

[10.1071/PC24030](https://doi.org/10.1071/PC24030)

Pacific Conservation Biology

Supplementary Material

Waterbird assemblages of Australia's largest east-coast wetland complex: environmental determinants of spatial and temporal distribution

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Supplementary information

Table S1 Locations and characteristics of survey sites. 'Area' indicates area surveyed (ha). Survey 1, sites 100 to 445; Survey 2, sites 1 to 25. The number of species records the total number over all samples in each survey

Site no.	Name applied	Location: °S, E		Area	Number of species
1	Bowling Green Bay 1	19.401	147.025	0.2	8
2	Emmett Creek	19.450	147.050	82.0	24
3	St. Margaret Creek	19.475	147.058	6.0	16
4	Johnson	19.508	147.058	18.3	21
5	Horseshoe Lagoon 1	19.550	147.117	50.0	19
6	Cromarty	19.500	147.050	77.3	12
7	Bowling Green Bay 2	19.397	147.033	3.3	4
8	Cape Cleveland	19.358	146.833	0.9	17
9	Corrick Plains 1	19.508	147.133	36.7	21
10	Corrick Plains 2	19.508	147.121	14.7	22
11	Barramundi lagoon	19.233	146.775	0.3	3
12	Town Common 1	19.242	146.758	172.7	19
13	Nome	19.383	146.933	0.3	8
14	Reed Bed Road	19.492	147.050	0.2	9
15	Kingsun 1	19.504	147.050	45.0	18
16	Town Common 2	19.233	146.758	1.0	18
17	Mackenzie Creek	19.408	147.049	8.4	6
18	Meehan	19.400	147.057	3.3	8
19	Signal Hole	19.501	147.133	0.1	16
20	Pink Lily Lagoon	19.542	147.100	58.3	18
21	Link Road	19.508	147.069	0.0	9
22	Killymoon Creek	19.392	146.997	0.2	12
23	Kingsun 2	19.501	147.068	0.7	1
24	Fraser	19.667	147.083	0.4	9

25	Kingsun 3	19.503	147.064	0.0	5
100	Horseshoe Lagoon 2	19.546	147.119	400.0	28
103	Clare-Haughton Rd	19.681	147.123	4.9	12
122	Upset Farmer	19.502	147.134	400.0	17
123	Dead Dog	19.521	147.135	4.0	7
128	Windmill	19.680	147.138	7.0	6
137	Nelumbo	19.647	147.140	8.0	11
138	Catanzaros Dam	19.590	147.141	60.0	18
144	Mel Swamp Oxbow	19.678	147.153	0.5	2
173	Gladys Lagoon	19.890	147.197	13.0	19
180	W. Barratta Clay Hole	19.583	147.200	7.0	3
182	Jabiru	19.609	147.204	4.0	12
193	Lower W. Barratta	19.569	147.207	11.0	7
200	Red Wing Parrot	19.603	147.212	30.0	21
209	Lily on Head	19.536	147.216	10.0	5
219	E. Barratta 1	19.570	147.223	8.8	3
222	Jerona Sedge Flat	19.539	147.228	32.0	8
232	Remote Turtles	19.540	147.234	0.7	6
237	Didgeridoo	19.576	147.245	5.7	4
252	E. Barratta 2	19.523	147.252	60.0	21
259	Bannisters	19.549	147.262	40.0	29
272	Cox's Dam	19.670	147.283	16.0	24
274	Greenswamp	19.627	147.284	50.0	9
278	Livistonia	19.539	147.284	5.4	20
288	Spring Hole	19.574	147.296	0.9	5
307	Red Lilly Lagoon	19.631	147.307	14.0	15
320	Labatt Lagoon	19.611	147.320	16.0	17
327	Bourkes Swamp	19.537	147.325	15.0	26
354	Menso	19.626	147.337	5.3	22
411	Oxbow	19.648	147.185	8.0	12
442	Stockyard dam	19.886	147.029	0.9	16
444	Woodhouse Lagoon	19.822	147.134	3.2	7
445	Haughton Storage	19.714	147.067	400.0	31

