2021/22

Port of Brisbane shorebird monitoring

Penn Lloyd, Peter V. Driscoll and Jonathan T. Coleman

Queensland Wader Study Group

Port of Brisbane shorebird monitoring annual report 2021/22

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Cover image:

Mixed flock of nine shorebird species feeding and roosting in Port of Brisbane reclamation area pond: Eva Plaganyi-Lloyd, QWSG.

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EXECUTIVE SUMMARY

BACKGROUND

For over 30 years, Port of Brisbane (Port) lands on Fisherman Island have been used as high tide roosting habitat by large numbers of shorebirds, mostly migratory shorebirds but also resident shorebirds. Since 2003, the QWSG has been commissioned by Port of Brisbane Pty Ltd to undertake regular (typically monthly) counts of birds at roost sites on Fisherman Island. This is the ninth annual report since 2013 to present the results of the shorebird monitoring activities of the QWSG at the Port of Brisbane and covers the period September 2021 to August 2022.

OBJECTIVES

The specific objectives of this report are to:

- Provide a summary of bird numbers by species and site (individually and overall) at the Port for 2021/22, presented as a table of raw numbers and suitable graph(s).
- Quantify the relative importance of the Port for supporting roosting shorebirds in Moreton Bay by comparing total Port counts with the total Moreton Bay count.
- Present annual changes in shorebird numbers by species for each roost site within the Port.
- Analyse longer-term trends of shorebird numbers at the Port by species.
- Provide a summary of shorebird banding activities at the Port.

STUDY APPROACH

Twelve counts were conducted over the period September 2021 to August 2022 at eleven roost sites on Fisherman Island that were used by shorebirds. During each count, QWSG volunteers recorded the total number of individuals for each species observed at each site within a 2-hour period, approximately an hour either side of high tide. Birds were observed through high-powered spotting telescopes mounted on sturdy tripods. Any movement of birds between count sites during the count were noted and communicated between counting teams to avoid double-counting. Two visits were made specifically to resight flagged shorebirds.

KEY RESULTS

Monthly shorebird counts

A total of 20 migratory shorebird species and seven resident shorebird species were recorded at the Port. The total migratory shorebird count ranged between 1,337 and 7,590 birds during the south migration period (September to mid-November), between 1,033 and 9,824 birds during the non-breeding period (mid-November to mid-March), between 299 and 1,725 during the north migration period (mid-March to May) and between 234 and 945 during the northern hemisphere breeding period (June to August). The total resident shorebird count ranged between 144 and 1,001 birds. Six of the eleven Port sites supported 98% of the total migratory shorebirds overall: reclamation area ponds C3, R3, BS2, BS3, FPE and the claypan, with pond BS3 being the most important, supporting 45% of migratory shorebirds. Pond R3 was the most important site for resident shorebirds, supporting 32% of the total resident shorebirds overall, with the claypan and reclamation area pond BS3 the next most important. The artificial roost supported 0.7% of migratory shorebirds and 5.8% of resident shorebirds overall.

Seasonal variation in shorebird counts

Total migratory shorebird numbers roosting at the Port have shown the expected cyclical pattern of increasing during the south migration period (September to mid-November, generally reaching peak numbers through the non-breeding period (mid-November to mid-March), before decreasing again during the north migration period (mid-March to May) to relatively low numbers during the northern hemisphere breeding period. Total migratory shorebird numbers

were consistently high and most stable over the period October to mid-March. Total resident shorebird numbers have overall shown an opposite seasonal pattern to migratory shorebirds, reaching lowest average numbers during the period of high migratory shorebird numbers, increasing from mid-April to late August when migratory shorebird numbers are low. Resident shorebirds were substantially less abundant than migratory shorebirds, making up only 9% of the overall total shorebird abundance from all counts since 2003.

Long-term trends in shorebird counts

There has been no significant trend in the average total migratory shorebird count over the past 20 years during either summer (1 October to 15 March) or winter (1 May to 31 August) periods. The average summer count has ranged between 5436 and 8607 whereas the average winter count has ranged between 528 and 2820 birds. The maximum count of total migratory shorebirds roosting at the Port each year has ranged between 7159 and 13703, with no evidence of a trend in the maximum count during the non-breeding period over the past 20 years. Similarly, there has also been no significant trend in the average annual total resident shorebird count over the past 20 years. Thus, there is no evidence of a substantive change in overall shorebird numbers roosting at the Port over the 20-year period 2002-2021. Among individual migratory shorebird species, there has been a significant decreasing trend in the average summer count for three species (Far Eastern Curlew, Grey Plover and Red-necked Stint) and a significant increasing trend for three species (Bar-tailed Godwit, Great Knot and Broad-billed Sandpiper) over the 20-year period.

Roost site rankings

The relative rankings of the eleven Port roost sites have varied over the past five years, largely in response to the amounts of dredge spoil deposited in each pond each year and its effects on pond water levels and the areas of shallow water and surrounding damp substrates. In 2021, reclamation pond BS3 (PBS3), which has increased steadily in ranking since 2018 overtook pond C3 (PBC3) as the highest-ranked site supporting the most migratory shorebirds through the shorebird year. The artificial roost was the lowest ranked site in 2021, supporting the least migratory shorebirds. Reclamation pond C4 (PBC4) was created in March 2020 when it was excised from pond FPE (PFPE), whereas pond BS1 (PBS1) ceased to exist in 2021 after it became fully filled in with sand. Ponds BS3 and C3 were both split into two smaller cells in 2021.

The reclamation area ponds have consistently supported 80-90% of the migratory shorebirds over the past 20 years, with the artificial roost, claypan, visitor centre and rail loop sites supporting substantially lower numbers. Averaged across all years, the reclamation area ponds have supported 88%, the claypan 8%, the artificial roost 4%, and the visitor centre and rail loop less than 1% of the migratory shorebirds.

Comparison with Moreton Bay as a whole

During 2021/22, the Index of Relative Importance (IRI) for the Port was highest for Curlew Sandpiper, with an average of 73% of the Moreton Bay total numbers of this species using the Port, and lowest for Far Eastern Curlew, with an average of 5% of the Moreton Bay total using the Port. Relative to 2020, the IRI increased for five species and decreased for seven species in 2021, with a slight decrease from 0.46 to 0.43 in the average across all 12 species. Relative to 2016, which had the highest overall IRI over the past five years, the IRI in 2021 increased for three species and decreased for the remaining nine species. The overall average IRI across all 12 important species has remained relatively unchanged over the past four years 2017-2020, within the range 0.43 to 0.46.

Shorebird banding

No catching and banding of shorebirds took place at the Port during the reporting period. There were 35 shorebird flag re-sightings on Fisherman Island during the 2021/22 reporting period,

including: 33 green flags on birds banded in Moreton Bay; one orange flag on a Curlew Sandpiper banded in Victoria; and one white over blue flag on a Lesser Sand Plover banded in Wang-Gong, Chang-Hua County, Taiwan. Most flagged birds resighted at the Port have been observed feeding on tidal flats or roosting at other roost sites within 14 km along the mainland shoreline of Moreton Bay to the south of the Port, particularly the Manly Harbour roost site and tidal flats from Wynnum to Thorneside.

RECOMMENDATIONS

Port of Brisbane Pty Ltd is encouraged to continue to prioritise the management and monitoring of shorebirds at the Port. Satellite tracking of birds using the Port should be continued in tandem with the ongoing monthly count monitoring of the Port roost sites and the alternative roosts in the local region to develop a better understanding of the movement of birds between the Port and alternative roost sites in the local region and potential constraints, for example temporal variation in roost suitability due to tide cycles and disturbance. Such information is important for predicting the impacts on shorebirds of the eventual loss of the Port reclamation area for roosting once the area becomes fully reclaimed.

There is also a need to continue to explore opportunities to provision habitat for shorebirds within or adjacent to Port lands to compensate for the expected future loss of roosting habitat in the reclamation area, particularly since the artificial roost, which was specially constructed to provide alternative roosting habitat close to the reclamation area, has only been used by relatively small numbers of migratory shorebirds. In this regard, Port of Brisbane Pty Ltd could advocate for such an outcome together with other interested and relevant stakeholders and regulators. Planning to provide adequate shorebird habitat in Moreton Bay into the future is required to manage the increasing pressures on shorebirds from the continued growth and development of Brisbane and the anticipated future loss of roosting habitat in the Port reclamation area.

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Glossary of Terms and Abbreviations

EAAF	East Asian Australasian Flyway
Port	Port of Brisbane
QWSG	Queensland Wader Study Group

1.0 INTRODUCTION

1.1 THE DEVELOPMENT OF THE PORT OF BRISBANE

Located on the southern side of the mouth of the Brisbane River in Moreton Bay, the Port of Brisbane (the Port) has experienced substantial change over the past 60 years. Prior to 1960, the site comprised a collection of islands surrounded by tidal mudflats (**Figure 1.1**). The islands included several mangrove islands in the south, collectively known as the Fisherman Islands, together with Bishop Island in the north. Bishop Island was a man-made island about two metres above the high-water mark and 17 hectares in area that was formed over the period 1909-1912 when the dredger 'Hercules' directed 4.5 million tons of dredge material to the tidal flat on the southern side of the Brisbane River mouth (Ludlow 2013). The tidal flats on the south-eastern flank of Bishop Island subsequently became a graveyard for the disposal of up to 18 ships (Roderick 1973) and a signal station operated on the island until 1968 (Ludlow 2013).

Construction of the current Port infrastructure footprint commenced in the early 1960's when large volumes of dredge material were directed over the tidal mudflats to connect the Fisherman Islands into a single land mass, connected to the Lytton mainland through the construction of a road and rail bridge. Infilling with dredge material has taken place continuously since then to expand the Port infrastructure footprint over mangroves, tidal mudflats, Bishop Island and subtidal waters to the north and east to progressively develop the footprint to its current extent (**Figures 1.1** and **1.2**).

Figure 1.1. *Composite illustration of the development of the Port of Brisbane site between 1946 and 2006.*

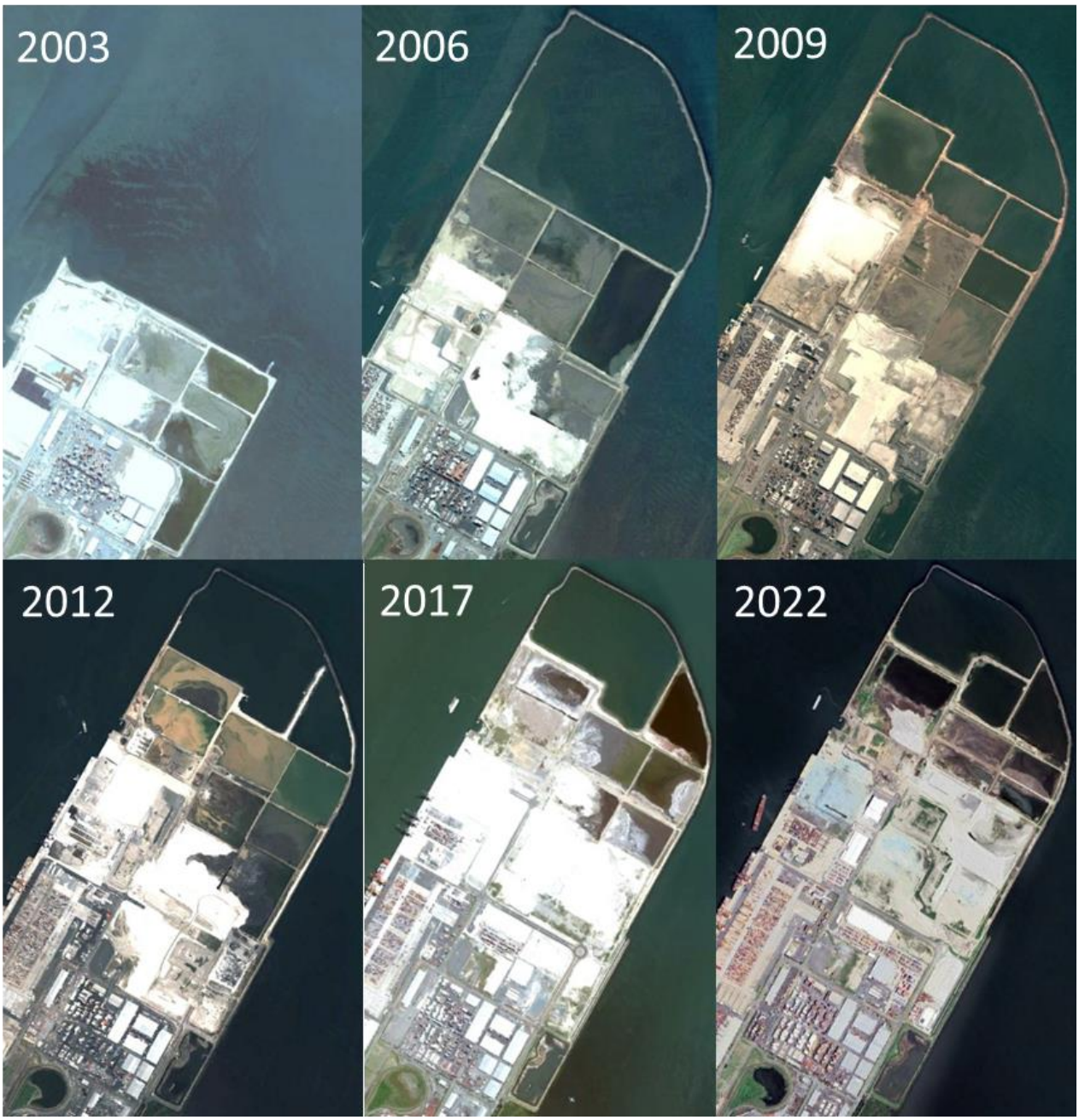

Figure 1.2. *Composite illustration of the development of the reclamation area at the Port of Brisbane site between 2003 and 2022.*

The reclamation area was expanded considerably during 2004 with the construction of the outer bund rock wall. Between 2004 and 2022, cells within this expansion area have been progressively bunded off and used to settle dredge material, a process that has resulted in the progressive infilling of these cells and their eventual incorporation into the expanded Port development (**Figure 1.2**).

