flow rate gauged at c.94 ML/day on November 8th (DEW 2022) and a WSEL lower than the adjacent bed of LHN. It was also noted that the Lake Hawdon Connecting Drain was trickling flows into the southern end of LHN during the survey. The Connecting Drain regulator was closed and flows were confined to the fishway at a rate of c.3 ML/day (visual estimate).

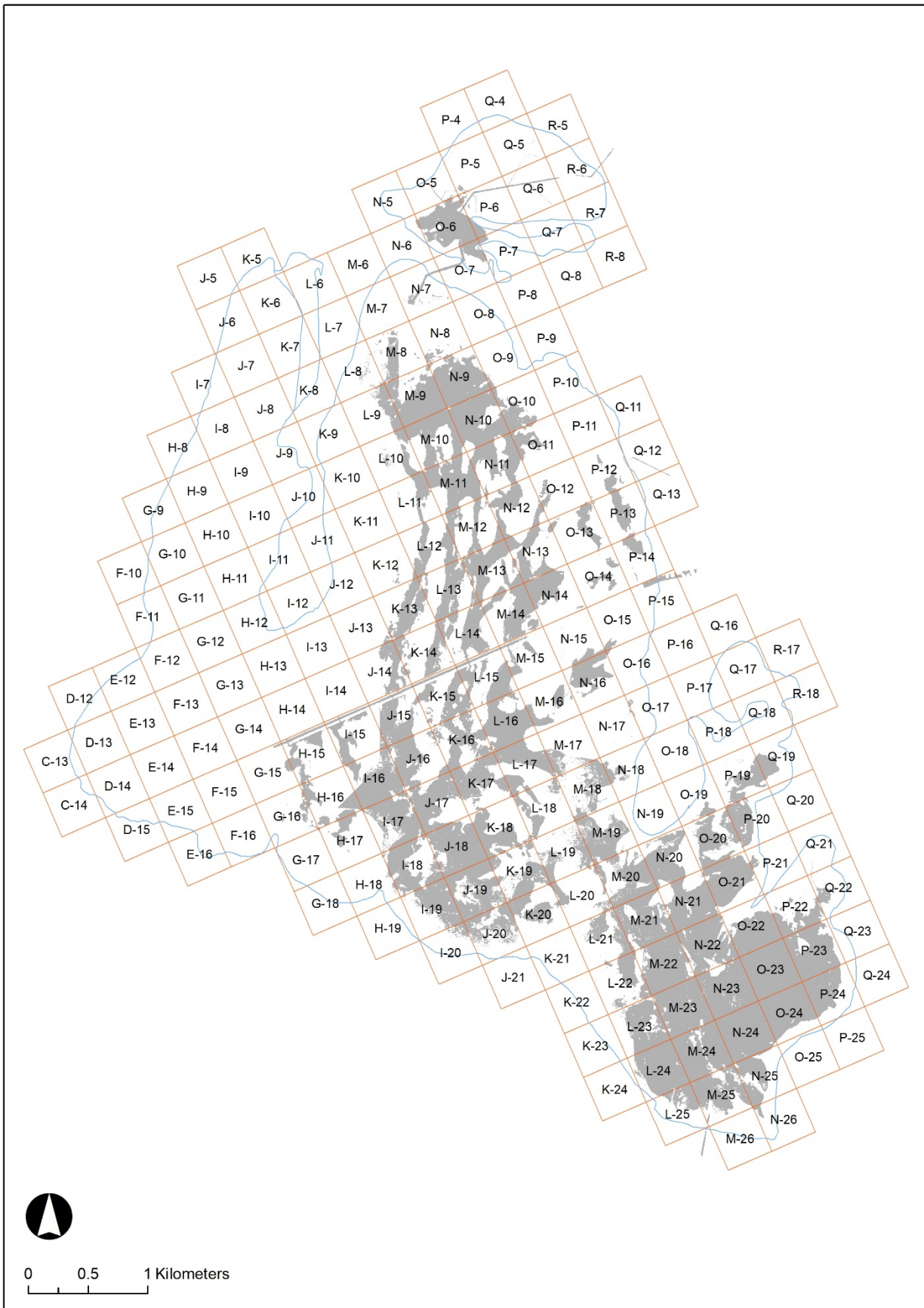


Figure 2. Estimated extent of inundation of the survey area on 8-9th November 2022.

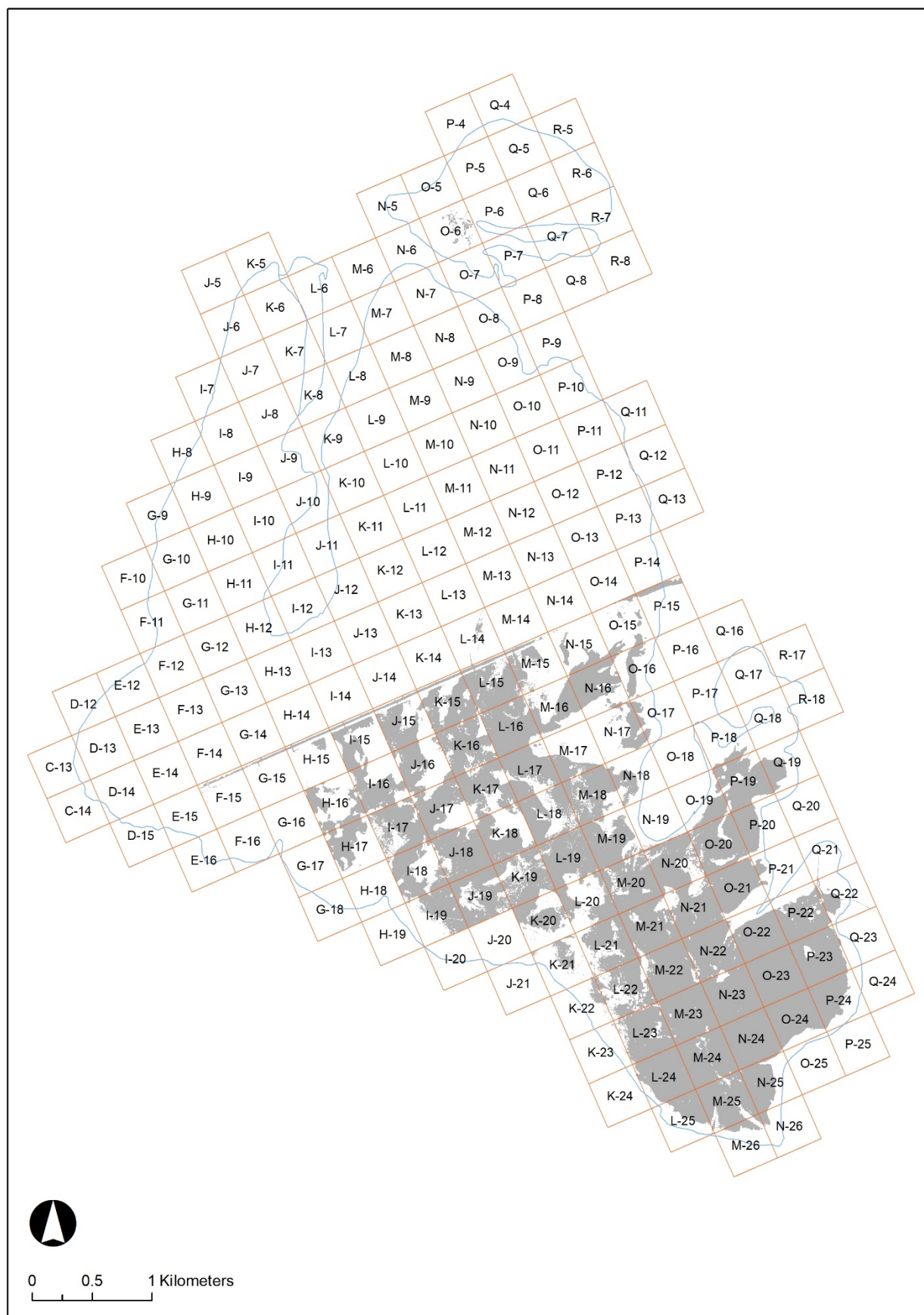


Figure 3. Estimated extent of inundation of the survey area on 10-11th November 2021, presented for comparison.