Table S2 Occurrence records (x) and total number of waterbird species (Anseriformes, Podicepiformes, Gruiformes, Pelecaniformes and Charadriiformes) for all samples in each survey in the study area based on: the BirdLife database for the main study area (Bdat) and the Wongaloo (Wong) and Horseshoe Lagoon (HL) sites (BirdLife Australia 2022); aerial survey (Kingsford and Porter 2009) (UNSW); Driscoll et al. (2012) (Drisc); and surveys 1 and 2 in this study (S1&2). Taxonomic order and nomenclature follow Garnett et al. (2015) and BirdLife Australia (2022). Study area excludes intertidal zones. Conservation status of species is of Least Concern unless otherwise indicated: Near Threatened (NT), Vulnerable (V), Endangered (E) (Garnett and Baker 2021). Grand total of species = 100. Number of samples (sites x occasions) shown in brackets. Methods etc. outlined in Table S5

Species		Conservation status ↓	Bdat (4235)	Wong (234)	HL (26)	UNSW (121)	Drisc (4)	S1&2 (198)
Magpie Goose	<i>Anseranas semipalmata</i>		x	x	x	x	x	x
Plumed Whistling-Duck	<i>Dendrocygna eytoni</i>		x	x		x	x	x
Wandering Whistling-Duck	<i>Dendrocygna arcuata</i>		x	x	x	x	x	x
Pink-eared Duck	<i>Malacorhynchus membranaceus</i>		x	x				
Black Swan	<i>Cygnus atratus</i>		x	x	x	x	x	x
Radjah Shelduck	<i>Radjah radjah</i>		x	x				
Hardhead	<i>Aythya australis</i>		x	x	x	x	x	x
Australasian Shoveler	<i>Spatula rhynchotis</i>		x		x			
Pacific Black Duck	<i>Anas superciliosa</i>		x	x	x	x	x	x
Grey Teal	<i>Anas gracilis</i>		x	x	x	x	x	x
Chestnut Teal	<i>Anas castanea</i>		x					x
Freckled Duck	<i>Stictonetta naevosa</i>		x					
Australian Wood Duck	<i>Chenonetta jubata</i>		x	x			x	x
Cotton Pygmy-goose	<i>Nettapus coromandelianus</i>		x		x		x	x
Green Pygmy-goose	<i>Nettapus pulchellus</i>		x	x	x		x	
Australasian Grebe	<i>Tachybaptus novaehollandiae</i>		x	x	x		x	x
Hoary-headed Grebe	<i>Poliiocephalus poliocephalus</i>		x					
Great Crested Grebe	<i>Podiceps cristatus</i>		x	x				
Buff-Banded Rail	<i>Hypotaenidia philippensis</i>		x					
Baillon's Crake	<i>Zapornia pusilla</i>		x					
Spotless Crake	<i>Zapornia tabuensis</i>		x					
White-browed Crake	<i>Amaurornis cinerea</i>		x	x				
Purple Swamphen	<i>Porphyrio porphyrio</i>		x	x		x	x	x
Dusky Moorhen	<i>Gallinula tenebrosa</i>		x		x		x	
Eurasian Coot	<i>Fulica atra</i>		x	x	x			x
Sarus Crane	<i>Antigone antigone</i>		x					
Brolga	<i>Antigone rubicunda</i>		x	x		x	x	x
Bush Stone-curlew	<i>Burhinus grallarius</i>		x	x				
Beach Stone-curlew	<i>Esacus magnirostris</i>		x					
Australian Pied Oystercatcher	<i>Haematopus longirostris</i>		x					
Red-necked Avocet	<i>Recurvirostra novaehollandiae</i>		x			x		
Black-winged Stilt	<i>Himantopus leucocephalus</i>		x	x	x	x	x	x
Grey Plover	<i>Pluvialis squatarola</i>	V	x					
Pacific Golden Plover	<i>Pluvialis fulva</i>		x				x	
Red-capped Plover	<i>Charadrius ruficapillus</i>		x	x				x
Lesser Sand Plover	<i>Charadrius mongolus</i>	E	x					
Greater Sand Plover	<i>Charadrius leschenaultii</i>	NT	x					
Black-fronted Dotterel	<i>Elsayornis melanops</i>		x	x	x		x	x