The tidal flats to the north and south of the Brisbane River mouth provide important feeding habitat for shorebirds, particularly migratory shorebirds (see Box 1), used by several thousands of shorebirds when the flats become exposed at low tide (Thompson 1990, Driscoll 1993a, Lloyd *et al*. 2021). While the construction of the Port has led to the loss of some areas of tidal flat feeding habitat, the repeated process of pumping fresh dredge material into the relatively large (10-20 ha) cells and then allowing it to settle and dry out has created ideal roosting habitat conditions for shorebirds in the area over decades. These ideal roosting habitat conditions include: The repeated process of pumping fresh dredge material into the relatively large (10-20 ha) cells and then allowing it to settle and dry out creates highly suitable roosting habitat for shorebirds that combines the following features: (1) large areas of bare, open ground with little to no cover that provide a clear view of approaching predators; (2) being adjacent to the shoreline or incorporating areas of

water and wet substrates that allow the birds to stay cool on hot days; (3) incorporating areas with uneven relief with small surface mounds and depressions that assists with camouflage and affords some protection from strong winds; and (4) being close to preferred tidal flat feeding areas that reduces their energy expenditure flying between roosting and feeding sites (Rogers *et al.* 2006a, Ryeland *et al.* 2020); and (5) periodic refreshment with a nutrient rich slurry that promotes zooplankton growth in the shallow waters, providing abundant food for smaller shorebirds such as Red-necked Stint and sandpipers, allowing them to continue feeding through the high-tide phase of the tidal cycle (Fuller *et al*. 2021).

Box 1: Shorebird ecology in Moreton Bay

Shorebirds are bird species in the order Charadriiformes, which includes avocets, curlews, dotterels, godwits, lapwings, oystercatchers, plovers, sandpipers, stilts, stone-curlews, tattlers and whimbrels, but does not include groups such as gulls and terns (Colwell 2010). Coastal shorebirds have a daily activity pattern that follows the tides, feeding on tidal flats once they become exposed at low tide and moving to rest in flocks at roost sites above the high-water mark once the rising tide covers their feeding habitat. They feed on a wide variety of benthic invertebrates, including crustaceans, molluscs and polychaete worms that are taken either on the surface of tidal flats or extracted from soft, muddy or sandy sediments by probing with their bills, which are elongated in many species. Most shorebirds can feed at night as well as during the day.

Most shorebirds using Moreton Bay are migratory, spending their non-breeding season (the Austral summer) in Australia and migrating up to 13,000 km north through south-east Asia along the East Asian–Australasian Flyway (the Flyway) to breeding grounds in eastern Siberia and western Alaska (Bamford et al. 2008) where they breed through the austral winter. An exception is the Double-banded Plover (*Charadrius bicinctus*), which breeds in New Zealand during the austral summer and a portion of the population migrates to Australia for its winter non-breeding season (Pierce 1999).

Moreton Bay is recognised as a Ramsar wetland of international significance and is the most important site for shorebirds in Queensland. Up to 37,900 shorebirds including up to 35,800 migratory shorebirds have been counted in Moreton Bay (Clemens *et al*. 2008), with a total estimate of up to 50,000 migratory shorebirds using Moreton Bay in the past (Thompson 1990). Moreton Bay regularly supports internationally significant numbers (greater than 1% of the Flyway population) of nine migratory shorebird species (Fuller *et al*. 2021).

1.2 Background to the Annual Reporting

The Queensland Wader Study Group (QWSG) has monitored shorebirds and other waterbirds at the Port from as early as August 1991, when three consecutive years of monitoring were commissioned by the Port of Brisbane Corporation during the initial major development works that led to the creation of the current dredge reclamation area (Driscoll 1992, 1993b, 1994). Between three and 16 counts were then conducted annually to 2002 in an unstandardised way. Since January 2003, the QWSG has been commissioned by Port of Brisbane Pty Ltd to undertake regular (typically monthly) standardised counts of birds on Port lands within the reclamation area, a purpose-built shorebird roost site (PBAR), a nearby claypan (FICP) a freshwater lake (FIVC) and an ephemeral freshwater pondage area within a rail loop (PBRL) on Fisherman Island (**Figure 1.3**). At the same time, QWSG members have also regularly counted between 50 and 65 other high tide roosts in Moreton Bay, to monitor shorebird numbers throughout Moreton Bay more broadly (Fuller *et al.* 2021).

Starting in 2007, the QWSG has included the Port of Brisbane in a network of locations around Moreton Bay where shorebirds are captured to be fitted with numbered metal bands and engraved green leg flags. The leg flags are engraved with a unique combination of letters and numbers that can be read from a distance and allows each bird to be individually identified without the need to re-capture it. Furthermore, some birds have been fitted with small Platform Terminal Transmitter (PTT) satellite tracking devices to track their local and migratory movements. This contributes to a

national and global programme that seeks to better understand the annual survival and movements of shorebirds both within Moreton Bay and on their migration through the Flyway to their breeding grounds in the northern hemisphere.

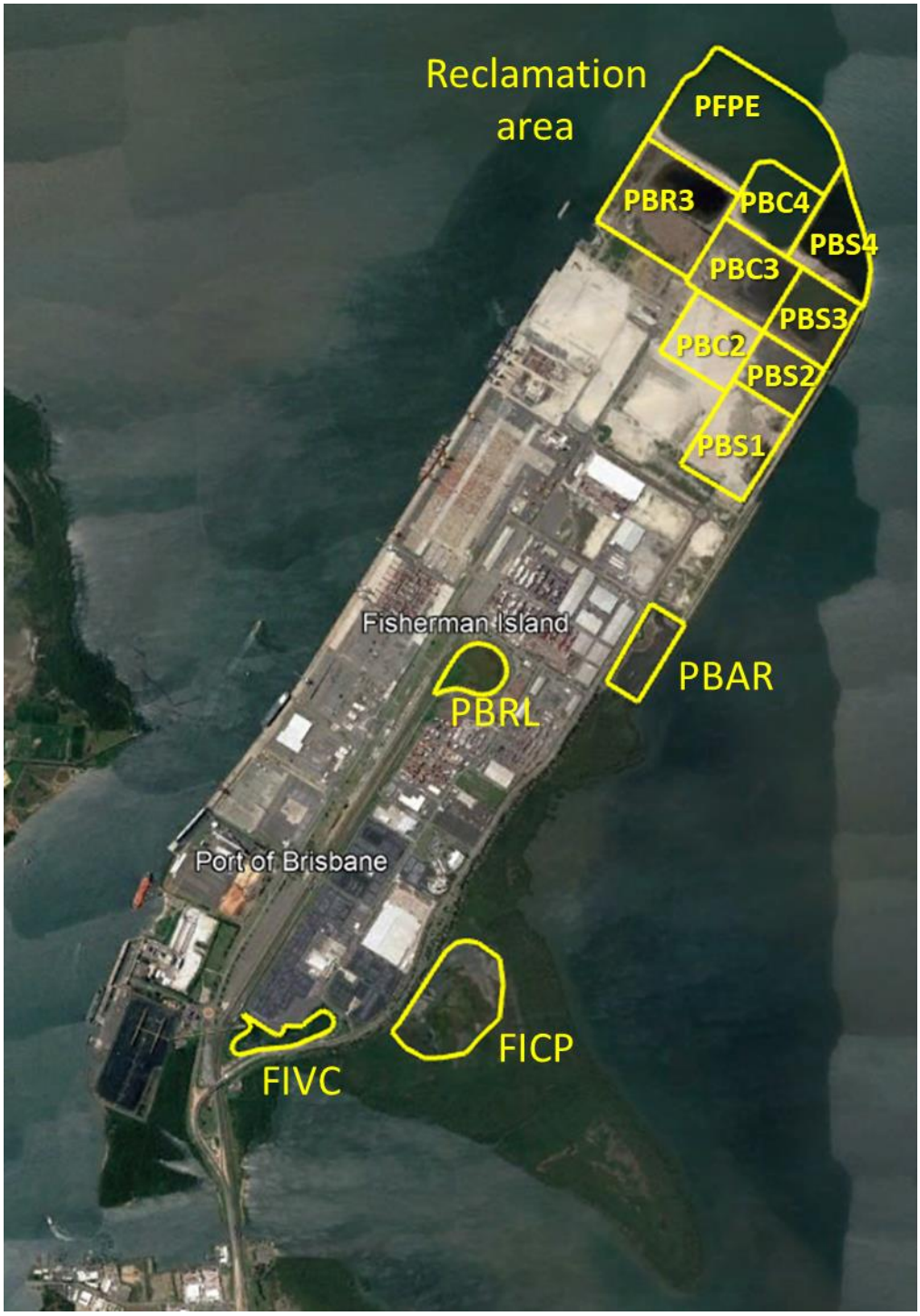

Figure 1.3. *Locations of shorebird count sites on Fisherman Island at Port of Brisbane in 2021/22, including nine sites within the current reclamation area, a purpose-built shorebird roost site (PBAR), a nearby claypan (FICP), a freshwater lake (FIVC) and an ephemeral freshwater pondage area within a rail loop (PBRL).*

This is the ninth annual report since 2013 to present the results of the shorebird monitoring activities of the QWSG at the Port of Brisbane and covers the period September 2021 to August 2022.

1.3 OBJECTIVES

The specific objectives of this report are to:

- provide a summary of bird numbers by species and site (individually and overall) at the Port for 2021/22, presented as a table of raw numbers and suitable graph(s);
- quantify the relative importance of the Port for supporting roosting shorebirds in Moreton Bay by comparing total Port counts with the total Moreton Bay count;
- present annual changes in shorebird numbers by species for each roost site within the Port;
- analyse longer-term trends of shorebird numbers at the Port by species; and
- provide a summary of shorebird banding and leg flag re-sighting activities at the Port.

2.0 MONITORING APPROACH

The annual monitoring involved two main activities: monthly counts; and irregular shorebird banding and leg flag re-sighting.

2.1 MONTHLY SHOREBIRD COUNTS

Twelve counts were conducted within the reporting period (**Table 2.1**). During 2020/21, eleven roost sites on Fisherman Island were used by shorebirds: nine within the reclamation area; a purpose-built shorebird roost site (PBAR); and a nearby claypan (FICP; **Figure 1.1**). QWSG count volunteers generally met on site 1.5 hours before high tide to be briefed and assigned to one or more count sites in teams of at least two members. Each team then proceeded to record the total number of individuals for each species observed within their assigned sites within a 2-hour period, approximately an hour either side of high tide. Birds were observed through high-powered spotting telescopes mounted on sturdy tripods. Any movement of birds between count sites during the count were noted and communicated between teams to avoid double-counting.

Monthly counts were also conducted at Lytton Claypan No. 1, a roost site on land managed by Port of Brisbane Pty Ltd just south of Fisherman Island. However, the results for this site are not included in the total Port counts and analyses reported in the following sections.

Counts were allocated to one of four periods that characterise the annual cycle of a typical migratory shorebird as follows:

- Breeding (the northern hemisphere breeding season or austral winter months June to August);
- South Migration (September to mid-November);
- Non-breeding (the austral summer months mid-November to mid-March); and
- North Migration (mid-March to May).

Table 2.1. *Count dates and high tide (HT) details during the September 2021 to August 2022 reporting period.*

Shorebird activity period	Date	HT height (m)	HT time
South migration	12/09/2021	2.15	13:24
South migration	24/10/2021	2.24	11:30
Non-breeding	21/11/2021	2.37	10:33
Non-breeding	12/12/2021	2.05	16:23
Non-breeding	09/01/2022	2.10	14:32
Non-breeding	06/02/2022	2.20	13:04
North migration	20/03/2022	2.39	10:51
North migration	03/04/2022	2.19	10:45
North migration	01/05/2022	2.08	09:40
Breeding	12/06/2022	2.06	07:11
Breeding	17/07/2022	1.90	12:22
Breeding	14/08/2022	2.01	11:12

2.2 SHOREBIRD BANDING AND FLAG RE-SIGHTING

No catching and banding of shorebirds took place at the Port during the reporting period. During the monthly counts, the details of any birds carrying engraved leg flags were recorded opportunistically when the flag combinations were able to be read. In addition, two visits were conducted by QWSG members specifically to re-sight flagged shorebirds using the Port roosts at high tide.