Bird Abundance

As for the first baseline census in 2021, the second baseline census recorded bird species in two categories:

- Species of open water and mudflat habitat for which confident counts were obtained for the entire survey area (23 species, including 4 not recorded in 2021). Total counts for these species are presented in Table 1 and counts for each cell are presented in Appendix A.
- Species recorded opportunistically (46 species, including 11 not recorded in 2021). While these species were counted when observed, total numbers counted are not representative of the entire survey area because these species favour dense shrubland and *Gahnia* vegetation that was not systematically surveyed for the census. For these species, counts for each cell are presented in Appendix A and total counts are presented in Appendix B.

In November 2022 the total count of waterbirds of open water and mudflat habitat was very low, 1916 compared to 10200 in 2021, despite the survey occurring at the same time of year (8-9 November in 2022, 9-10 November in 2021), similar weather conditions and a larger area of inundation in 2022. As in 2021, waterfowl were most abundant in the south-east of the survey area, where water depths were greatest due to a combination of a high WSEL (compared to other areas) and excavations within the mining tenement. As in 2021, the most abundant species in 2022 was Australian shelduck (1191), however the abundance of other waterfowl species was very low. Several waterbird species that had been relatively abundant in 2021 were in very low abundance or completely absent in 2022; black-winged stilt, chestnut teal, grey teal and whiskered tern. Species of open water and mudflat habitat recorded in 2022 that had been absent in 2021 were Australian pelican, dusky moorhen, marsh sandpiper and pied cormorant, all in low abundance.

Table 1. Total counts for bird species systematically counted for the Lake Hawdon North baseline census in 2021 and 2022. HCHB target species are indicated (bold).

Common Name	Total	
	2021	2022
Australasian shoveler	22	0
Australian pelican	0	16
Australian shelduck	2786	1191
Australian white ibis	11	1
banded lapwing	5	0
black swan	159	54
black-winged stilt	1313	0
Caspian tern	1	0
cattle egret	2	0
chestnut teal	116	4
common greenshank	47	49
dusky moorhen	0	5
great cormorant	2	0
great egret	2	1
grey teal	1394	7
hardhead	6	0
hoary-headed grebe	11	0

Common Name	Total	
	2021	2022
little egret	27	7
marsh sandpiper	0	1
masked lapwing	153	200
musk duck	5	4
Pacific black duck	330	46
piebald cormorant	0	1
pink-eared duck	2	0
red-capped plover	140	36
red-necked stint	331	16
royal spoonbill	1	0
sharp-tailed sandpiper	674	21
silver gull	702	155
straw-necked ibis	1	0
unidentified duck sp.	0	18
unidentified egret sp.	0	2
unidentified wader sp.	0	31
whiskered tern	1834	0
white-faced heron	123	50
TOTAL	10200	1916

Of the species recorded opportunistically, 11 species not recorded in 2021 were observed in 2022; Australian reed warbler, eastern yellow robin, forest raven, Latham's snipe, purple swamphen, southern emu-wren, stubble quail, tree martin, white-browed babbler, yellow-faced honeyeater and yellow-rumped thornbill. The most widely distributed species was white-fronted chat (24 cells) followed by common skylark (19 cells) and little grassbird (18 cells). Black-tailed native-hen, which were observed in flocks of up to 75 individuals in 2021, were not observed in 2022.

Target Shorebird Distribution

Of the seven HCHB RBR target species, only sharp-tailed sandpiper, red-necked stint, common greenshank and red-capped plover were recorded in the census, as was the case in 2021. However, with the exception of common greenshank, abundances were much lower in 2022. Two additional migratory shorebirds that are not HCHB target species, Latham's snipe and marsh sandpiper, were recorded in low abundance in 2022. The combined total abundance of HCHB target species was 122 in 2022, whereas in 2021 the figure was 1192.

The combined abundance and distribution of the HCHB target shorebird species is shown in Figure 4. Single species abundance and distribution maps for each of the four species recorded are provided in Figure 5 to Figure 8.