Banded Lapwing	<i>Vanellus tricolor</i>		X					X
Masked Lapwing	<i>Vanellus miles</i>		X	X	X	X	X	X
Red-kneed Dotterel	<i>Erythrogonys cinctus</i>		X	X				X
Australian Painted Snipe	<i>Rostratula australis</i>	E	X					
Comb-crested Jacana	<i>Irediparra gallinacea</i>		X	X	X		X	X
Whimbrel	<i>Numenius phaeopus</i>		X					
Little Curlew	<i>Numenius minutus</i>		X					
Eastern Curlew	<i>Numenius madagascariensis</i>	E	X					
Bar-tailed Godwit	<i>Limosa lapponica</i>	E	X	X				X
Black-tailed Godwit	<i>Limosa limosa</i>	E	X					
Great Knot	<i>Calidris tenuirostris</i>	NT	X	X				
Red Knot	<i>Calidris canutus</i>	V	X	X				
Broad-billed Sandpiper	<i>Calidris falcinellus</i>		X					
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>	V	X	X		X	X	X
Curlew Sandpiper	<i>Calidris ferruginea</i>	E	X					
Red-necked Stint	<i>Calidris ruficollis</i>	NT	X	X				X
Sanderling	<i>Calidris alba</i>		X					
Pectoral Sandpiper	<i>Calidris melanotos</i>		X					
Terek Sandpiper	<i>Xenus cinereus</i>	V	X					
Latham's Snipe	<i>Gallinago hardwickii</i>	V	X	X				
Common Sandpiper	<i>Actitis hypoleucos</i>		X					X
Grey-tailed Tattler	<i>Tringa brevipes</i>		X					
Common Greenshank (V)	<i>Tringa nebularia</i>	V	X	X			X	
Wood Sandpiper	<i>Tringa glareola</i>		X	X				
Marsh Sandpiper	<i>Tringa stagnatilis</i>		X	X	X		X	
Red-necked Phalarope	<i>Phalaropus lobatus</i>		X					
Australian Pratincole	<i>Stiltia isabella</i>		X				X	
Oriental Pratincole	<i>Glareola maldivarum</i>		X					
Silver Gull	<i>Chroicocephalus novaehollandiae</i>		X	X	X			
Little Tern	<i>Sternula albifrons</i>	V	X	X				
Australian Gull-billed Tern	<i>Gelochelidon macrotarsa</i>		X	X	X	X	X	X
Caspian Tern	<i>Hydroprogne caspia</i>		X	X	X	X		
Whiskered Tern	<i>Chlidonias hybrida</i>		X	X	X	X	X	X
White-winged Black Tern	<i>Chlidonias leucopterus</i>		X	X	X		X	
Roseate Tern	<i>Sterna dougallii</i>		X					
Common Tern	<i>Sterna hirundo</i>		X				X	
Crested Tern	<i>Thalasseus bergii</i>		X					X
Lesser Crested Tern	<i>Thalasseus bengalensis</i>		X					
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>		X	X	X	X	X	X
Australian Pelican	<i>Pelecanus conspicillatus</i>		X	X	X		X	X
Black Bittern	<i>Ixobrychus flavicollis</i>		X	X				
Nankeen Night-heron	<i>Nycticorax caledonicus</i>		X	X				X
Striated Heron	<i>Butorides striata</i>		X					
Cattle Egret	<i>Bubulcus ibis</i>		X	X	X		X	X
White-necked Heron	<i>Ardea pacifica</i>		X	X	X		X	X
Great-billed Heron	<i>Ardea sumatrana</i>		X					
Great Egret	<i>Ardea alba</i>		X	X	X	X		X
Intermediate Egret	<i>Ardea intermedia</i>		X	X	X	X	X	X
Pied Heron	<i>Egretta picata</i>		X					
White-faced Heron	<i>Egretta novaehollandiae</i>		X	X	X	X	X	X