2.3 IMPORTANT MIGRATORY SHOREBIRD SPECIES AT THE PORT OF BRISBANE

Twelve migratory shorebird species are a particular focus of the monitoring at the Port (**Table 2.2**). The 12 species have all been recorded at some time or another on Fisherman Island in numbers exceeding 0.2 % of the total Flyway population size, and often in numbers exceeding 1% of the Flyway population (**Table 2.1**). Note that a site is considered internationally or nationally significant for a species if the population at the site exceeds >1% or > 0.1% of the total Flyway population size respectively (Bamford *et al.* 2008).

Table 2.2. *Maximum summer counts of 12 important species at the Port of Brisbane on Fisherman Island also expressed as the percentage of the total population size in the EAAF (Hansen et al. 2016) and their frequency of occurrence in all counts between September 2003 and August 2022, including all seasons not just summer.*

Species	Maximum count since 2003 (% flyway population)	Year of maximum
Grey-tailed Tattler	1434 (2.0)	2019
Red-necked Stint	6803 (1.4)	2003
Lesser Sand Plover	2433 (1.4)	2003
Curlew Sandpiper	2607 (2.9)	2017
Sharp-tailed Sandpiper	2078 (2.4)	2005
Far Eastern Curlew	670 (1.2)	2006
Pacific Golden Plover	1219 (1.0)	2019
Great Knot	708 (0.2)	2013
Greater Sand Plover	441 (0.2)	2006
Ruddy Turnstone	213 (0.7)	2016
Bar-tailed Godwit	1572 (0.5)	2019
Grey Plover	145 (0.2)	2007

2.4 ANALYSIS

Temporal trends in the annual average austral summer count (over the period 1 October to 15 March inclusive, the period that migratory shorebird numbers at the Port were consistently high and most stable) of individual species or shorebird groupings over the 20-year period of shorebird years 2002 to 2021 were tested using a non-parametric Mann-Kendall trend test in R (R Core Team 2021) to statistically assess if there is a monotonic upward or downward trend in shorebird numbers over time. A monotonic upward (or downward) trend means that the variable consistently increases (or decreases) through time, but the trend may or may not be linear.

To determine the relative importance of the different sites within the Port to migratory shorebirds, each of the 11 sites (PBAR, FICP and nine sites within the reclamation area) were ranked (1 to 11, from highest to lowest values) for each of:

- the total number of migratory shorebirds recorded for the shorebird year (September to August);
- the average number of migratory shorebird species recorded for the shorebird year; and
- an average rank for each site based upon individual site rankings for the total birds counted throughout the shorebird year for each of the 12 important species (**Appendix A**).

The average of these three rankings was used as a measure of the relative importance of the site to migratory shorebirds during the shorebird year. The lower the ranking the higher the importance of the site for migratory shorebirds.

To assess the relative importance of the Port to the 12 important migratory shorebird species listed in **Table 2.1**, an Index of Relative Importance (IRI) was calculated for each species as the ratio of the total Port count to the whole of Moreton Bay count (refer to **Appendix D** for a list of sites used) averaged across all counts from September to April inclusive using the equation:

$$\mathrm{IRI} = \frac{1}{n}\sum_{i=1}^{n}\frac{PortofBrisbaneCount_i}{MoretonBayCount_i}$$

Where *n* = the total number of counts and *i* = the *i* th count.

2.5 PERMITS AND APPROVALS

All QWSG field activities were carried out in accordance with scientific purposes permits WISP16744415 and WA0032220, Moreton Bay Marine Park Permit QS2007/CVL1337A and Animal Ethics Approvals CA 2018-02-1159 and CA 2020-11-1435.

3.0 RESULTS AND DISCUSSION

3.1 MONTHLY SHOREBIRD COUNTS 2020/21

The total counts of both migratory and resident (non-migratory) shorebirds at each site each month between September 2021 and August 2022 are summarised in **Table 3.1**. The total migratory shorebird count ranged between 1,337 and 7,590 birds during the south migration period (September to mid-November), between 1,033 and 9,824 birds during the non-breeding period (mid-November to mid-March), between 299 and 1,725 during the north migration period (mid-March to May) and between 234 and 945 during the northern hemisphere breeding period (June to August). The total resident shorebird count ranged between 144 and 1,001 birds (**Table 3.1**).

Six of the eleven Port sites supported 98% of the total migratory shorebirds overall: reclamation area ponds C3, R3, BS2, BS3, FPE and the claypan, with pond BS3 being the most important, supporting 45% of migratory shorebirds (**Table 3.1**). Pond R3 was the most important site for resident shorebirds, supporting 32% of the total resident shorebirds overall, with the claypan and reclamation area pond BS3 the next most important. The artificial roost supported 0.7% of migratory shorebirds and 5.8% of resident shorebirds overall.

A total of 20 migratory shorebird species and seven resident shorebird species were recorded at the Port (**Appendix B**).

Counts for each of the 12 important species for each site and month during the past year are given in **Appendix A**. **Appendix B** outlines the monthly totals across all Port sites for all shorebird species, not just the twelve important species.

The results of the monthly counts at Lytton Claypan No. 1 are summarised in **Appendix E**. Up to 3310 migratory shorebirds (14 species) and up to 379 resident shorebirds (6 species) were recorded roosting at the claypan during the 2021 shorebird year. Lytton Claypan No. 1 is an important roost site for Bar-tailed Godwit, Curlew Sandpiper, Eurasian Whimbrel, Far Eastern Curlew, Great Knot, Red-necked Stint and Sharp-tailed Sandpiper in particular.

Table 3.1. *Total counts of both migratory and resident shorebirds at each site each month between September 2021 and August 2022. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022 Breeding	17 Jul 2022	14 Aug 2022	**Total**	% of total
Total migratory shorebirds															
Pond BS3	PBS3	82	4,122	7,530	2,735	2,582	111	41	60	41	363	187	18	17,872	45.2
Pond R3	PBR3	463	620	1,311	228	1,356	174	413	139	7	31	78	107	4,927	12.5
Pond C3	PBC3	193	1,428	106	630	380	245	887	0	52	244	157	27	4,349	11.0
Pond BS2	PBS2	24	357	158	25	373	127	1,614	1,220	67	41	86	0	4,092	10.4
Claypan	FICP	0	361	28	1,100	925	109	1,168	55	0	55	190	80	4,071	10.3
Pond FPE	PFPE	565	682	444	127	263	247	633	241	132	0	0	0	3,334	8.4
Pond BS4	PBS4	0	11	84	29	8	0	0	5	0	211	5	0	353	0.9
Artificial roost	PBAR	10	6	150	46	36	7	0	2	0	0	0	2	259	0.7
Pond C4	PBC4	0	3	13	10	173	13	32	3	0	0	0	0	247	0.6
Pond C2	PBC2	0	0	0	0	28	0	0	0	0	0	0	0	28	0.1
Pond BS1	PBS1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Visitor Centre	FIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Total	1,337	7,590	9,824	4,930	6,124	1,033	4,788	1,725	299	945	703	234	39,532	100
Total resident shorebirds															
Pond R3	PBR3	355	188	16	24	26	121	114	87	99	123	198	193	1,544	32.1
Pond BS3	PBS3	7	737	67	18	14	3	8	24	20	88	40	9	1,035	21.5
Claypan	FICP	32	15	17	15	8	4	9	46	283	204	132	83	848	17.6
Pond BS2	PBS2	10	19	33	22	59	11	82	25	58	4	12	8	343	7.1
Artificial roost	PBAR	71	12	15	10	13	16	2	6	4	47	62	20	278	5.8
Pond C4	PBC4	3	2	5	37	182	29	2	0	2	3	3	0	268	5.6
Pond C3	PBC3	11	8	11	10	6	2	2	0	84	73	19	29	255	5.3
Pond BS4	PBS4	3	5	2	6	0	0	0	2	58	63	46	8	193	4.0
Pond FPE	PFPE	4	5	2	2	1	4	3	2	1	0	0	0	24	0.5
Pond C2	PBC2	2	10	0	0	0	0	0	0	0	0	0	0	12	0.2
Visitor Centre	FIVC	0	0	2	0	0	3	0	0	0	0	3	0	8	0.2
Pond BS1	PBS1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Total	498	1,001	170	144	309	193	222	192	609	605	515	350	4,808	100

The maximum summer counts recorded during the 2021 shorebird year did not exceed the overall maximum count since 2003 for any of the 12 important species (**Table 3.3**).

Table 3.3. *Maximum summer counts of 12 important species at the Port of Brisbane also expressed as the percentage of the total population size in the EAAF (Hansen et al. 2016) and their frequency of occurrence in all counts between September 2003 and August 2022, including all seasons not just summer.*

Species	Maximum count for 2021	Maximum count since 2003 (% flyway population)	Year of maximum	Frequency (% of all surveys)
Grey-tailed Tattler	1,013	1,434 (2.0)	2019	89
Red-necked Stint	2,513	6,803 (1.4)	2003	100
Lesser Sand Plover	1,032	2,433 (1.4)	2003	91
Curlew Sandpiper	2,227	2,607 (2.9)	2017	100
Sharp-tailed Sandpiper	1,640	2,078 (2.4)	2005	87
Far Eastern Curlew	88	670 (1.2)	2006	89
Pacific Golden Plover	378	1,219 (1.0)	2019	87
Great Knot	407	708 (0.2)	2013	72
Greater Sand Plover	53	441 (0.2)	2006	74
Ruddy Turnstone	98	248 (0.8)	2020	87
Bar-tailed Godwit	989	1,572 (0.5)	2019	96
Grey Plover	35	145 (0.2)	2007	66

3.2 SEASONAL VARIATION IN SHOREBIRD COUNTS AT THE PORT OF BRISBANE

Total migratory shorebird numbers roosting at the Port have shown the expected cyclical pattern of increasing during the south migration period (September to mid-November, generally reaching peak numbers through the non-breeding period (mid-November to mid-March), before decreasing again during the north migration period (mid-March to May) to relatively low numbers during the northern hemisphere breeding period (**Figure 3.1**). Total migratory shorebird numbers were consistently high and most stable over the period October to mid-March. Total resident shorebird numbers have overall shown an opposite seasonal pattern to migratory shorebirds, reaching lowest average numbers during the period of high migratory shorebird numbers, increasing from mid-April to late August when migratory shorebird numbers are low (**Figure 3.1**). Resident shorebirds were substantially less abundant than migratory shorebirds, making up only 9% of the overall total shorebird abundance from all counts since 2003.

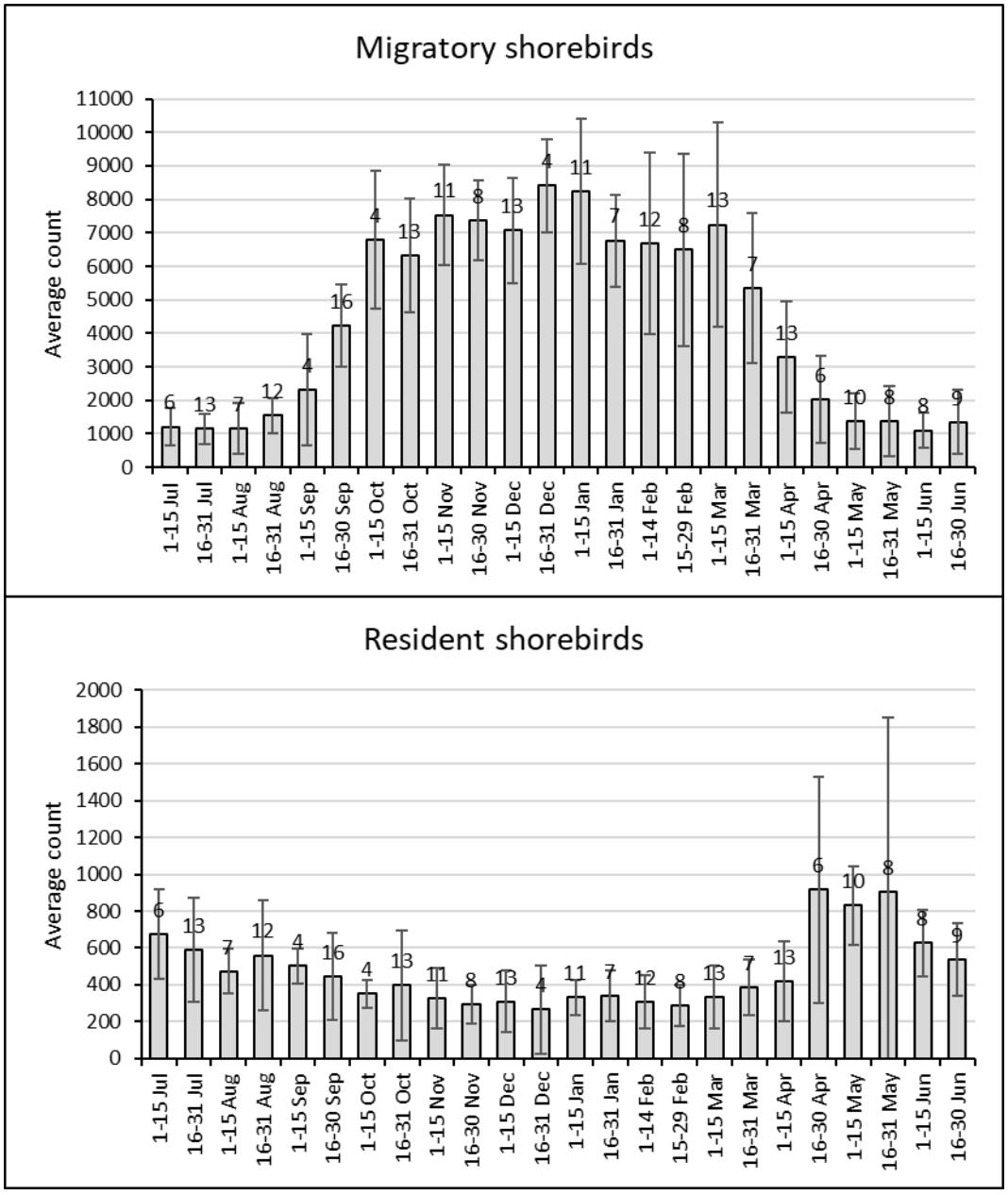

Figure 3.1. *Average (±1 SD) total migratory and resident shorebird counts each fortnight through the year over the shorebird years 2002-2021. The total number of counts for each fortnight are shown above the respective column*.