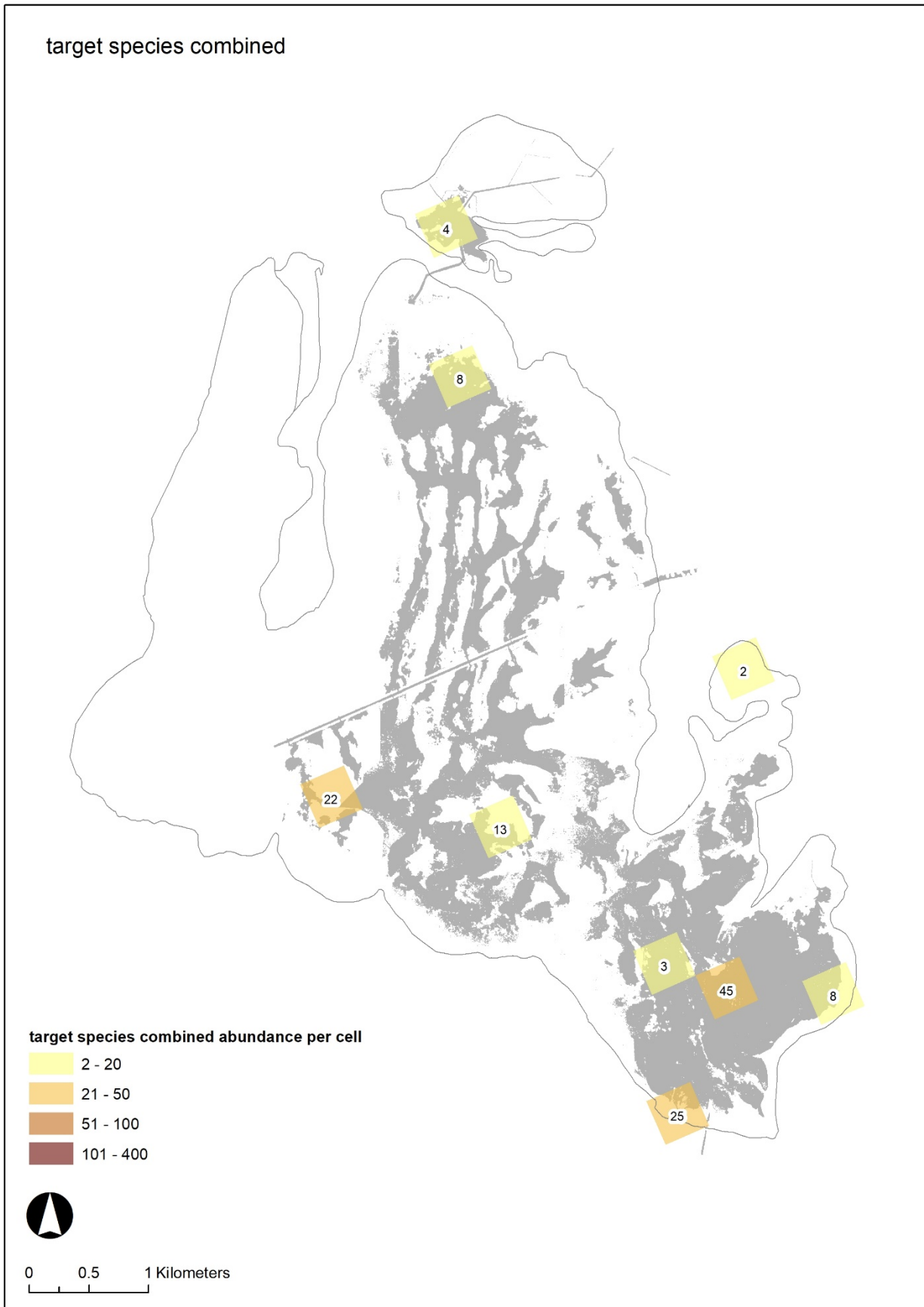


Figure 4. Distribution and abundance of HCHB RBR target shorebirds (combined) at LHN, 8-9 November 2022. Extent of inundation is also indicated.

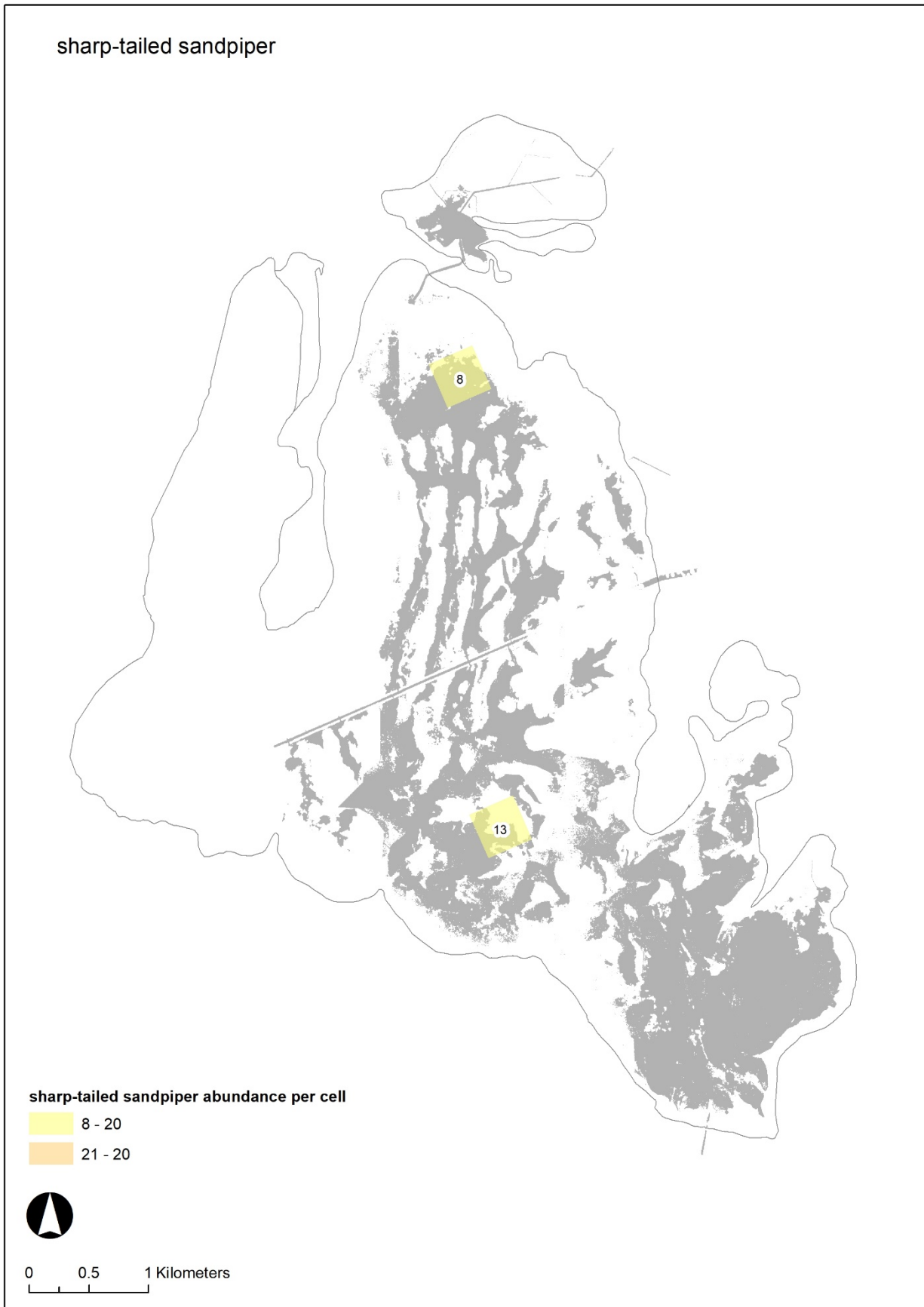


Figure 5. Distribution and abundance of sharp-tailed sandpiper at LHN, 8-9 November 2022.
Extent of inundation is also indicated.