Little Egret	<i>Egretta garzetta</i>	x	x	x	x	x	x
Eastern Reef Egret	<i>Egretta sacra</i>	x	x				
Australian White Ibis	<i>Threskiornis moluccus</i>	x	x	x	x	x	x
Straw-necked Ibis	<i>Threskiornis spinicollis</i>	x	x	x	x	x	x
Yellow-billed Spoonbill	<i>Platalea flavipes</i>	x	x	x	x	x	x
Royal Spoonbill	<i>Platalea regia</i>	x	x	x	x	x	x
Glossy Ibis	<i>Plegadis falcinellus</i>	x	x	x	x	x	x
Little Pied Cormorant	<i>Microcarbo melanoleucos</i>	x	x	x		x	x
Great Cormorant	<i>Phalacrocorax carbo</i>	x	x	x	x		x
Little Black Cormorant	<i>Phalacrocorax sulcirostris</i>	x	x	x	x	x	x
Pied Cormorant	<i>Phalacrocorax varius</i>	x	x	x	x	x	x
Australasian Darter	<i>Anhinga novaehollandiae</i>	x	x	x	x	x	x
Total number of species on database		100	61	40	30	43	47

Table S3 Pre-clearing and 2019 areas of wetlands in the Burdekin-Townsville Coastal Aggregation DIWA Nationally Important Wetland. 'Intertidal' includes saltmarsh, saltflats and mangroves. *Natural and highly modified combined. Data source: Queensland Government, *WetlandInfo* (wetlandinfo.des.qld.gov.au/wetlands/facts-maps/diwa-wetland-burdekin-townsville-coastal-aggregation/) [accessed August 12, 2024]

System	2019 area (ha)	pre-clear area (ha)	2019/pre-clear %		2019 incl. modified/pre-clear area (ha)*	2019 incl. modified/pre-clear %*
Total	23785	22473	105.8		23785	105.8
Artificial/highly modified	227	0				
Intertidal (natural)	13758	17141	80.3	}	14092	82.2
Intertidal (modified)	334	0				
Lacustrine (natural)	68	157	43.3	}	590	375.8
Lacustrine (modified)	522	0				
Palustrine (natural)	2830	4739	59.7	}	8595	181.4
Palustrine (modified)	5765	0				
Riverine	280	436	64.2		280	64.2

Table S4 Major anthropogenic threats and impacts on Burdekin-Townsville wetlands. Information sources: Brizga et al. (2006), GBRMPA (2013), Queensland Government (2024), Abbott et al. (2020), Vandergragt et al. (2020)

Agent	Explanation	Effects
Wetland loss	<ul style="list-style-type: none"> - Clearing and levelling for agriculture 	<ul style="list-style-type: none"> - ~40% loss of freshwater wetland area, compensated by modified wetlands
Hydrological change	<ul style="list-style-type: none"> - Flows and groundwater levels increased as a result of irrigation supply and drainage - Levees reduce overbank floods from the Burdekin River - Bund walls in ponded pastures - Tidal barrages 	<ul style="list-style-type: none"> - Seasonality reduced or eliminated by barrages, bunds and increased dry-season flows - Barrages and bunds block fish access but increase wetland area - Permanent waterlogging kills riparian vegetation - Flood-enabled flushing and resetting of habitats greatly reduced - reduction of saline intrusion allows excessive growth of macrophytes such as <i>Typha</i> - weed invasion enhanced by permanent inundation
Weed invasion	<ul style="list-style-type: none"> - Invasion of wetlands by exotic plants 	<ul style="list-style-type: none"> - Choking of water surface causing hypoxia and fish loss (water hyacinth) - Choking of riparian areas and shallow waters reducing habitat (para grass, hymenachne) - prevention of fish passage
Feral animals	<ul style="list-style-type: none"> - Abundant feral pigs 	<ul style="list-style-type: none"> - major disturbance of substrate of shallow wetlands
Water quality	<ul style="list-style-type: none"> - Input of herbicides and increased inputs of suspended sediments and nutrients (fertilisers) from farmland - increased turbidity in wetlands due to irrigation water being constantly turbid 	<ul style="list-style-type: none"> - Increase in productivity due to nutrients - Possible decrease in productivity due to turbidity - Possible toxic effects of pesticides on native plants and animals - Turbidity may reduce growth of native plants, but also weeds
Fire	<ul style="list-style-type: none"> - Riparian areas are prone to fire, exacerbated by fuel load of invasive grasses and by burning cane prior to harvest 	<ul style="list-style-type: none"> - Loss of riparian zone and associated values
Riparian loss	<ul style="list-style-type: none"> - Caused by clearing, waterlogging and fire 	<ul style="list-style-type: none"> - Loss of breeding and roosting sites
Instream structures	<ul style="list-style-type: none"> - Culverts, drop boards, weirs 	<ul style="list-style-type: none"> - May prevent or obstruct fish passage - Drop boards and weirs artificially maintain water levels