There was some variation in seasonal patterns of abundance between migratory shorebird species (**Figure 3.2**). Far Eastern Curlew had the earliest arrival during the southward migration, with increased counts from the first half of August, and the earliest departure during northward migration, with most migrating birds having left by mid-March. By contrast, species such as Bar-tailed Godwit, Great Knot, Red Knot, Pacific Golden Plover, Grey Plover and Red-necked Stint began increasing in numbers from mid-September, whereas Lesser and Greater sand plovers only began increasing from late September through the first half of October. Red Knot was most abundant within the period mid-September to mid-October, decreasing thereafter, suggesting it stops over in Moreton Bay during the southward migration before continuing to non-breeding grounds further south, and does not stop over in Moreton Bay on the return migration. Double-banded Plover, which breeds in New Zealand during the austral summer and migrates to Australia for the non-breeding period through the austral winter, was generally present from the first half of April through to mid-August (**Figure 3.2**).

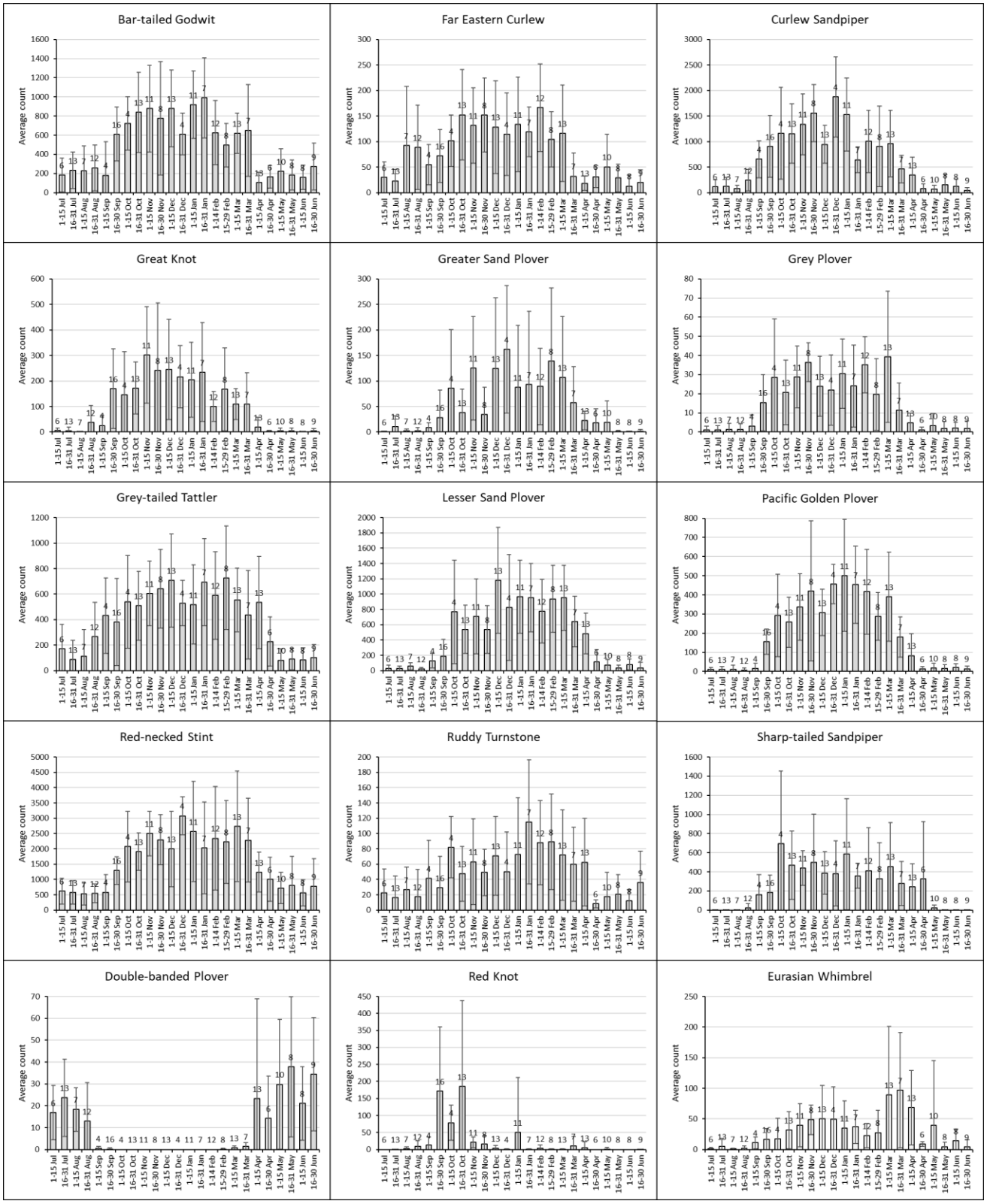

Figure 3.2. *Average (±1 SD) counts for individual migratory shorebird species each fortnight through the year over the shorebird years 2002-2021. The total number of counts for each fortnight are shown above the respective column*.

The four most common resident shorebird species showed variable seasonal changes in abundance (**Figure 3.3**). Counts of Red-capped Plover remained relatively uniform throughout the year whereas counts of Pied Oystercatcher increased from January to March, suggesting an influx of birds at this time, before decreasing again (**Figure 3.3**).

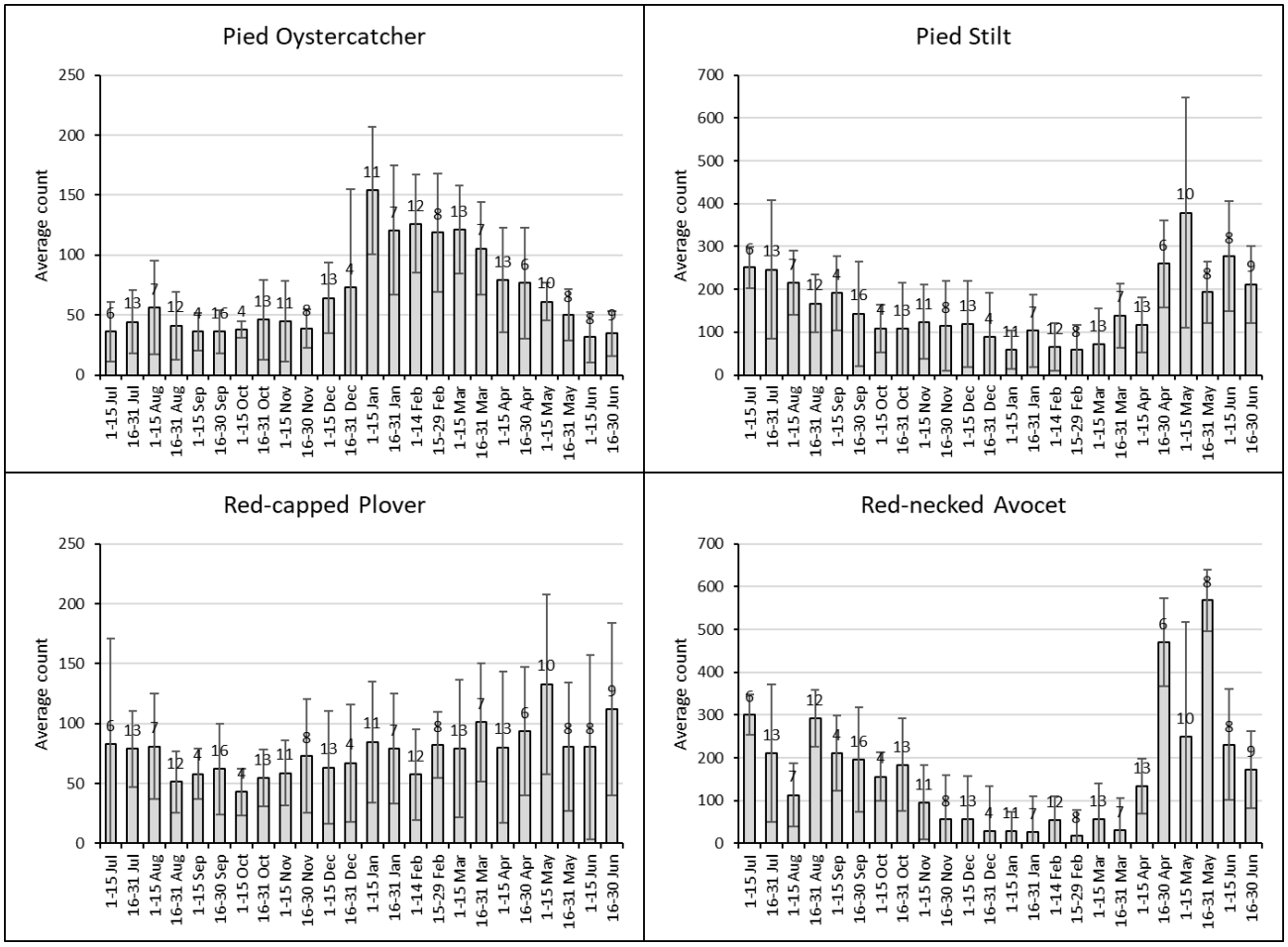

Figure 3.3. *Average (±1 SD) counts for individual resident shorebird species each fortnight through the year over the shorebird years 2002-2021. The total number of counts for each fortnight are shown above the respective column.*

Seasonal movement of Pied Oystercatchers from summer breeding areas on exposed ocean beaches into sheltered estuaries and bays during the non-breeding winter period occurs in Tasmania and some parts of Victoria (Weston & Heislers 1995, Taylor *et al*. 2014). The timing of the influx of Pied Oystercatchers into Moreton Bay from January, after the breeding season, matches the pattern observed in southern Australia. Multiple re-sightings in Moreton Bay of Pied Oystercatchers originally banded as young birds in northern NSW indicate that at least some of the influx likely represents young birds moving north from NSW at the end of the breeding season. Red-necked Avocet and Pied Stilt showed a seasonal pattern of increased abundance from mid-April before gradually declining to reach lowest abundance within the period October/November through to March, during the summer wet season. This pattern of seasonal change in abundance is likely due to the movement of birds away from the coast into the interior to breed during the summer wet season followed by an influx of birds moving back to the coast once the interior dries out during the winter dry season.

3.3 LONG TERM TRENDS IN SHOREBIRD COUNTS AT THE PORT OF BRISBANE

Figure 3.4 shows the average summer and winter total migratory shorebird counts during the shorebird years 1991-2001 when the counting at the Port was considered non-standardised (shown as orange symbols, including only counts when both the claypan (FICP) and reclamation area were surveyed at the same time) and over the shorebird years 2002-2021 once a standardised approach was adopted. The step increase in the average summer count between 2001 and 2002 suggests that Port surveys prior to 2002 were not as comprehensive as the standardised surveys from 2002 onwards. For this reason, the statistical analysis of trends was restricted to the period 2002-2021.

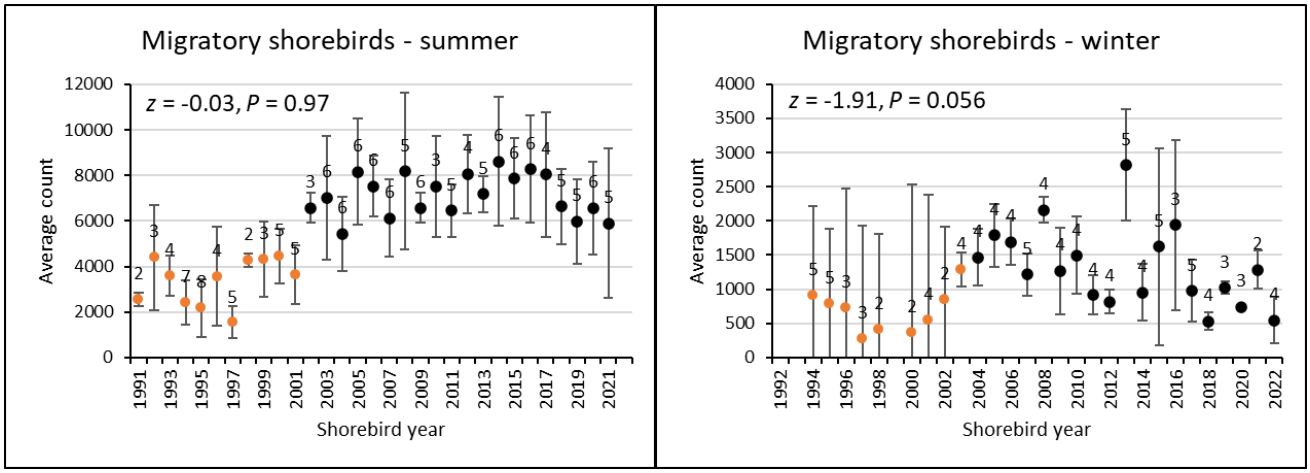

Figure 3.4. *Average total Port counts (±1 SD) for migratory shorebirds during the summer (1 October to 15 March) and winter (1 May to 31 August) periods over the shorebird years 1991-2001 (orange symbols) and 2002-2021 (black symbols). The total number of counts for each shorebird year are shown above the respective average.*

There has been no significant trend in the average total migratory shorebird count over the past 20 years 2002-2021 during either summer (1 October to 15 March: Mann-Kendall trend test z = -0.03, P = 0.97) or winter (1 May to 31 August: Mann-Kendall trend test z = -1.91, P = 0.056) periods (**Figure 3.4**). The average summer count has ranged between 5436 and 8607 whereas the average winter count has ranged between 528 and 2820 birds over the past 20 years.