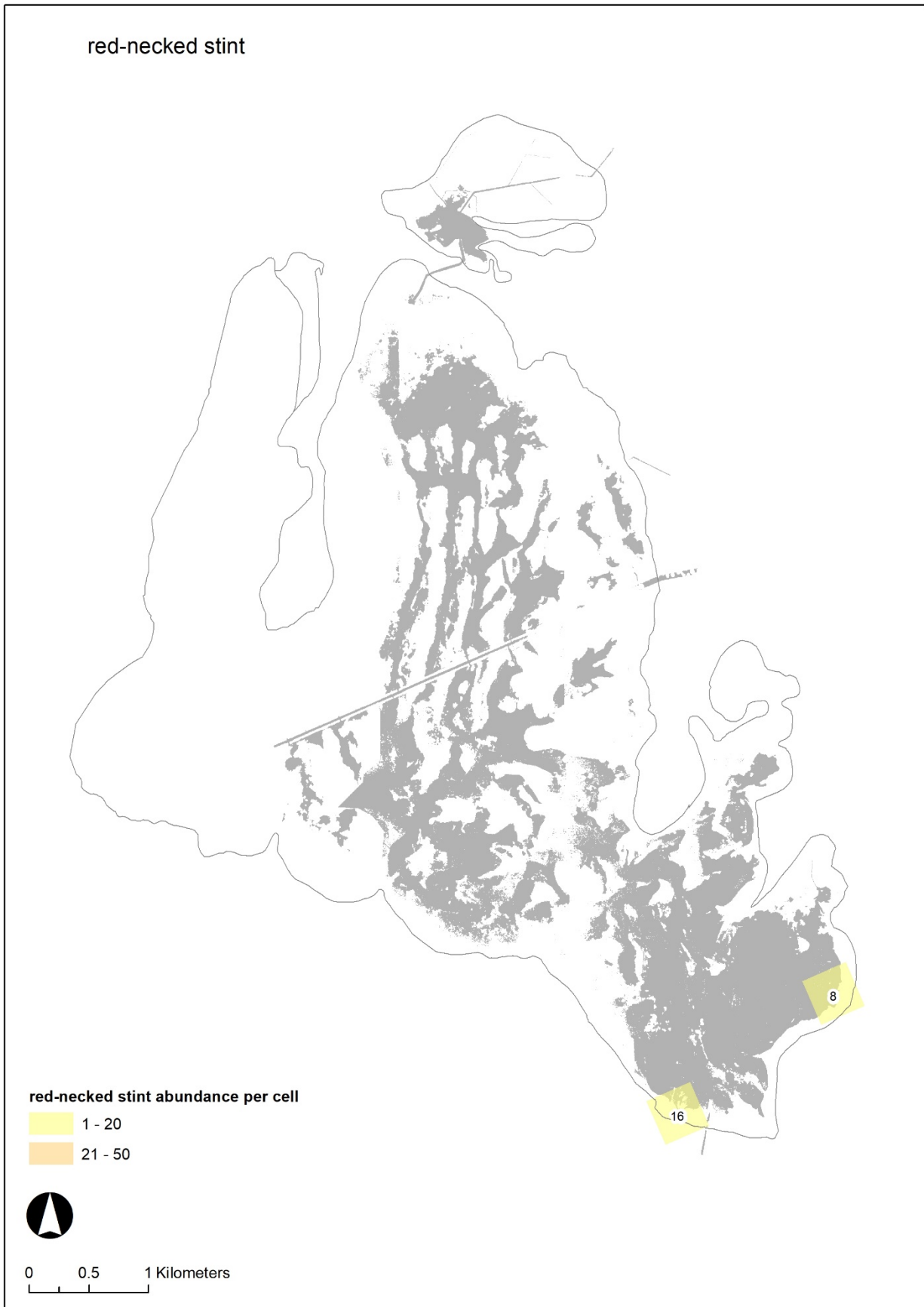


Figure 6. Distribution and abundance of red-necked stint at LHN, 8-9 November 2022.
Extent of inundation is also indicated.

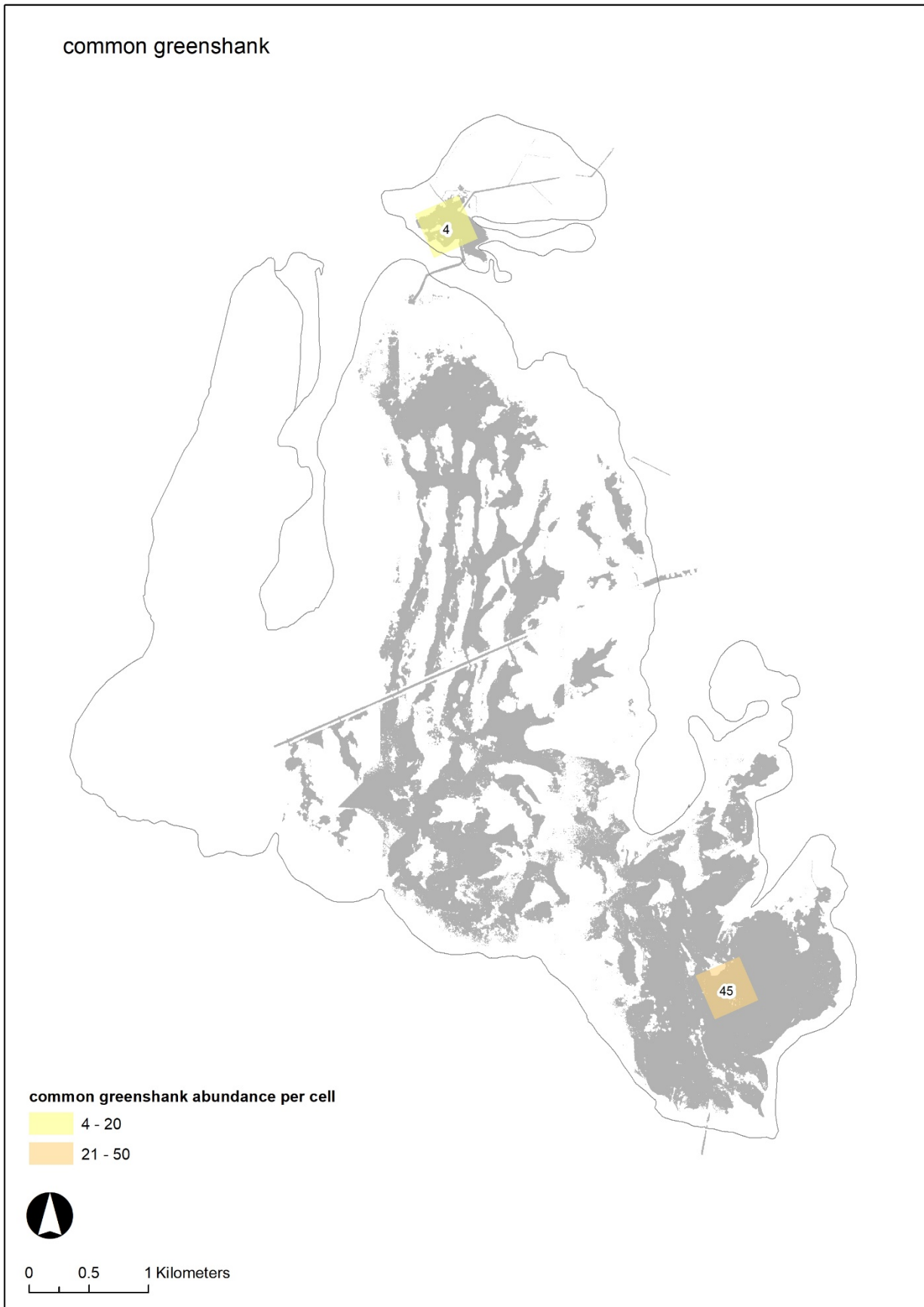


Figure 7. Distribution and abundance of common greenshank at LHN, 8-9 November 2022.
Extent of inundation is also indicated.