Table S5 Summary of seven surveys (groups of samples or censuses), hypotheses tested (1-5, listed below table), analyses applied (*italics*) and variables involved. Statistical methods explained in text. NMDS = Nonmetric multidimensional scaling; DistLM = Distance-based linear modelling; ANOSIM = Analysis of Similarities

Survey	Sample Area	Timing	No. sites x times	Hypothesis no. tested (see below table) & analyses	Independent variables	Response/key water-bird variables	Purpose/question (see also hypotheses, below table)
Study area – BirdLife Australia (2022)	Fixed-area 500-m radius	1998-2022	4235	1 – Correlations among surveys 4, 5 – NMDS, DistLM 5 – ANOSIM	Year and antecedent rainfall NMDS groups	Occurrence Assem. similarity %, P/A Assem. similarity %, P/A	Compare assemblages Changes with time or rainfall? NMDS groups differ?
Wongaloo – BirdLife Australia (2022)	Fixed-area 500-m radius	2012-2022	234	1 – Correlation among surveys 3 – Repeated measures ANOVA 4, 5 – NMDS, DistLM 5 – ANOSIM	Season Year and antecedent rainfall NMDS groups	Occurrence Density Assem. similarity %, P/A Assem. similarity %, P/A	Compare assemblages Seasonal changes? Changes with time or rainfall? NMDS groups differ?
Horseshoe Lagoon – BirdLife Australia (2022)	Fixed-area 500-m radius	2011-2019	26	1 – Correlation among surveys 3 – Repeated measures ANOVA 4, 5 – NMDS, DistLM 5 – ANOSIM	Season Year and antecedent rainfall NMDS groups	Occurrence Density Assem. similarity %, P/A Assem. similarity %, P/A	Compare assemblages Seasonal changes? Changes with time or rainfall? NMDS groups differ?
UNSW – Kingsford & Porter (2009); Kingsford <i>et al.</i> (2020)	Broad aerial survey	1983-2019	121	1 – Correlation among surveys 4, 5 – NMDS, DistLM 5 – ANOSIM	Year and antecedent rainfall NMDS groups	Occurrence Assem. similarity %, P/A Assem. similarity %, P/A	Compare assemblages Changes with time or rainfall? NMDS groups differ?
Driscoll <i>et al.</i> (2012)	Fixed-area 500-m radius	Aug 2011- Mar 2012	4	1 – Correlation among surveys 4, 5 – NMDS, DistLM 5 – ANOSIM	Year and antecedent rainfall NMDS groups	Occurrence Assem. similarity %, P/A Assem. similarity %, P/A	Compare assemblages Changes with time or rainfall? NMDS groups differ?
S1 (this study)	Variable area according to size of wetland	Jul 1991- Sep 1993	128	1 – Correlation among surveys 1 – Nestedness 2 – Regression of birds vs. habitat 2 – DistLM 4, 5 – NMDS, DistLM 5 – ANOSIM	Area, depth, riparian 32 environmental variables Year and antecedent rainfall NMDS groups	Occurrence Density Abundance, density, richness Assemblage similarity Assem. similarity %, P/A Assem. similarity %, P/A	Compare assemblages Nested metacommunity? Environmental effects on spp. Env. effects on assemblages Changes with time or rainfall? NMDS groups differ?
S2 (this study)	Variable area as above	May-Sep., 2002	75	1 – Correlation among surveys 1 – Nestedness 3 – Drying, description only 4, 5 – NMDS, DistLM 5 – ANOSIM	Wetland wet or dry Year and antecedent rainfall NMDS groups	Occurrence Density Density, richness Assem. similarity %, P/A Assem. similarity %, P/A	Compare assemblages Nested metacommunity? Succession of spp. leaving? Changes with time or rainfall? NMDS groups differ?