The maximum count of total migratory shorebirds roosting at the Port each year has ranged between 7159 and 13703, with no evidence of a trend in the maximum count during the non-breeding period over the past 20 years (**Figure 3.5**). The highest counts are generally recorded during the non-breeding period through the austral summer, occasionally during the south migration, with typically lower maximum counts during the north migration and the lowest counts during the breeding period through the austral winter (**Figure 3.5**).

The high variability of the summer season counts within each year, evidenced by the relatively large standard deviations, indicates that many of the migratory shorebirds using roost sites at the Port are likely to also be using alternative roost sites outside the Port on a regular basis. The other important shorebird roost sites nearby include Lytton Claypan No. 1, Luggage Point and Manly Harbour.

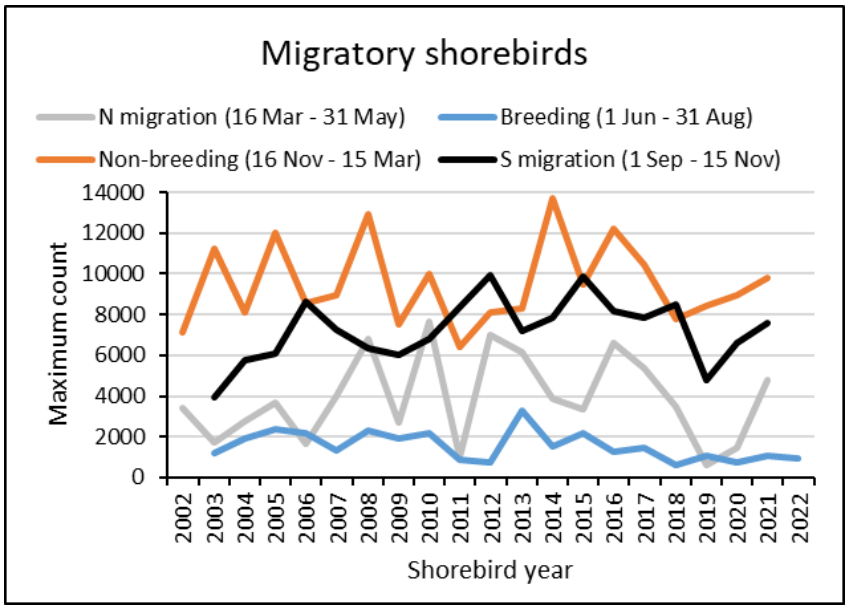

Figure 3.5. *Maximum counts during the south migration, non-breeding, north migration and breeding periods over the shorebird years 2002-2021.*

There has also been no significant trend in the average annual total resident shorebird count over the past 20 years 2002-2021 (Mann-Kendall trend test z = 1.40, P = 0.16; **Figure 3.6**). Thus, there is no evidence of a substantive change in overall shorebird numbers roosting at the Port over the 20-year period 2002-2021.

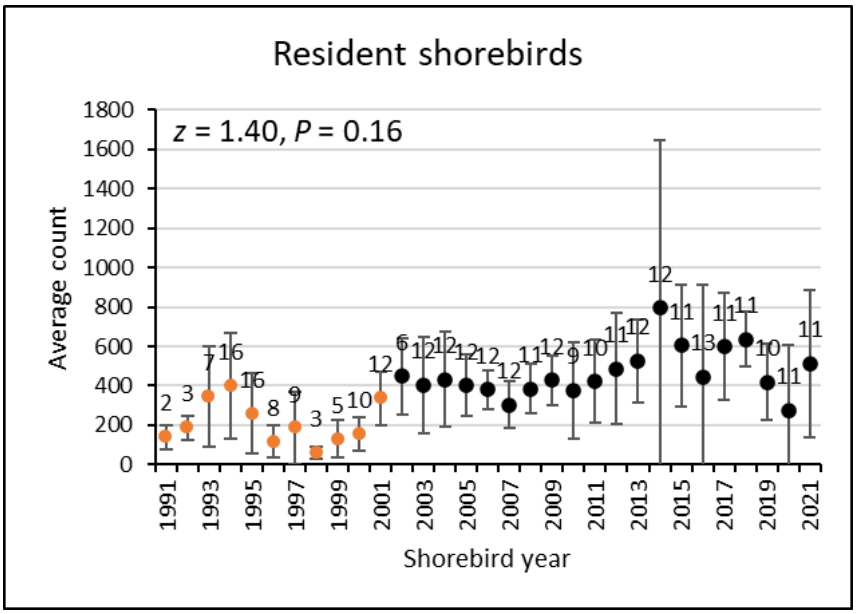

Figure 3.6. *Average total Port counts (±1 SD) for resident shorebirds (annual) over the shorebird years 1991-2001 (orange symbols) and 2002-2021 (black symbols). The total number of counts for each shorebird year are shown above the respective column.*

Among individual migratory shorebird species, there has been a significant decreasing trend in the average summer count for three species (Far Eastern Curlew, Grey Plover and Red-necked Stint) and a significant increasing trend for three species (Bar-tailed Godwit, Great Knot and Broad-billed Sandpiper) over the 20-year period 2002-2021 (**Figure 3.7**).

The declines in Far Eastern Curlew and Grey Plover appear to have been gradual, whereas the decline in Red-necked Stint has occurred since 2017; only Far Eastern Curlew is known to have experienced a significant population decline within Moreton Bay (Wilson *et al*. 2011). Despite Bar-tailed Godwit and Great Knot experiencing significant population declines within Moreton Bay over the period 1992 to 2008 (Wilson *et al*. 2011), the increase in Bar-tailed Godwit counts at the Port since 2002 appears to have been gradual whereas Great Knot counts increased after 2010 (**Figure 3.7**). A similar increase in Great Knot abundance after 2010 was observed at low tide foraging habitat adjacent to the Port (Lloyd *et al.* 2021). Broad-billed Sandpiper was infrequently recorded in low numbers prior to 2014, whereafter numbers have increased, particularly during the northward migration in March-April.

Although the counts prior to 2002 must be interpreted with caution given that they appear to have been less comprehensive than counts since the standardised survey approach was implemented from 2002, they do provide some interesting contrasts. Great Knot roosted at the Port in substantially larger numbers during the early 1990s than at any time since then, and while counts of Bar-tailed Godwit roosting at the Port have increased significantly over the period 2002-2021, they may have decreased over the period 1991-2001 (**Figure 3.7**). Grey-tailed Tattler and Ruddy Turnstone, which roost preferentially on the outer bund rock wall, appear to have increased in numbers at the Port only after the outer bund rock wall was constructed during 2004. Pacific Golden Plover, Red-necked Stint and Sharp-tailed Sandpiper also appear to have roosted in relatively low numbers at the Port prior to 2002.

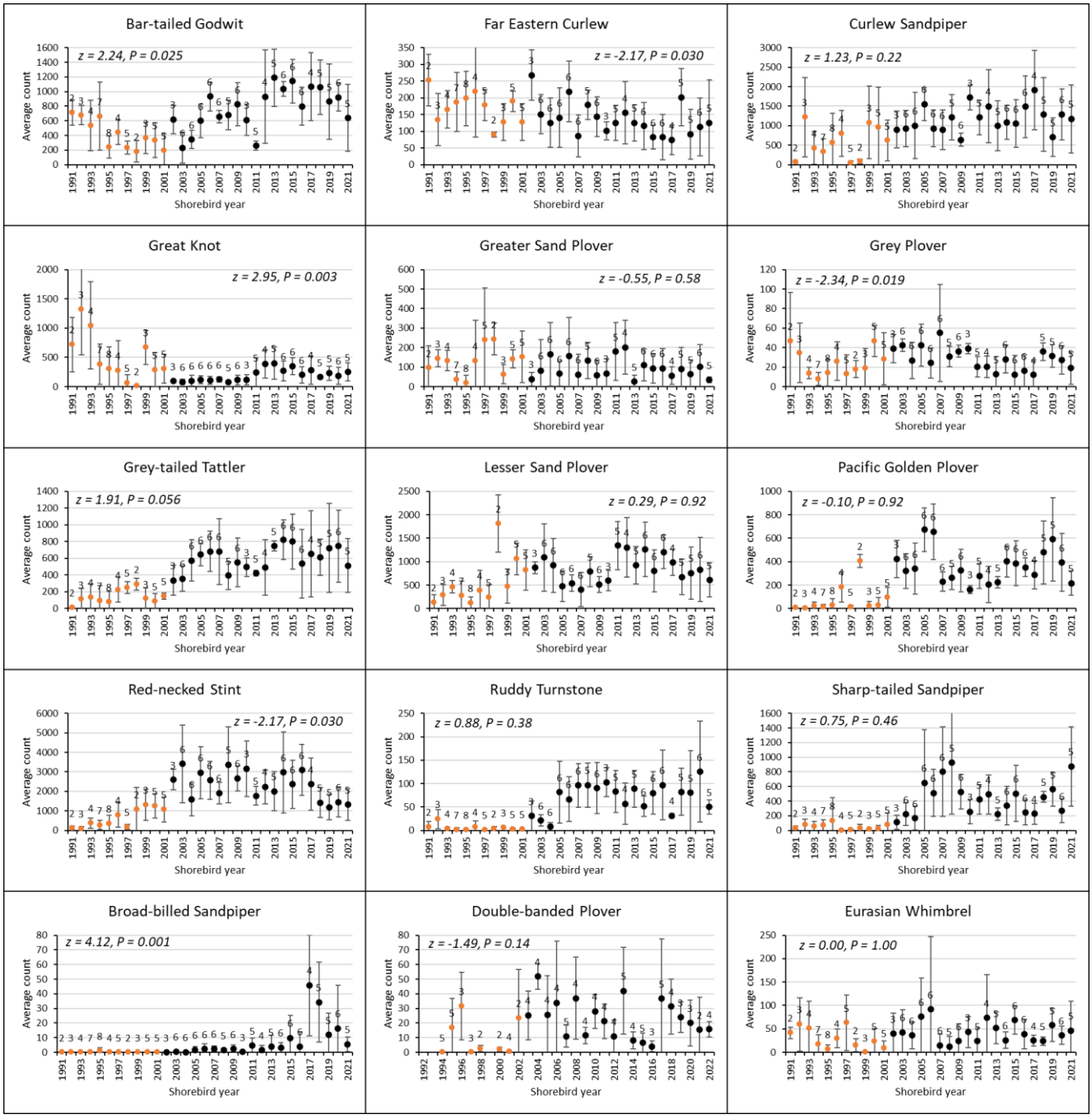

Figure 3.7. *Average total Port counts (±1 SD) for 15 migratory shorebird species during the summer period (1 October to 15 March: 14 species) or winter period (1 May to 31 August: Double-banded Plover) over the shorebird years 1991-2001 (orange symbols) and 2002-2022 (black symbols). The total number of counts for each shorebird year are shown above the respective column.*

Among individual resident shorebird species, there has been no significant trend in the average annual count for the four commonly occurring species over the 20-year period 2002-2021 (**Figure 3.6**).