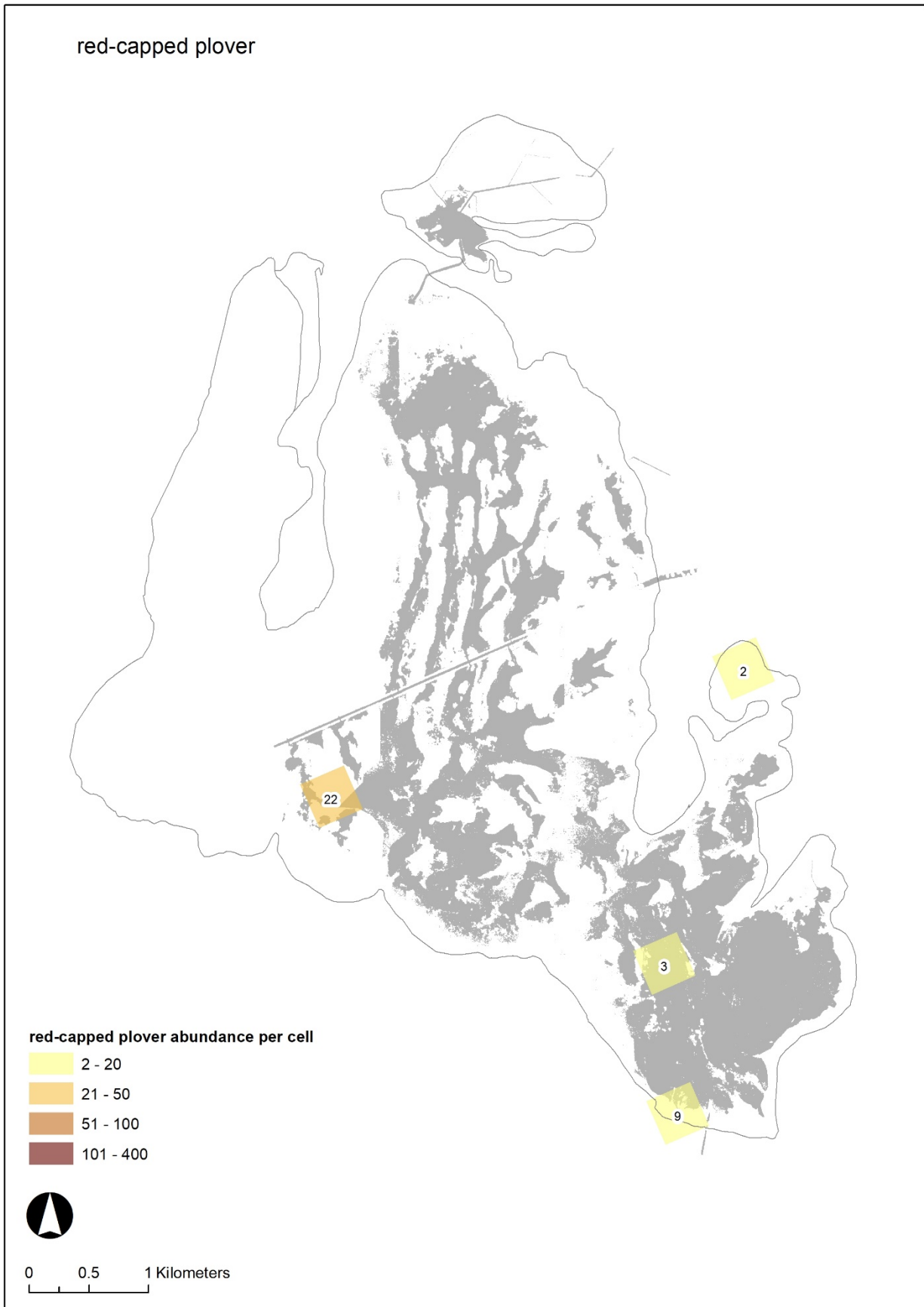


Figure 8. Distribution and abundance of red-capped plover at LHN, 8-9 November 2022.
Extent of inundation is also indicated.

4. Discussion

The most notable result of the 2022 baseline waterbird survey was the very low abundance of waterbirds, down 81% on the previous year despite the alignment of timing and the larger availability of habitat at LHN in 2022. This was likely due to waterbirds responding to habitat availability at a continental scale. The period 1st August to 30th November 2022 had the highest rainfall on record in almost the entire Victorian and New South Wales portions of the Murray-Darling Basin (Figure 8). Most Murray-Darling Basin rivers were in flood in early November, several in major flood, with unusually high waterbird habitat availability throughout the Basin. It is likely that waterbirds from the reliably wet coastal zone of south eastern South Australia had opportunistically migrated inland to take advantage of food and breeding resources available inland. There were also anecdotal reports of large number of black swans and ducks on adjacent Lake Hawdon South on the days following the LHN survey (Maureen Christie, FoSSE, pers. com., 12/11/2022). Lake Hawdon South was full to its cease-to-flow level (4.56 mAHD) at the time, with the Connecting Drain weir closed and flows trickling over the fishway. This local habitat availability may in part explain the low abundance of waterfowl observed in LHN. However, this does not explain the low abundances of waders and migratory shorebirds, including the HCHB target species, observed in LHN because Lake Hawdon South provides minimal foraging habitat for these species at this level of inundation.

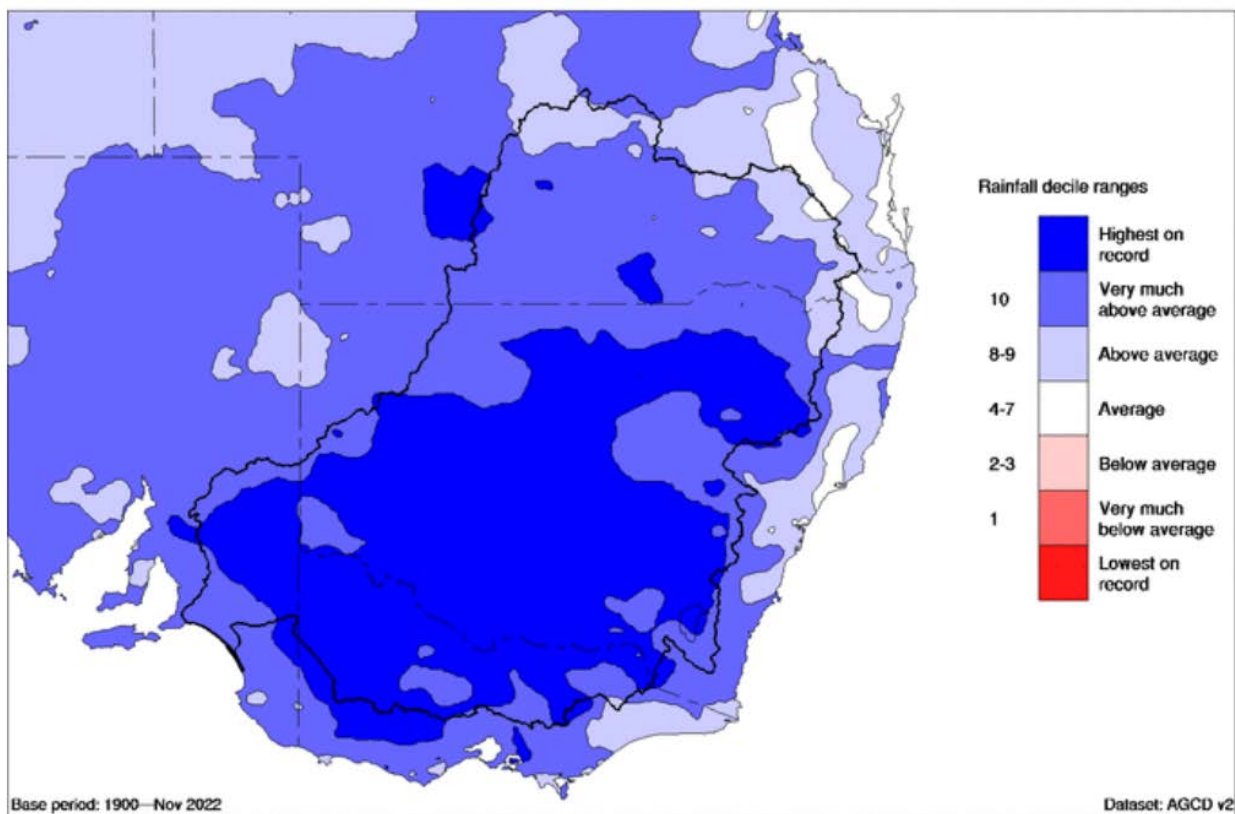


Figure 9. Four monthly rainfall deciles for the Murray-Darling Basin 1st August to 30th November 2022 (source: BOM 2022).