Hypotheses:

- 1) waterbird assemblages are generally similar among the wetlands surveyed;
- 2) waterbird assemblages vary spatially with wetland character – 32 measured variables encompassing the timing of sampling (year, month, season) wetland dimensions, hydrology, agricultural or urban disturbance, weed growth and water quality;
- 3) abundance of waterbird populations and assemblage composition vary seasonally, with maxima in the wet season;
- 4) assemblages vary annually according to antecedent rainfall;
- 5) assemblages have changed over four decades as a result of floodplain development for agriculture (clearing, levelling, irrigation supply, drainage).

Table S6 Thirty-two environmental variables recorded for samples in survey 1 and used in analyses of waterbird-environment associations; and number of positive or negative influences ($P < 0.05$) in regression analyses between bird species' density and environmental variables (see Table 2).

Variable	Abbreviation	+ve	-ive	Total
Ammonium concentration	NH ₄	8		8
Chlorophyll-a concentration	Chlorophyll a	4		4
Potassium concentration	K	2	2	4
Sodium concentration	Na		4	4
Phosphate concentration	PO ₄	4		4
Total suspended solids	TSS	2	2	4
Log area of wetland	Wetland area	1	3	4
Electrical conductivity	Conductivity	2	1	3
Dissolved oxygen (% saturation)	DO ₂	1	2	3
Magnesium concentration	Mg	1	2	3
Nitrate + nitrite concentration	NO _x	2	1	3
Phaeophytin-a concentration	Phaeophytin		3	3
Total phosphorus concentration	TP	1	3	3
Calcium concentration	Ca	2		2
Maximum water depth	Depth		2	2
Evidence of wetland drying	Drying		2	2
Log distance from coast	Km from coast	2		2
Water temperature	Temperature	1	1	2
Discharge in Barratta Ck at time of sampling	Discharge		1	1
Macrophyte species richness	Macrophyte		1	1
Riparian vegetation species richness	Riparian		1	1
Total nitrogen concentration	TN		1	1
pH	Ph			
Log distance from agricultural disturbance	Km from cane fields			
Discharge in Barratta Ck previous 12 months	Discharge 12 mo			
Discharge in Barratta Ck previous 4 months	Discharge 4 mo			
Rainfall within current month	Rainfall			
Rainfall previous 12 months	Rainfall 12 mo			
Rainfall previous 4 months	Rainfall 4 mo			
Wet, transition or dry season	Season			
Month of sample	Month			
Year of sample	Year			

Table S7 Seasonal contrasts (repeated measures ANOVA and post-hoc Tukey contrasts, $P < 0.05$) for total abundance, number of species and abundance of common species at Horseshoe Lagoon and Wongaloo, 2015-2021, with monthly abundances and species counts summed over the seven years. See Fig. 3

	F	P	Contrasts by season: Wet, Transition, Dry
Horseshoe Lagoon df=2,8			
Total abundance	1.75	0.2339	-
Number of species	0.33	0.7251	-
Black Swan	2.75	0.1230	-
Hardhead	3.53	0.0796	-
Magpie Goose	1.5	0.2807	-
Wongaloo df=2,9			
Total abundance	11.26	0.0035	b, a, ab
Number of species	2.43	0.1432	-
Black Swan	5.12	0.0327	ab, a, b
Brolga	4.49	0.0445	-
Grey Teal	19.43	0.0005	b, a, a
Hardhead	2.32	0.1544	-
Hardhead (offset 1 month)	53.54	< 0.0001	b, a, b
Magpie Goose	6.25	0.0199	b, a, ab
Pacific Black Duck	5.34	0.0296	b, a, ab
Plant feeders	8.61	0.0081	b, a, a
Invertebrate feeders	6.04	0.0217	b, a, ab
Fish feeders	4.37	0.0472	b, a, ab