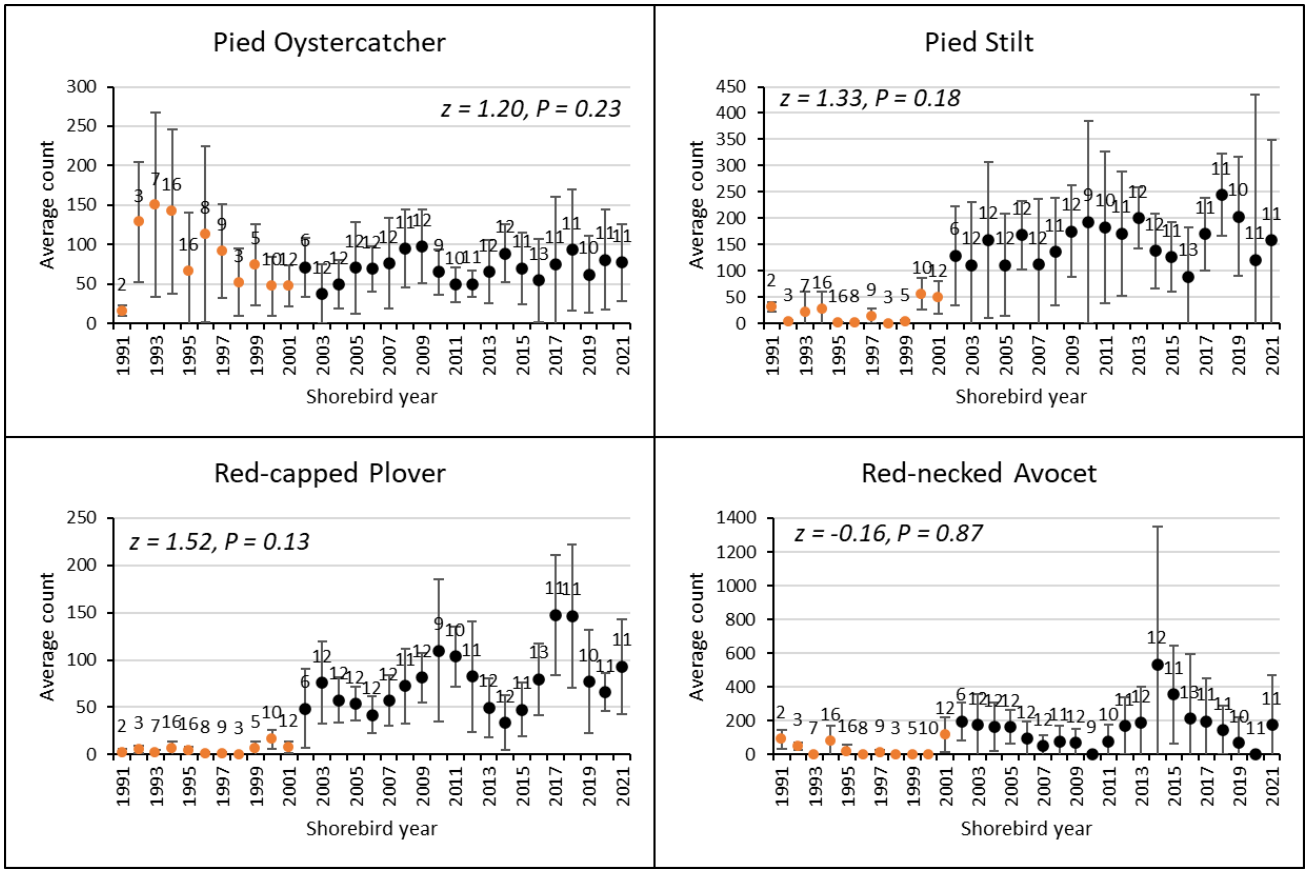

Figure 3.6. *Average annual total Port counts (±1 SD) for four resident shorebird species over the shorebird years 1991-2001 (orange symbols) and 2002-2021 (black symbols). The total number of counts for each shorebird year are shown above the respective column.*

Fourteen of 48 (29%) non-breeding period counts across the 12 important species in 2021 were below the critical threshold values for the respective species that might indicate a significant decrease in the number of birds using the Port. Most of the counts below the critical threshold were due to an overall low count on 6th February (**Table 3.4**), which may therefore represent an anomalous count. Three of the four Red-necked Stint counts were below the critical threshold, consistent with the trend analysis that found this species has declined significantly in recent years. Similarly, three of the four Red-necked Stint counts were below the critical threshold in 2019 (Driscoll 2021) and 2020 (Lloyd and Driscoll 2021). There is no published evidence that the population of Red-necked Stint using Moreton Bay has declined; while one study reported a significant decline in the population visiting Australia (Clemens *et al.* 2016), another found no significant decline (Studds *et al.* 2016), and a third found a significant increase in the population within Moreton Bay over the period 1996-2008 (Wilson *et al.* 2011). Red-necked Stint commonly uses high-tide roosting habitats as feeding areas at high tide; consequently, the decrease in numbers using the Port may reflect a reduction in the suitability of the reclamation area ponds for Red-necked Stint foraging in recent years, or their use of alternative nearby roost sites such as Luggage Point where they are also able to feed.

Table 3.4. *Comparison of summer counts for the 12 most important species with the lower 90% confidence limit threshold (in red; threshold values derived from either of two successive 8-year sampling blocks between 2003 and 2018; see **Appendix C**). The coloured cells indicate counts that fall below the threshold for that species.*

Species	Threshold	21-Nov-21	12-Dec-21	09-Jan-22	06-Feb-22	2021 mean
Bar-tailed Godwit	*469*	1060	385	1065	0	628
Curlew Sandpiper	*505*	1847	767	996	35	911
Far Eastern Curlew	*61*	92	0	68	133	73
Great Knot	*64*	236	407	312	0	239
Greater Sand Plover	*13*	30	41	53	16	35
Grey Plover	*15*	35	30	28	1	24
Grey-tailed Tattler	*291*	1013	532	263	193	500
Lesser Sand Plover	*673*	1032	626	801	63	631
Pacific Golden Plover	*202*	205	206	378	84	218
Red-necked Stint	*1373*	2513	1128	1301	204	1287
Ruddy Turnstone	*27*	36	60	60	32	47
Sharp-tailed Sandpiper	*137*	1678	714	622	255	817

3.4 ROOST SITE RANKINGS

The relative rankings of the eleven Port roost sites have varied over the past five years (**Table 3.5**), largely in response to the amounts of dredge spoil deposited in each pond each year and its effects on pond water levels and the areas of shallow water and surrounding damp substrates. In 2021, reclamation pond BS3 (PBS3), which has increased steadily in ranking since 2018 overtook pond C3 (PBC3) as the highest-ranked site supporting the most migratory shorebirds through the shorebird year. The artificial roost was the lowest ranked site in 2021, supporting the least migratory shorebirds. Reclamation pond C4 (PBC4) was created in March 2020 when it was excised from pond FPE (PFPE), whereas pond BS1 (PBS1) ceased to exist in 2021 after it became fully filled in with sand. Ponds BS3 and C3 were both split into two smaller cells in 2021.

Table 3.5. *Derived rank of relative importance of the 11 sites currently in use at the Port based on data from **Table 3.1** and **Appendix A**. The rankings are for each of the past five shorebird years. The data for earlier years can be found in previous reports. The site rankings within years are colour graduated from light green (high rank or low numeric value) to dark green (low rank or high numeric value). The last column indicates the extent of change in ranking between 2017 and 2021; a negative value indicates the ranking has improved*.

Site	Site code	Rank 2017	Rank 2018	Rank 2019	Rank 2020	Rank 2021	Change since 2017
Pond BS3	PBS3	6.20	7.70	6.70	2.80	2.43	-3.8
Pond R3	PBR3	1.70	1.40	1.80	2.67	3.47	1.8
Pond C3	PBC3	3.20	3.00	2.30	1.50	3.60	0.4
Claypan	FICP	3.30	6.10	4.00	4.70	5.53	2.2
Pond BS2	PBS2	6.80	6.60	4.90	8.40	5.53	-1.3
Pond BS4	PBS4	5.50	4.30	5.00	7.13	6.17	0.7
Pond C2	PBC2	8.60	9.40	9.70	7.50	6.47	-2.1
Pond C4	PBC4				9.67	6.83	-2.8
Pond FPE	PFPE	3.80	4.10	4.90	6.30	7.23	3.4
Artificial roost	PBAR	6.90	3.90	6.90	5.97	7.73	0.8
Pond BS1	PBS1	9.00	8.50	8.80	9.33		0.3

The reclamation area ponds have consistently supported 80-90% of the migratory shorebirds over the past 20 years, with the artificial roost, claypan, visitor centre and rail loop sites supporting substantially lower numbers (**Figure 3.7**). Averaged across all years, the reclamation area ponds have supported 88%, the claypan 8%, the artificial roost 4%, and the visitor centre and rail loop less than 1% of the migratory shorebirds.

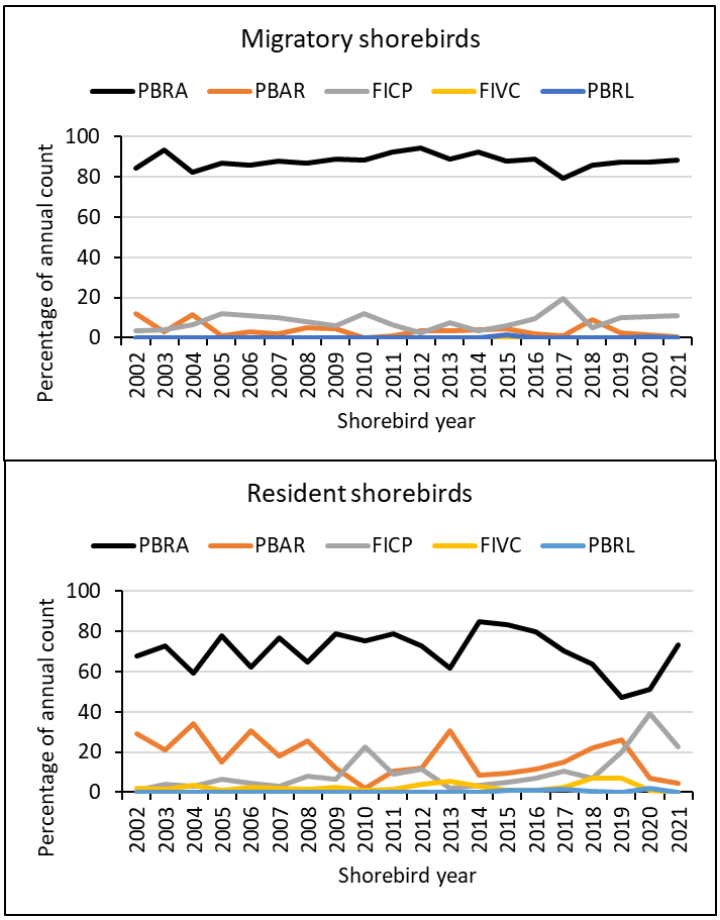

Figure 3.7. *Percentage of the total annual count of migratory and resident shorebirds supported by each of the reclamation area (PBRA), artificial roost (PBAR), claypan (FICP), visitor centre (FIVC) and rail loop (PBRL) sites over the shorebird years 2002-2021*.

Similarly, the reclamation area ponds have consistently supported most of the resident shorebirds over the past 20 years (**Figure 3.7**). Averaged across all years, the reclamation area ponds have supported 70%, the artificial roost 17%, the claypan 10%, the visitor centre 3% and rail loop less than 1% of the resident shorebirds.

3.5 COMPARISONS WITH MORETON BAY AS A WHOLE

During 2021/22, the Index of Relative Importance (IRI) for the Port was highest for Curlew Sandpiper, with an average of 73% of the Moreton Bay total numbers of this species using the Port, and lowest for Far Eastern Curlew, with an average of 5% of the Moreton Bay total using the Port (**Table 3.6**). Relative to 2020, the IRI increased for five species and decreased for seven species in 2021, with a slight decrease from 0.46 to 0.43 in the average across all 12 species. Relative to 2016, which had the highest overall IRI over the past five years, the IRI in 2021 increased for three species and decreased for the remaining nine species. The overall average IRI has remained relatively unchanged over the past four years 2017-2020, within the range 0.43 to 0.46. Continued use of this index of relative importance will help to monitor the changes in shorebird numbers at the Port compared to elsewhere throughout Moreton Bay.

Table 3.6. *Index of Relative Importance (IRI) for the Port, for each of the last five shorebird years for each of the 12 most important species at the Port of Brisbane. Colour coding between years, not between species: yellow (lowest) to green (highest).*

Species	2016	2017	2018	2019	2020	2021
Curlew Sandpiper	0.68	0.84	0.71	0.56	0.79	0.73
Greater Sand Plover	0.72	0.63	0.61	0.53	0.60	0.68
Lesser Sand Plover	0.71	0.76	0.67	0.67	0.53	0.65
Grey Plover	0.85	0.70	0.79	0.90	0.75	0.58
Red-necked Stint	0.51	0.51	0.40	0.37	0.47	0.54
Sharp-tailed Sandpiper	0.40	0.25	0.42	0.39	0.42	0.52
Grey-tailed Tattler	0.43	0.31	0.36	0.34	0.40	0.38
Ruddy Turnstone	0.66	0.36	0.54	0.37	0.50	0.33
Pacific Golden Plover	0.57	0.44	0.49	0.63	0.53	0.32
Great Knot	0.36	0.35	0.31	0.39	0.26	0.22
Bar-tailed Godwit	0.21	0.16	0.15	0.12	0.12	0.16
Far Eastern Curlew	0.16	0.07	0.12	0.07	0.13	0.05
Average across all 12 species	0.52	0.45	0.46	0.44	0.46	0.43

3.6 SHOREBIRD BANDING AND FLAG RESIGHTING

No catching and banding of shorebirds took place at the Port during the reporting period. There were 35 shorebird flag re-sightings on Fisherman Island during the 2021/22 reporting period, including:

- 33 green flags on birds banded in Moreton Bay;
- one orange flag on a Curlew Sandpiper banded in Victoria;
- one white over blue flag on a Lesser Sand Plover banded in Wang-Gong, Chang-Hua County, Taiwan.