The 2022 results illustrate that waterbird abundance is not necessarily a good indicator of waterbird habitat condition and/or availability at a local scale due to continental scale influences. As waterbird monitoring in adjoining Lake Hawdon South has shown (see Taylor 2020), it is only through repeated annual monitoring over decadal time periods that the importance of a site for waterbirds is revealed, by capturing occasional high abundances, which presumably occur when local conditions are optimal but

habitat availability at a continental scale is low. The value of the wetlands of the coastal zone, such as the Lake Hawdon system, is the reliability of inundation and therefore the role they play as refuge habitat during droughts in the interior, or habitat loss caused by other factors. Note that the monitoring program designed to assess the outcomes of the proposed restoration of LHN also includes measures of vegetation, benthic invertebrates and fish (Taylor et al. 2022), which are not subject to continental scale influences.

Despite the low waterbird abundance in 2022, results confirm that at least four of the seven HCHB target species utilise LHN; sharp-tailed sandpiper, red-necked stint, common greenshank and red-capped plover. The number of waterbird species (of open water/mudflat habitat systematically surveyed) detected by this monitoring program increased by four as a result of the 2022 survey to include Australian pelican, dusky moorhen, marsh sandpiper and pied cormorant. Notable species recorded opportunistically included Latham's snipe (regionally rare, state rare, JAMBA, CAMBA, ROKAMBA) and southern emu-wren (south east ssp.) (regionally rare, state rare) (Gillam and Urban 2011).

Rainfall in the South East of South Australia 2022 appeared to have provided ideal conditions for the proliferation of introduced pasture grasses on the bed of some areas of LHN. Inundation of LHN tends to disadvantage pasture grasses and favour native aquatic plants. Anecdotally (Andrew Ogilvie, adjoining landholder, pers. com., 25/11/2022), winter/spring inundation of LHN arising due to Drain L and Connecting Drain inflows was relatively shallow and brief in 2022. This is confirmed by water level data recorded by telemetered gauge A2391283, on the bed of Lake Hawdon North (in cell M-11). These data show inundation did not commence until 6th August and peaked at just 0.26 m (approximately 4.12 mAHD) (DEW 2022). That is an 8 week later commencement and a peak 0.18 m lower than the average hydrograph achievable under restoration (see DEW 2021). Additionally, the wet spring provided ideal conditions for pasture grass growth in areas not inundated and even in some areas that were shallowly (<5 cm) inundated on the survey dates. The eastern side of LHN, north of Drain L, showed particularly dense coverage of pasture grasses during the survey (Figure 9). Dominant species included annual beard-grass (*Polypogon monspeliensis*) and sea barley-grass (*Hordeum marinum*). Dense pasture grass coverage may render habitat unsuitable for HCHB target species that would otherwise be suitable. It is anticipated that restoration, by extending the duration of inundation, would disadvantage pasture grasses and reduce their coverage (Taylor 2020).



Figure 10. Dense coverage of introduced pasture grasses in shallow (<5 cm) water on the bed of Lake Hawdon North (cell N-11), 9th November 2022 (photo Ben Taylor).

5. Other Notable Opportunistic Observations

During the waterbird census a population of grass daisy, *Brachyscome graminea*, was discovered in Lake Hawdon North. The images of this species below (Figure 9, Figure 10) were taken at E403214, N5889361 within cell L-13. The species is rated as rare in South Australia and vulnerable within the South East region (Gillam and Urban 2011). A single specimen of swamp buttons, *Craspedia paludicola* (Figure 11), was observed at E403267, N5889361, also within cell L-13. This species is rated as vulnerable in South Australia and vulnerable within the South East region (Gillam and Urban 2011). Neither species has been recorded previously in the Lake Hawdon complex to our knowledge.



Figure 11. Grass daisy, *Brachyscome graminea*, at Lake Hawdon North, 9th November 2022.



Figure 12. Meadow of grass daisy at Lake Hawdon North, 9th November 2022.



Figure 13. Swamp buttons, *Craspedia paludicola*, at Lake Hawdon North, 9th November 2022.

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APPENDIX A – Bird Abundance Counts for each survey cell

[illegible]

		Counts per cell																																
common name	Total	H-11	H-12	H-13	H-14	H-15	H-16	H-17	H-18	H-19	I-7	I-8	I-9	I-10	I-11	I-12	I-13	I-14	I-15	I-16	I-17	I-18	I-19	I-20	J-5	J-6	J-7	J-8	J-9	J-10	J-11	J-12	J-13	J-14
depth (cm)							0.8	0.7											8	0.8		9	8.5											9
<i>Species for which confident counts for entire survey area were obtained</i>																																		
Australasian shoveler	0																																	
Australian pelican	16																																	
Australian shelduck	1191																																	
Australian white ibis	1																																	
banded lapwing	0																																	
black swan	54					2																												
black-winged stilt	0																																	
Caspian tern	0																																	
cattle egret	0																																	
chestnut teal	4																																	
common greenshank	49																																	
dusky moorhen	5																																	
great cormorant	0																																	
great egret	1																																	
grey teal	7																																	
hardhead	0																																	
hoary-headed grebe	0																																	
little egret	7																		2															
marsh sandpiper	1																																	
masked lapwing	200						2	1																										
musk duck	4																																	
Pacific black duck	46																			1														
pied cormorant	1																																	
pink-eared duck	0																																	
red-capped plover	36						22																											
red-necked stint	16																																	
royal spoonbill	0																																	
sharp-tailed sandpiper	21																																	
silver gull	155						3																											
straw-necked ibis	0																																	
unidentified duck sp.	18					4																												
unidentified egret sp.	2					1																												
unidentified wader sp.	31																																	
whiskered tern	0																																	
white-faced heron	50					1																												

[illegible]

common name	Total	Counts per cell																																																		
		L-12	L-13	L-14	L-15	L-16	L-17	L-18	L-19	L-20	L-21	L-22	L-23	L-24	L-25	M-6	M-7	M-8	M-9	M-10	M-11	M-12	M-13	M-14	M-15	M-16	M-17	M-18	M-19	M-20	M-21	M-22	M-23	M-24	M-25	M-26																
depth (cm)		8	15	21		21.5	16	19	11	17 22	18	16.5	19	77	11		4	3	9	13	15	15	19	21	7.5	7.5		16	15	11	13	17	18	31	7.5																	
<i>Species for which confident counts for entire survey area were obtained</i>																																																				
Australasian shoveler	0																																																			
Australian pelican	16																																																			
Australian shelduck	1191		4	75	81					13	5	21																	4			4	55		10		4	31														
Australian white ibis	1																																																			
banded lapwing	0																																																			
black swan	54																																																			
black-winged stilt	0																																																			
Caspian tern	0																																																			
cattle egret	0																																																			
chestnut teal	4																																																			
common greenshank	49																																																			
dusky moorhen	5					1																																														
great cormorant	0																																																			
great egret	1																																																			
grey teal	7																																																			
hardhead	0																																																			
hoary-headed grebe	0																																																			
little egret	7					1																																														
marsh sandpiper	1																																																			
masked lapwing	200					4		3					2																																							
musk duck	4																																																			
Pacific black duck	46					2		6																																												
pied cormorant	1																																																			
pink-eared duck	0																																																			
red-capped plover	36																																																			
red-necked stint	16																9																																			
royal spoonbill	0																																																			
sharp-tailed sandpiper	21																																																			
silver gull	155																																																			
straw-necked ibis	0																																																			
unidentified duck sp.	18																																																			
unidentified egret sp.	2																																																			
unidentified wader sp.	31																																																			
whiskered tern	0																																																			
white-faced heron	50					1																																														