Table S8 Occurrence (shaded cells) of species sorted into three foraging (behavioural) groups at three sites in survey 2 as wetlands dried: M, May-June; J, July; A, August-September. Mean number of species for the three periods, respectively, were 17.7 ± 2.0 , 13.3 ± 1.8 , 0.7 ± 0.3 . ANOVA for difference between periods: $F_{2,9} = 31.92$, $P = 0.0006$. Tukey contrasts were between August-September and the prior months. *Magpie Goose and Australia Wood Duck forage terrestrially

	Site 2			Site 3			Site 4			
	M	J	A	M	J	A	M	J	A	
Aerial foragers										
Caspian Tern										
Australian Gull-billed Tern										
Whiskered Tern										
Swimmers/divers										
Australasian Darter										
Australian Pelican										
Australian Wood Duck*										
Black Swan										
Grey Teal										
Hardhead										
Little Black Cormorant										
Little Pied Cormorant										
Magpie Goose*										
Pacific Black Duck										
Waders										
Australian White Ibis										
Black-fronted Dotterel										
Black-necked Stork										
Brolga										
Cattle Egret										
Comb-crested Jacana										
Glossy Ibis										
Great Egret										
Little Egret										
Masked Lapwing										
Black-, winged Stilt										
Intermediate Egret										
Red-kneed Dotterel										
Royal Spoonbill										
Straw-necked Ibis										
White-faced Heron										
White-necked Heron										
Yellow-billed Spoonbill										
No. of species	21	14	1	14	10	1	18	16	0	

Table S9 Periods of breeding activity noted at Wongaloo, 2012-2021.

Species	Months
Australian Pelican	September
Australian White Ibis	May-July
Black Swan	May-October
Black-fronted Dotterel	July
Black-necked Stork	May-October
Brolga	November
Cattle Egret	June-July
Little Black Cormorant	March-May
Little Pied Cormorant	July
Magpie Goose	June-October
Masked Lapwing	May-September
Plumed Whistling-Duck	April-June
Straw-necked Ibis	October-January
White-necked Heron	May
Yellow-billed Spoonbill	September

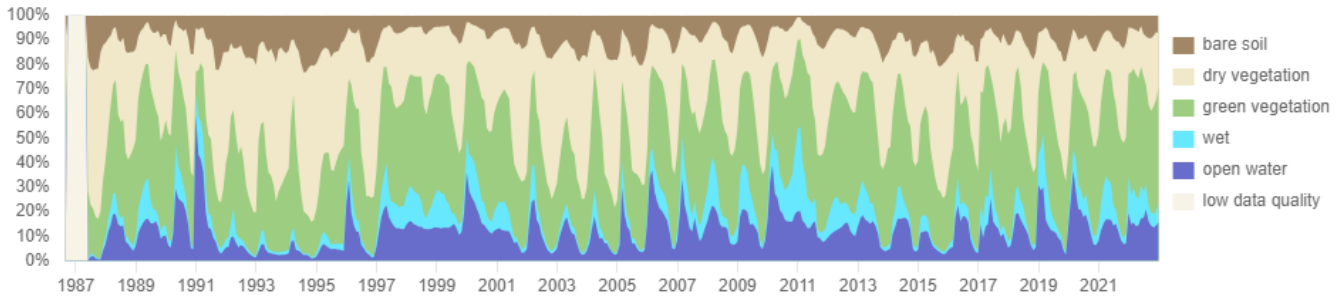


Fig. S1 Wetland extent in the Burdekin-Townsville aggregation 1987-2022. Note seasonality and inter-annual variation. Source: Queensland Government, WetlandInfo: <https://wetlandinfo.des.qld.gov.au/wetlands/facts-maps/> (accessed August 3, 2024)