Table 3.7 below summarises the species composition of the leg-flag re-sightings at the Port and the locations where the flagged birds have been observed since they were originally banded. Most flagged birds resighted at the Port have been observed feeding on tidal flats or roosting at other roost sites within 14 km along the mainland shoreline of Moreton Bay to the south of the Port, particularly the Manly Harbour roost site and tidal flats from Wynnum to Thorneside.

Table 3.7. *Species composition of the leg-flag re-sightings at the Port and the locations where the flagged birds have been observed since they were originally banded*.

Re-sighting location	Distance from Port (km)	Bar-tailed Godwit	Curlew Sandpiper	Great Knot	Grey Plover	Grey-tailed Tattler	Lesser Sand Plover	Pied Oystercatcher	Ruddy Turnstone	Total
Number resighted		8	2	4	1	11	6	1	2	35
St Helena Island	5							1		1
Lytton Claypan	6	3								3
Lytton Roost						3				3
Jackson Creek Point, Kedron	8				1					1
Wynnum Esplanade	10	6				9			1	16
George Clayton Park, Wynnum foreshore	10					2				2
Rose Bay, Manly	10	4		1						5
Manly Harbour	11	6	1	2		10		1	2	22
Lota Esplanade	12	6		1		5				12
Thorneside Esplanade	14	4		1						5
Geoff Skinner Wetlands	15	2								2
Nandeebie Park, Cleveland	21							1		1
Kakadu Beach, Bribie Island	34	1					1			2
Toorbul Wader Roost	35	1								1
Mathiesson Homestead, Great Sandy Strait				1						1
Bushland Beach, Townsville				1						1
Swan Bay, near Port Stephens, NSW								1		1
Victoria			1							1
Aphae Island, SOUTH KOREA		1								1
Songdo mudflat, Incheon, SOUTH KOREA		1								1
Wang-Gong, Chang-Hua County, TAIWAN							1			1
Nishizaki-town, Itoman-shi,Okinawa, JAPAN									1	1

4.0 RECOMMENDATIONS

Two major shorebird roost sites on the western shoreline of Moreton Bay are located relatively close to the Port of Brisbane roosts on Fisherman Island:

- Lytton Claypan No. 1, located 2 km south of FICP and 6 km south of the reclamation area; and
- Luggage Point Claypan, located 4 km south-west of the reclamation area on the northern side of the Brisbane River mouth.

These two roosts cover relatively large areas that support suitable roosting habitat for most of the migratory shorebird species that roost at the Port roost sites, and, for many individuals may be located closer to feeding habitat areas along the mainland shoreline to the north and south of the Port. However, since they are subject to natural tidal cycles, their suitability for roosting changes dynamically with tide height, whereas the suitability of the Port reclamation area roosts remains mostly independent of tidal cycles. The ongoing satellite tracking and flag resighting studies also

indicate that Bar-tailed Godwits that use Port roosting sites also regularly roost as far south as the Manly Harbour roost that is located 11 km south of the Port reclamation area.

The proximity of alternative roosts to the Port means that temporal variability and trends in the numbers of shorebirds roosting at the Port cannot be properly understood without considering the potential movement of shorebirds between the Port and these alternative roost sites. A better understanding of these linkages, and potential constraints to the movement of shorebirds between roosts, for example temporal variation in roost suitability due to tide cycles and disturbance will be important for predicting the impacts on shorebirds of the eventual loss of the Port reclamation area for roosting once the area becomes fully reclaimed. Satellite tracking has the potential to provide detailed information on the movements of birds between roost sites to better understand these local dynamics. Therefore, it is recommended that satellite tracking of birds using the Port be continued in tandem with the ongoing monthly count monitoring of the Port roost sites and the alternative roosts in the local region.

Port of Brisbane Pty Ltd is encouraged to continue to prioritise the management and monitoring of shorebirds at the Port. There is a need to continue to explore opportunities to provision habitat for shorebirds within or adjacent to Port lands to compensate for the expected future loss of roosting habitat in the reclamation area, particularly since the artificial roost, which was specially constructed to provide alternative roosting habitat close to the reclamation area, has only been used by relatively small numbers of migratory shorebirds. In this regard, Port of Brisbane Pty Ltd could advocate for such an outcome together with other interested and relevant stakeholders and regulators. Planning to provide adequate shorebird habitat in Moreton Bay into the future is required to manage the increasing pressures on shorebirds from the continued growth and development of Brisbane and the anticipated future loss of roosting habitat in the Port reclamation area (Fuller *et al.* 2021).

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APPENDIX A: Monthly count data for the 12 most important migratory shorebird species by site in 2021/22

Table A1. *Monthly counts of Grey-tailed Tattler by site in 2021/22. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022 Breeding	17 Jul 2022	14 Aug 2022	**Total**	% total
Pond FPE	PFPE	560	561	430	125	263	193	629	230	132				3123	75.9
Pond BS3	PBS3			583	406									989	24.0
Pond C4	PBC4				1									1	0.0
	Total	**560**	**561**	**1013**	**532**	**263**	**193**	**629**	**230**	**132**	**0**	**0**	**0**	**4113**	

Table A2. *Monthly counts of Red-necked Stint by site in 2021/22. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022 Breeding	17 Jul 2022	14 Aug 2022	**Total**	% total
Pond BS3	PBS3	10	385	1994	530	670	27	16		34	343	71	18	4098	38.2
Pond BS2	PBS2	24	349	155	25	356	123	1055	479	62	41	78		2747	25.6
Pond C3	PBC3	74	439	51	207	3	15	257		44	243	135	27	1495	13.9
Pond R3	PBR3	5	310	278	9	164	28	166	65	5		62	87	1179	11.0
Claypan	FICP				350	91	9	433	40					923	8.6
Pond BS4	PBS4		1	30	4	1			3		208			247	2.3
Pond C4	PBC4		1	5	2	11	1	2						22	0.2
Pond FPE	PFPE		7											7	0.1
Pond C2	PBC2					5								5	0.0
Artificial roost	PBAR				1		1							2	0.0
	Total	**113**	**1492**	**2513**	**1128**	**1301**	**204**	**1929**	**587**	**145**	**835**	**346**	**132**	**10725**	

Table A3. *Monthly counts of Curlew Sandpiper by site in 2021/22. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022 Breeding	17 Jul 2022	14 Aug 2022	**Total**	% total
Pond BS3	PBS3	24	2180	1665	361	414		21		4		116		4785	62.0
Pond R3	PBR3	429	36	171	72	205	20	134			17	16	1	1101	14.3
Claypan	FICP				274	289		509						1072	13.9
Pond BS2	PBS2		2			15	4	127	228	3		8		387	5.0
Pond C3	PBC3	5	8		53	2		188		2		1		259	3.4
Pond C4	PBC4			3	1	54	11	13						82	1.1
Pond BS4	PBS4		1	7	6	2					3			19	0.2
Pond C2	PBC2					13								13	0.2
Artificial roost	PBAR			1		2								3	0.0
	Total	**458**	**2227**	**1847**	**767**	**996**	**35**	**992**	**228**	**9**	**20**	**141**	**1**	**7721**	

Table A4. *Monthly counts of Sharp-tailed Sandpiper by site in 2021/22. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022 Breeding	17 Jul 2022	14 Aug 2022	**Total**	% total
Pond BS3	PBS3	48	75	1531	66	164	12	2		3				1901	42.0
Pond C3	PBC3		766	9	7	102	123					2		1009	22.3
Pond R3	PBR3	29	258	94	142	201	115	42	4				2	887	19.6
Claypan	FICP			3	452	114		2	5			1		577	12.8
Artificial roost	PBAR			35	39	33	3							110	2.4
Pond BS4	PBS4		5	3	7				1					16	0.4
Pond BS2	PBS2		1	3					5	1				10	0.2
Pond C4	PBC4				1	2		4						7	0.2
Pond C2	PBC2					6								6	0.1
Pond FPE	PFPE						2							2	0.0
	Total	**77**	**1105**	**1678**	**714**	**622**	**255**	**50**	**15**	**4**	**0**	**3**	**2**	**4525**	

Table A5. *Monthly counts of Bar-tailed Godwit by site in 2021/22. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022 Breeding	17 Jul 2022	14 Aug 2022	**Total**	% total
Pond BS3	PBS3		680	331	377	210								1598	47.1
Pond R3	PBR3		1	623		630		5						1259	37.1
Claypan	FICP					175		43	2		1	142		363	10.7
Artificial roost	PBAR	3		71										74	2.2
Pond BS4	PBS4		1	35	8	1						5		50	1.5
Pond C4	PBC4					49		1						50	1.5
	Total	**3**	**682**	**1060**	**385**	**1065**	**0**	**49**	**2**	**0**	**1**	**147**	**0**	**3394**	

Table A6. *Monthly counts of Great Knot by site in 2021/22. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022 Breeding	17 Jul 2022	14 Aug 2022	**Total**	% total
Pond BS3	PBS3		301	91	406	92								890	67.1
Pond R3	PBR3			142		146								288	21.7
Claypan	FICP					30		70						100	7.5
Pond C4	PBC4					44								44	3.3
Artificial roost	PBAR			3										3	0.2
Pond BS4	PBS4				1									1	0.1
	Total	**0**	**301**	**236**	**407**	**312**	**0**	**70**	**0**	**0**	**0**	**0**	**0**	**1326**	

Table A7. *Monthly counts of Far Eastern Curlew by site in 2021/22. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022 Breeding	17 Jul 2022	14 Aug 2022	**Total**	% total
Claypan	FICP		340			68	91						80	579	81.4
Pond BS3	PBS3			86			34							120	16.9
Artificial roost	PBAR	1		2			3						2	8	1.1
Pond R3	PBR3			2			2							4	0.6
	Total	**1**	**340**	**90**	**0**	**68**	**130**	**0**	**0**	**0**	**0**	**0**	**82**	**711**	

Table A8. *Monthly counts of Ruddy Turnstone by site in 2021/22. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022 Breeding	17 Jul 2022	14 Aug 2022	**Total**	% total
Pond R3	PBR3		11			5	2	54	67					139	32.3%
Pond BS3	PBS3		15	5	46	27								93	21.6%
Pond C3	PBC3		3	11	9	25	30	1						79	18.3%
Pond FPE	PFPE	1	31	14	2			3	11					62	14.4%
Pond BS2	PBS2							13	16					29	6.7%
Pond C4	PBC4			3	3	1		11	3					21	4.9%
Pond BS4	PBS4		2	3		1			1					7	1.6%
Pond C2	PBC2					1								1	0.2%
	Total	**1**	**62**	**36**	**60**	**60**	**32**	**82**	**98**	**0**	**0**	**0**	**0**	**431**	

Table A9. *Monthly counts of Lesser Sand Plover by site in 2021/22. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022 Breeding	17 Jul 2022	14 Aug 2022	**Total**	% total
Pond BS3	PBS3		253	1011	317	550	1							2132	50.7%
Pond C3	PBC3	92	186	19	305	244	62	390			1			1299	30.9%
Pond BS2	PBS2		3					201	460	1				665	15.8%
Pond BS4	PBS4		1	2	3	1								431	10.2%
Pond FPE	PFPE		80											431	10.2%
Pond R3	PBR3							1	3		13			17	0.4%
Pond C4	PBC4		2		1	4								7	0.2%
Pond C2	PBC2					2								2	0.0%
	Total	**92**	**525**	**1032**	**626**	**801**	**63**	**592**	**463**	**1**	**14**	**0**	**0**	**4209**	

Table A10. *Monthly counts of Greater Sand Plover by site in 2021/22. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022 Breeding	17 Jul 2022	14 Aug 2022	**Total**	% total
Pond C3	PBC3	22	26	4	40	2	15	44				1		154	62.1%
Pond BS3	PBS3			26		45								71	28.6%
Pond BS2	PBS2							7	1					8	3.2%
Pond R3	PBR3		3			2		1						6	2.4%
Pond C4	PBC4				1	2	1							4	1.6%
Pond FPE	PFPE		3											3	1.2%
Pond C2	PBC2					1								1	0.4%
Pond BS4	PBS4					1								1	0.4%
	Total	**22**	**32**	**30**	**41**	**53**	**16**	**52**	**1**	**0**	**0**	**1**	**0**	**248**	

Table A11. *Monthly counts of Pacific Golden Plover by site in 2021/22. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022	17 Jul 2022	14 Aug 2022	**Total**	% total
Pond BS3	PBS3		186	162	190	375	37		60					1010	74.9%
Pond BS2	PBS2		2			1		211	28					242	18.0%
Pond FPE	PFPE	3					46	1						50	3.7%
Pond C3	PBC3			12	9	1		7						29	2.2%
Artificial roost	PBAR		5		5				2					12	0.9%
Pond R3	PBR3						1	8						9	0.7%
Pond C4	PBC4			2		1		1						4	0.3%
Pond BS4	PBS4			4										4	0.3%
	Total	**3**	**188**	**180**	**199**	**378**	**84**	**228**	**88**	**0**	**0**	**0**	**0**	**1348**	