[illegible]

Baseline Waterbird Monitoring of Lake Hawdon North, 2022

		Counts per cell																																		
common name	Total	O-16	O-17	O-18	O-19	O-20	O-21	O-22	O-23	O-24	O-25	P-4	P-5	P-6	P-7	P-8	P-9	P-10	P-11	P-12	P-13	P-14	P-15	P-16	P-17	P-18	P-19	P-20	P-21	P-22	P-23	P-24	P-25	Q-4	Q-5	
depth (cm)		1				12	17		16	21										5		5							15	15	11	10				
Species for which confident counts for entire survey area were obtained																																				
Australasian shoveler	0																																			
Australian pelican	16																																			
Australian shelduck	1191								80																							23				
Australian white ibis	1																											1								
banded lapwing	0																																			
black swan	54								3	6																					10	3				
black-winged stilt	0																																			
Caspian tern	0																																			
cattle egret	0																																			
chestnut teal	4						1																													
common greenshank	49																																			
dusky moorhen	5																							1												
great cormorant	0																																			
great egret	1																																			
grey teal	7																																			
hardhead	0																																			
hoary-headed grebe	0																																			
little egret	7																																			
marsh sandpiper	1																																			
masked lapwing	200					1				2												1									2	3				
musk duck	4																																			
Pacific black duck	46								7															4								3				
piebald cormorant	1																																			
pink-eared duck	0																																			
red-capped plover	36																																			
red-necked stint	16																																			
royal spoonbill	0																																			
sharp-tailed sandpiper	21																																			
silver gull	155				9			6																							5	45				
straw-necked ibis	0																																			
unidentified duck sp.	18																																			
unidentified egret sp.	2																																			
unidentified wader sp.	31																																			
whiskered tern	0																																			
white-faced heron	50									1																						1				

		Counts per cell																				
common name	Total	Q-6	Q-7	Q-8	Q-11	Q-12	Q-13	Q-16	Q-17	Q-18	Q-19	Q-20	Q-21	Q-22	Q-23	Q-24	R-5	R-6	R-7	R-8	R-17	R-18
depth (cm)									125													
<i>Species for which confident counts for entire survey area were obtained</i>																						
Australasian shoveler	0																					
Australian pelican	16																					
Australian shelduck	1191								61													
Australian white ibis	1																					
banded lapwing	0																					
black swan	54								3													
black-winged stilt	0																					
Caspian tern	0																					
cattle egret	0																					
chestnut teal	4																					
common greenshank	49																					
dusky moorhen	5																					
great cormorant	0																					
great egret	1																					
grey teal	7																					
hardhead	0																					
hoary-headed grebe	0																					
little egret	7																					
marsh sandpiper	1																					
masked lapwing	200								9													
musk duck	4																					
Pacific black duck	46																					
piebald cormorant	1																					
pink-eared duck	0																					
red-capped plover	36								2													
red-necked stint	16																					
royal spoonbill	0																					
sharp-tailed sandpiper	21																					
silver gull	155								1													
straw-necked ibis	0																					
unidentified duck sp.	18																					
unidentified egret sp.	2																					
unidentified wader sp.	31																					
whiskered tern	0																					
white-faced heron	50								1													

[illegible]

		Counts per cell																																							
common name	Total	H-16	H-17	H-18	H-19	I-7	I-8	I-9	I-10	I-11	I-12	I-13	I-14	I-15	I-16	I-17	I-18	I-19	I-20	J-5	J-6	J-7	J-8	J-9	J-10	J-11	J-12	J-13	J-14	J-15	J-16	J-17	J-18	J-19	J-20	J-21	K-5	K-6	K-7		
depth (cm)		0.8	0.7											8	0.8		9	8.5											9	11.5	15.2	12		8	11						
<i>Species counted opportunistically - counts not representative of entire survey area</i>																																									
Australasian pipit	15		5																										2												
Australian hobby	1			1																																					
Australian magpie	50		2	1										3																1											
Australian raven	12	2												2																											
Australian reed warbler	6																																								
beautiful firetail	3																																								
black-tailed native-hen	0																																								
brown falcon	1																																								
brown songlark	13																																								
brown thornbill	7																																								
collared sparrowhawk	0																																								
common blackbird	3																																								
common bronzewing	0																																								
common skylark	41																																								
common starling	6																																								
crested pigeon	0																																								
eastern yellow robin	1																																								
emu	3																																								
European goldfinch	8												3																												
forest raven	4																																								
galah	18													2																											
golden whistler	5																																								
golden-headed cisticola	8																																								
grey butcherbird	1																																								
grey currawong	1																																								
grey fantail	8																												1												
grey shrike-thrush	11												1																												
Horsfield's bronze-cuckoo	1																																								
Latham's snipe	4			2																											1										
little grassbird	35																																								
little raven	7																																								
magpie-lark	16																																								
Nankeen kestrel	0																																								
purple swamphen	1																																								
raven sp.	46																	2																							
silveryeye	5																																								
singing honeyeater	1																																								
southern emu-wren	2																																								
spiny-cheeked honeyeater	19																																								
striated fieldwren	8																																								
stubble quail	3																																								
superb fairy-wren	19												1																												
swamp harrier	9	1																																							
tree martin	2																																								
wedge-tailed eagle	2																																								
welcome swallow	49																																								
white-browed babbler	1																																								
white-browed scrubwren	1																																								
white-fronted chat	89	4																																							
willie wagtail	0																																								
yellow-faced honeyeater	1																																								
yellow-rumped thornbill	1																																								

		Counts per cell																																						
common name	Total	K-8	K-9	K-10	K-11	K-12	K-13	K-14	K-15	K-16	K-17	K-18	K-19	K-20	K-21	K-22	K-23	K-24	L-6	L-7	L-8	L-9	L-10	L-11	L-12	L-13	L-14	L-15	L-16	L-17	L-18	L-19	L-20	L-21	L-22	L-23	L-24	L-25	M-6	
depth (cm)							9	7	9.5		23.5	6	10	18	6.5							2	8	7	14	8	15	21		21.5	16	19	11	17	18	16.5	19	77	11	
Species counted opportunistically - counts not representative of entire survey area																																								
Australasian pipit	15							1	2		1															1							1							
Australian hobby	1																																							
Australian magpie	50						2	6																				2												
Australian raven	12																																							
Australian reed warbler	6																																							
beautiful firetail	3																																							
black-tailed native-hen	0																																							
brown falcon	1																																		1					
brown songlark	13							1																																
brown thornbill	7																																							
collared sparrowhawk	0																																							
common blackbird	3																																							
common bronzewing	0																																							
common skylark	41								2		1															2	3							2	1					
common starling	6																																		1					
crested pigeon	0																																							
eastern yellow robin	1																																							
emu	3																											1												
European goldfinch	8																																							
forest raven	4																																							
galah	18																																							
golden whistler	5																										2													
golden-headed cisticola	8																																							
grey butcherbird	1																																							
grey currawong	1																																							
grey fantail	8																																							
grey shrike-thrush	11																																							
Horsefield's bronze-cuckoo	1																												1						1			1		
Latham's snipe	4														1																									
little grassbird	35						2	1																																
little raven	7																																							
magpie-lark	16						2	7																																
Nankeen kestrel	0																																						1	
purple swamphen	1																																							
raven sp.	46							4																																
silveryeye	5																											2												
singing honeyeater	1																																							
southern emu-wren	2																																						1	
spiny-cheeked honeyeater	19														6																									
striated fieldwren	8									2		1														1		2				1								
stubble quail	3																																							
superb fairy-wren	19																								1									2						
swamp harrier	9													2																								1		
tree martin	2									2																														
wedge-tailed eagle	2																																							
welcome swallow	49														8														5					1		2				7
white-browed babbler	1																																							
white-browed scrubwren	1																																							
white-fronted chat	89						7		1		5	2			7								1			9														
willie wagtail	0																																							
yellow-faced honeyeater	1																												1											
yellow-rumped thornbill	1																																							