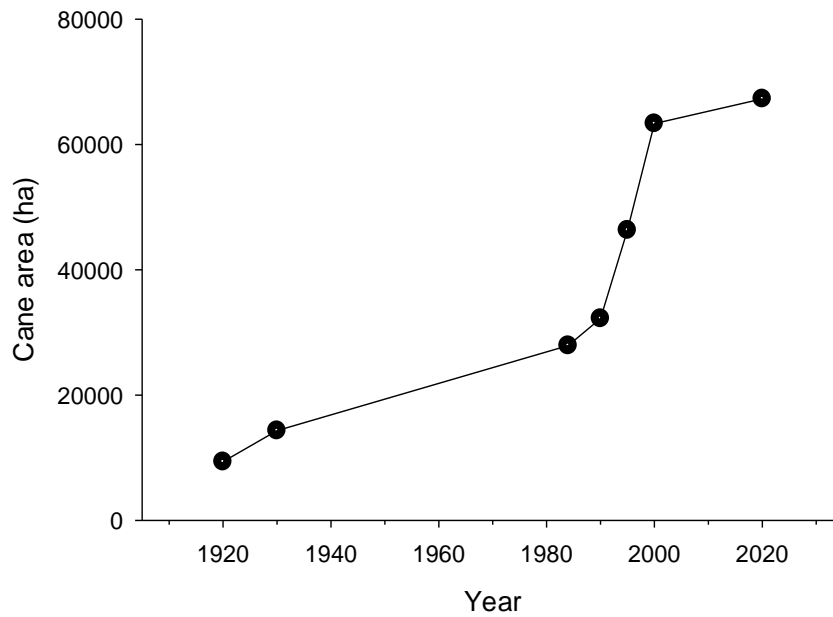


Fig. S2 Increase in Burdekin sugarcane growing area with time. Source: Australian Bureau of Statistics, <https://www.abs.gov.au/statistics/industry/agriculture/sugarcane-experimental-regional-estimates-using-new-data-sources-and-methods/latest-release#data-downloads>. Downloaded March 27, 2023



Fig. S3 Monthly occurrence (percentage of total count for each species) of common waterbirds at the Wongaloo wetlands, 2012-2021.

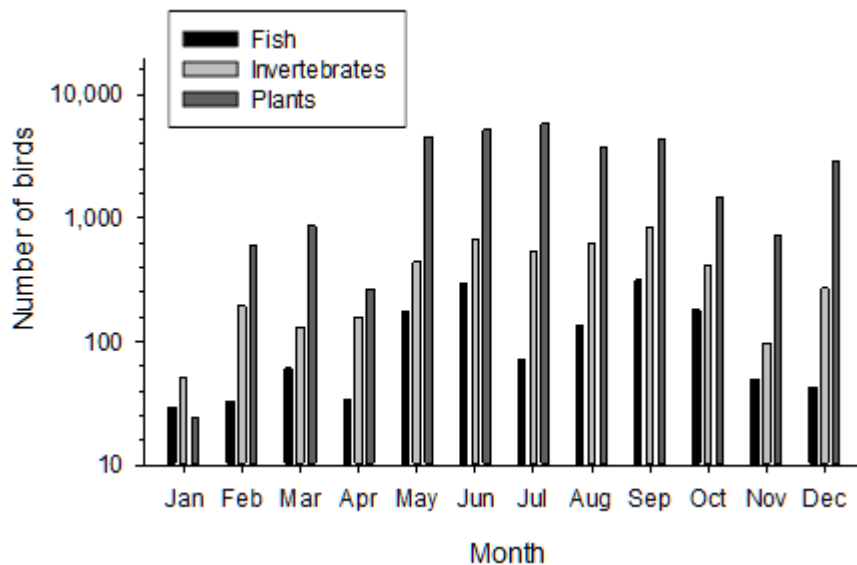


Fig. S4 Monthly abundance of birds by functional group at Wongaloo, 2015-2021. Functional groups are labelled by their main sources of food.

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