Table A12. *Monthly counts of Grey Plover by site in 2021/22. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	12-Sep-2021 S Migration	24-Oct-2021 S Migration	21-Nov-2021 Non-breeding	12-Dec-2021 Non-breeding	09-Jan-2022 Non-breeding	06-Feb-2022 Non-breeding	20 Mar 2022 Non-breeding	03 Apr 2022 N Migration	01 May 2022	12 Jun 2022 Breeding	17 Jul 2022	14 Aug 2022	**Total**	% total
Pond BS3	PBS3			35	30	27								92	96.8%
Pond R3	PBR3		1				1							2	2.1%
Pond C4	PBC4					1								1	1.1%
	Total		**1**	**35**	**30**	**28**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**95**	

APPENDIX B: Monthly Port of Brisbane total count data for all shorebird species in 2021/22

Date	12-Sep-21	24-Oct-21	21-Nov-21	12-Dec-21	09-Jan-22	06-Feb-22	20-Mar-22	03-Apr-22	01-May-22	12-Jun-22	17-Jul-22	14-Aug-22
Migratory species	12	16	16	16	18	13	13	11	6	7	8	5
Resident species	6	5	5	6	6	4	5	6	6	6	6	6
Total shorebirds	1858	8649	10030	5092	6439	1225	5101	2013	993	1567	1243	608
Migratory												
Bar-tailed Godwit	3	682	1060	385	1065	0	49	2	0	1	147	0
Broad-billed Sandpiper	0	1	10	6	11	0	1	0	0	0	0	0
Common Greenshank	0	1	1	2	1	0	0	0	0	1	1	0
Common Sandpiper	0	0	0	0	1	0	0	0	0	0	0	0
Curlew Sandpiper	458	2227	1847	767	996	35	992	228	9	20	141	1
Double-banded Plover	0	0	0	0	0	0	3	3	8	20	18	17
Eurasian Whimbrel	6	8	37	21	157	9	105	2	0	54	46	0
Far Eastern Curlew	2	340	92	0	68	133	0	0	0	0	0	84
Great Knot	0	301	236	407	312	0	70	0	0	0	0	0
Greater Sand Plover	22	32	30	41	53	16	52	1	0	0	1	0
Grey Plover	0	1	35	30	28	1	0	0	0	0	0	0
Grey-tailed Tattler	560	561	1013	532	263	193	629	230	132	0	0	0
Lesser Sand Plover	92	525	1032	626	801	63	592	463	1	14	0	0
Marsh Sandpiper	0	0	1	4	4	5	0	0	0	0	0	0
Pacific Golden Plover	3	206	205	206	378	84	234	96	0	0	0	0
Red Knot	0	46	0	1	3	0	0	0	0	0	0	0
Red-necked Stint	113	1492	2513	1128	1301	204	1929	587	145	835	346	132
Ruddy Turnstone	1	62	36	60	60	32	82	98	0	0	0	0
Sharp-tailed Sandpiper	77	1105	1678	714	622	255	50	15	4	0	3	2
Terek Sandpiper	0	0	0	0	0	6	0	0	0	0	0	0
Wandering Tattler	1	0	0	0	0	0	0	0	0	0	0	0
Resident												
Black-fronted Dotterel	4	0	0	2	6	0	0	6	9	3	3	2
Masked Lapwing	3	5	8	5	9	9	14	12	8	7	3	4
Pied Oystercatcher	32	77	40	54	184	127	93	95	87	21	30	29
Pied Stilt	82	29	24	14	8	25	105	136	379	376	251	109
Red-capped Plover	56	52	125	72	107	28	100	38	189	103	106	79
Red-necked Avocet	343	896	7	15	0	0	0	0	22	112	147	149
Sooty Oystercatcher	0	0	0	0	1	0	1	1	0	0	0	0

APPENDIX C: Non-breeding period (mid-November to mid-March) means and lower 90% confidence limits for the 12 most important migratory shorebird species at the Port

The results (derived from log transformed counts) are for successive 8-year sampling blocks since 2003. Colour coding indicates for each species the higher (green) and lower (yellow) means for the different time periods. Red font indicates the critical count that can serve as a trigger to suggest the relevant species may be exhibiting a real decline in numbers at the Port.

The table uses two periods of sampling, that is, 2010 and earlier, and after 2010. Both sets of data incorporate eight years of sampling. For some species the sample mean for the earlier sampling is higher and for some it is lower than for sampling after 2010. Colour coding is used to indicate whether the mean is higher (green) or lower (yellow) than the alternative mean for each species. Each mean has an associated threshold value that can serve as a trigger for response if any future count is lower than this figure. For each species there are two choices of threshold value, one for each of the sampling periods. A conservative approach would be to use the higher of these two values for each species. These are the choices of threshold values that have been highlighted in red lettering. Future counts of each species can be evaluated.

The 90% lower confidence limit represents a threshold value, below which only 1 in 10 sample means will occur. Hence a single count below this value is likely to be an indication of a real change in the population mean, that is, an actual change in the numbers of birds (refer to the 2019 report for details of derivation of this table).

Period	2003-2010		2011-2018	
Species	Mean	Threshold	Mean	Threshold
Bar-tailed Godwit	418	*114*	818	*469*
Curlew Sandpiper	954	*505*	911	*439*
Far Eastern Curlew	129	*61*	75	*27*
Great Knot	64	*18*	182	*64*
Greater Sand Plover	35	*4*	53	*13*
Grey Plover	33	*15*	10	*2*
Grey-tailed Tattler	507	*291*	558	*259*
Lesser Sand Plover	524	*163*	1033	*673*
Pacific Golden Plover	367	*202*	295	*164*
Red-necked Stint	2457	*1373*	1853	*936*
Ruddy Turnstone	44	*14*	61	*27*
Sharp-tailed Sandpiper	307	*100*	260	*137*

APPENDIX D: List of QWSG monthly roost monitoring sites in Moreton Bay used to calculate the Moreton Bay count

Table E1. *List of QWSG monthly roost monitoring sites in Moreton Bay used to calculate the Moreton Bay total count that is an input to calculating the Index of Relative Importance; the list does not include the Port of Brisbane roost sites that are also included in the Moreton Bay total count.*

Site code	Site name	Latitude	Longitude
ACAC	Acacia St Wellington Pt	-27.48	153.23
AMSB	Amity Point sandbank	-27.39	153.43
BECK	Bell's Creek Caloundra	-26.85	153.11
BHBI	Buckleys Hole sandbar Bribie Is	-27.10	153.16
BHMS	Bishop's Marsh	-27.04	153.06
BSVP	Base Street, Victoria Point	-27.59	153.31
CABO	Caboolture River mouth	-27.15	153.04
DAYS	Day's Gutter Moreton Island	-27.37	153.41
DBBA	Deception Bay claypan	-27.17	153.02
DBMN	Deception Bay south	-27.20	153.04
DOHL	Dohle's vic. Pine River nth side	-27.28	153.04
DTMI	Dead Tree Beach, Moreton Is	-27.34	153.43
DUNW	Dunwich Nth Straddie (One Mile)	-27.49	153.40
EAGS	East Geoff Skinner Reserve	-27.49	153.25
GOBC	Godwin Beach	-27.09	153.11
GOSE	Goat Is SE	-27.52	153.38
GRHI	Gregory Rd, Hays Inlet	-27.25	153.06
KBWL	Kedron Brook Wetlands	-27.36	153.08
KIAN	Kianawah Road Wetland	-27.45	153.14
KKBC	Kakadu Beach Bribie Is	-27.05	153.14
KSMF	King Street Mudflat - Thornlands	-27.56	153.28
LUPO	Luggage Point	-27.38	153.15
LYTT	Lytton	-27.42	153.16
MAHA	Manly Harbour	-27.46	153.19
MIPB	Mirapool beach, Moreton Is	-27.32	153.44
MIPO	Mirapool Moreton Island	-27.34	153.44
NAPK	Nandeebie Park Cleveland	-27.53	153.28
NARD	Nathan Rd Redcliffe	-27.21	153.07
OYPO	Oyster Point	-27.54	153.28
PEWA	Pelican Waters Lamerough Ck	-26.83	153.12
PRNS	Pine Rivers north	-27.29	153.03
PRWR	Pine Rivers Wetland Res	-27.29	153.04
PTHR	Pt Halloran reserve	-27.57	153.29
RANS	Redcliffe airport north side	-27.20	153.06
REPO	Reeders Point Moreton Is	-27.36	153.42
SBN1	Sandbank No 1 Caloundra	-26.81	153.13
SBN2	Sandbank No 2 Caloundra	-26.82	153.12
SBTH	Sandy Bank, Toondah Harbour	-27.53	153.31
SHIH	St Helena Is homestead	-27.39	153.23

Site code	Site name	Latitude	Longitude
SHIN	St Helena Is north	-27.38	153.23
SHIP	St Helena Is pier	-27.39	153.22
SHIS	St Helena Is south east	-27.40	153.24
TGBC	Toorbul George Bishop causeway claypan	-27.04	153.09
THLD	Thornlands Rd Thornlands	-27.56	153.28
THQE	Thorneside Queens Esp.	-27.48	153.21
TOOR	Toorbul	-27.05	153.11
TRNT	Toorbul north	-27.04	153.11
TRSF	Toorbul sandfly	-27.04	153.11
TRSS	Toorbul sandspit	-27.03	153.09
WEGS	West Geoff Skinner Reserve	-27.49	153.24

APPENDIX E: Summary of 2021/22 count data for Lytton Claypan No. 1.

Table F1. *Count results for each migratory and resident shorebird species at Lytton Claypan No. 1 (LYN1) roost site from September 2021 to August 2022.*

Common name	11/09/2021	12/09/2021	23/10/2021	24/10/2021	20/11/2021	21/11/2021	11/12/2021	12/12/2021	04/01/2022	08/01/2022	09/01/2022	05/02/2022	06/02/2022	05/03/2022	20/03/2022	02/04/2022	03/04/2022	30/04/2022	01/05/2022	28/05/2022	12/06/2022	16/07/2022	17/07/2022	13/08/2022	14/08/2022	16/08/2022	19/08/2022
Tide height (m)	2.17	2.15	2.27	2.24	2.38	2.37	2.15	2.05	2.74	2.27	2.1	2.38	2.2	2.39	2.39	2.3	2.19	2.16	2.08	2.01	1.62	1.9	1.9	1.97	2.01	2.02	1.94
Bar-tailed Godwit	373	474	1037	1242	464	1	872	1110	0	796	142	1056	953	662	943	180	231	172	168	187	198	87	84	262	194	338	427
Black-tailed Godwit	7	2	0	0	0	0	32	33	0	7	1	71	55	4	2	1	0	0	0	0	0	0	0	2	2	1	2
Common Greenshank	0	0	0	0	1	3	0	0	1	8	0	0	0	2	0	4	2	0	0	0	0	0	0	0	0	0	0
Curlew Sandpiper	0	30	0	0	44	54	507	615	0	157	2	986	1251	44	575	2010	1206	5	1	0	0	6	9	0	0	0	168
Eurasian Whimbrel	196	202	202	189	5	0	203	186	110	174	112	130	117	98	143	297	269	4	31	23	6	1	0	0	0	0	0
Far Eastern Curlew	306	316	176	23	17	179	293	366	0	152	234	157	169	56	61	43	43	98	156	143	78	48	63	184	198	193	410
Great Knot	41	38	0	4	11	1	11	4	0	0	2	121	92	108	2	0	0	0	0	0	0	28	53	46	84	52	79
Grey-tailed Tattler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	116	118	0	0	0	0
Marsh Sandpiper	0	2	0	0	22	14	15	18	0	14	0	0	0	6	0	0	3	0	0	0	0	0	0	0	0	0	0
Red Knot	0	0	11	22	0	0	0	0	0	0	0	9	2	0	0	0	0	0	0	0	0	1	1	16	19	12	17
Red-necked Stint	0	0	3	0	146	286	16	127	0	0	0	11	4	0	125	760	312	34	26	0	0	0	0	0	0	0	30
Ruff	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Sharp-tailed Sandpiper	0	16	0	6	505	474	174	150	0	58	31	17	4	7	1	15	11	0	0	0	0	0	0	0	0	0	0
Terek Sandpiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0
Unidentified small wader	0	300	0	0	0	0	0	200	0	0	0	0	0	140	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL migratory	**923**	**1380**	**1429**	**1486**	**1215**	**1012**	**2123**	**2809**	**111**	**1366**	**524**	**2558**	**2647**	**1127**	**1852**	**3310**	**2077**	**313**	**382**	**353**	**282**	**289**	**331**	**510**	**498**	**597**	**1134**
Black-fronted Dotterel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	8	7	2	2	0	2	2	7
Masked Lapwing	22	26	2	6	6	4	12	17	19	5	4	2	2	23	9	0	21	9	26	4	11	12	12	12	4	6	6
Pied Oystercatcher	25	29	6	6	6	14	36	34	0	34	35	54	189	12	3	1	2	0	0	0	0	0	0	3	2	6	1
Pied Stilt	43	39	0	1	44	12	56	49	17	14	19	2	12	127	1	235	163	264	329	314	359	271	273	159	148	152	82
Red-capped Plover	0	2	2	1	1	6	1	1	0	0	0	0	0	3	0	2	0	0	0	0	2	0	2	0	4	3	6
Red-necked Avocet	184	161	0	0	56	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL resident	**274**	**257**	**10**	**14**	**113**	**85**	**105**	**101**	**36**	**53**	**58**	**58**	**203**	**165**	**13**	**238**	**186**	**273**	**357**	**326**	**379**	**285**	**289**	**174**	**160**	**169**	**102**