		Counts per cell																																					
common name	Total	M-7	M-8	M-9	M-10	M-11	M-12	M-13	M-14	M-15	M-16	M-17	M-18	M-19	M-20	M-21	M-22	M-23	M-24	M-25	M-26	N-5	N-6	N-7	N-8	N-9	N-10	N-11	N-12	N-13	N-14	N-15	N-16	N-17	N-18	N-19	N-20	N-21	N-22
depth (cm)		4	3	9	13	15	15	19	21	7.5	7.5		16	15	11	13	17	18	31	7.5				3		6	13	10	11	21	18		21.5	4.5			15	12	18
Species counted opportunistically - counts not representative of entire survey area																																							
Australasian pipit	15																																						
Australian hobby	1																																						
Australian magpie	50		7																								6				2								
Australian raven	12																																						
Australian reed warbler	6																														2							2	
beautiful firetail	3																																		1				2
black-tailed native-hen	0																																						
brown falcon	1																																						
brown songlark	13							2																					1	1									
brown thornbill	7													2																						1			
collared sparrowhawk	0																																						
common blackbird	3																																			1			
common bronzewing	0																																						
common skylark	41						1	2	1																		1	1			1								
common starling	6																2																						
crested pigeon	0																																						
eastern yellow robin	1																																						
emu	3																																						
European goldfinch	8																																		2				
forest raven	4																																						
galah	18																																						
golden whistler	5												1																					4					
golden-headed cisticola	8								1	2																									4				
grey butcherbird	1																																						
grey currawong	1																																			1			
grey fantail	8																																						
grey shrike-thrush	11														1																		1		1			1	
Horsefield's bronze-cuckoo	1																																			1			
Latham's snipe	4																																						
little grassbird	35				2	1	2								4		1											2					2						
little raven	7																																						
magpie-lark	16																																						
Nankeen kestrel	0																																		2				
purple swamphen	1																																						
raven sp.	46		18				1																																
silveryeye	5																																		2				
singing honeyeater	1																																						
southern emu-wren	2														1																								
spiny-cheeked honeyeater	19														1																			3		1	1		
striated fieldwren	8					1																																	
stubble quail	3																																						
superb fairy-wren	19						2								3										1								2				1		
swamp harrier	9																		1																				
tree martin	2																																				1		
wedge-tailed eagle	2																																						
welcome swallow	49											7																											
white-browed babbler	1																																				1		
white-browed scrubwren	1																																						
white-fronted chat	89			4	2		2										3							4		9	2	2	6										
willie wagtail	0																																						
yellow-faced honeyeater	1																																						
yellow-rumped thornbill	1																																						

		Counts per cell																																						
common name	Total	N-23	N-24	N-25	N-26	O-5	O-6	O-7	O-8	O-9	O-10	O-11	O-12	O-13	O-14	O-15	O-16	O-17	O-18	O-19	O-20	O-21	O-22	O-23	O-24	O-25	P-4	P-5	P-6	P-7	P-8	P-9	P-10	P-11	P-12	P-13	P-14	P-15	P-16	
depth (cm)		41	22	9							8	12	7	15	2		1					12	17		16	21									5		5			
Species counted opportunistically - counts not representative of entire survey area																																								
Australasian pipit	15									1																														
Australian hobby	1																																							
Australian magpie	50				5							4					4																	2						
Australian raven	12																						8																	
Australian reed warbler	6															1																							1	
beautiful firetail	3																1																							
black-tailed native-hen	0																																							
brown falcon	1																																							
brown songlark	13											1		3																					2	2				
brown thornbill	7																1	2																					1	
collared sparrowhawk	0																																							
common blackbird	3																																						1	
common bronzewing	0																																							
common skylark	41										1	4	4	3	5																				5	1				
common starling	6																3																							
crested pigeon	0																																							
eastern yellow robin	1																	1																						
emu	3															2																								
European goldfinch	8															1																							2	
forest raven	4															4																								
galah	18									2													2														2			
golden whistler	5																																							
golden-headed cisticola	8															2																							2	
grey butcherbird	1																	1																						
grey currawong	1																																							
grey fantail	8																	1																		1			1	
grey shrike-thrush	11			1													1	1														1		1						
Horsefield's bronze-cuckoo	1																																							
Latham's snipe	4																																							
little grassbird	35															2																							1	
little raven	7																	6																						
magpie-lark	16							2																																
Nankeen kestrel	0																																							
purple swamphen	1																																							
raven sp.	46																																							
silvereye	5															2																		1		1			1	
singing honeyeater	1																																				1			
southern emu-wren	2																																				1			
spiny-cheeked honeyeater	19																1	1																		1		4		
striated fieldwren	8																																							
stubble quail	3																																					1		
superb fairy-wren	19																	1																			1	4		
swamp harrier	9																								1															
tree martin	2																									1														
wedge-tailed eagle	2																																			2				
welcome swallow	49			3																																	4		12	
white-browed babbler	1																																							
white-browed scrubwren	1																																							
white-fronted chat	89				2						8	2	1			2				2	2																			
willie wagtail	0																																							
yellow-faced honeyeater	1																																							
yellow-rumped thornbill	1																1																							

[illegible]

APPENDIX B – Birds Counted Opportunistically

Counts are not representative of the entire survey area because these species favour dense shrubland and *Gahnia* vegetation that was not systematically surveyed.

Common Name	2022 Total
Australasian pipit	15
Australian hobby	1
Australian magpie	50
Australian raven	12
Australian reed warbler	6
beautiful firetail	3
black-tailed native-hen	0
brown falcon	1
brown songlark	13
brown thornbill	7
collared sparrowhawk	0
common blackbird	3
common bronzewing	0
common skylark	41
common starling	6
crested pigeon	0
eastern yellow robin	1
emu	3
European goldfinch	8
forest raven	4
galah	18
golden whistler	5
golden-headed cisticola	8
grey butcherbird	1
grey currawong	1
grey fantail	8
grey shrike-thrush	11
Horsefield's bronze-cuckoo	1
Latham's snipe	4
little grassbird	35
little raven	7
magpie-lark	16
Nankeen kestrel	0
purple swamphen	1
raven sp.	46
silvereye	5
singing honeyeater	1
southern emu-wren	2
spiny-cheeked honeyeater	19
striated fieldwren	8
stubble quail	3
superb fairy-wren	19
swamp harrier	9
tree martin	2
wedge-tailed eagle	2
welcome swallow	49
white-browed babbler	1

Common Name	2022 Total
white-browed scrubwren	1
white-fronted chat	89
willie wagtail	0
yellow-faced honeyeater	1
yellow-rumped thornbill	1