2022/23

Port of Brisbane shorebird monitoring

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Queensland Wader Study Group

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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 eleventh 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 2022 to August 2023.

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 2022/23, presented as a table of raw numbers and associated graphs.
- 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

Thirteen counts were conducted over the period September 2022 to August 2023 (one per month except two in January) at twelve roost sites on Fisherman Island as well as the nearby Lytton Claypan No. 1 on the mainland. 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.

Temporal trends in the annual average austral summer count (over the period 1 October to 15 March inclusive, the period that migratory shorebird numbers on Fisherman Island were consistently high and most stable) of individual species or shorebird groupings over the 21-year period of shorebird years 2002 to 2022 were tested using a generalised linear model (GLM). To test whether the numbers of migratory shorebirds roosting on Fisherman Island are influenced by tide height, tide height was included as a covariate in the GLM. To assess the relative importance of the roosts on Fisherman Island to individual migratory shorebird species in Moreton Bay, an index of relative importance was calculated for each species as the ratio of the average annual maximum count on Fisherman Island over the period 2003 to 2023 to the maximum count for Moreton Bay since 2008 as reported in Fuller *et al*. (2021), expressed as a percentage. The significance of the roosts on Fisherman Island collectively and individually was also assessed on the basis of the percentage of the East Asian-Australasian Flyway (EAAF) population that the respective species counts represent, where counts representing greater than 1% of the EAAF population are internationally significant and counts representing greater than 0.1% of the EAAF population are nationally significant.

KEY RESULTS

Monthly shorebird counts

A total of 21 migratory shorebird species and seven resident shorebird species were recorded at the Port. The total migratory shorebird count (including Lytton Claypan No. 1) ranged between 2,191 and 5,510 birds during the south migration period (September to mid-November),

between 6,809 and 11,565 birds during the non-breeding period (mid-November to mid-March), between 957 and 2,938 during the north migration period (mid-March to May) and between 682 and 1,239 during the northern hemisphere breeding period (June to August). The total resident shorebird count ranged between 90 and 801 birds.

Three of the Port roost sites supported 76% of the total migratory shorebirds overall: reclamation area ponds R3 (34%) and C3 (21%) and Lytton Claypan No. 1 (21%). Similarly, three of the Port sites supported 66% of the total resident shorebirds overall: Lytton Claypan No. 1 (27%), Fisherman Island claypan (21%) and pond R3 (19%). The artificial roost supported 0.3% of migratory shorebirds and 5.9% of resident shorebirds overall.

Seasonal variation in shorebird counts

Total migratory shorebird numbers roosting on Fisherman Island 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 total migratory shorebird count on Fisherman Island over the past 21 years 2002-2022 during summer (1 October to 15 March) but there has been a significant decline in the total migratory shorebird count in winter (1 May to 31 August) controlling for a significant positive relationship between the total winter count and tide height. The average summer count has ranged between 5,436 and 8,607 whereas the average winter count has ranged between 528 and 2,820 birds over the past 21 years. The maximum count of total migratory shorebirds roosting on Fisherman Island each year has ranged between 7,159 and 13,703, with no evidence of a trend in the maximum count during the non-breeding period over the past 21 years. Similarly, there has also been no significant trend in the average annual total resident shorebird count over the past 21 years. 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 four species (Bar-tailed Godwit, Great Knot, Curlew Sandpiper and Broad-billed Sandpiper) over the 21-year period 2002-2022.

Site importance

The index of relative importance of the roosts on Fisherman Island to different migratory shorebird species ranged between 87% for Curlew Sandpiper and <1% for Black-tailed Godwit and Sanderling. Thus, the average annual maximum count of Curlew Sandpiper on Fisherman Island was 87% of the all-time maximum count of Curlew Sandpiper reported by Fuller *et al*. (2021) for the whole of Moreton Bay since 2008. The index of relative importance of Fisherman Island was greater than 50% for seven species and greater than 20% for 12 species. The roosts on Fisherman Island have together supported nationally significant numbers (greater than 0.1% of the EAAF population) of 16 migratory shorebird species and internationally significant numbers (greater than 1% of the EAAF population) of six of these since 2002.

The reclamation area ponds have consistently supported 80-90% of the migratory shorebirds over the past 21 years, with the artificial roost, Fisherman Island claypan, visitor centre and rail loop sites supporting substantially lower numbers. Averaged across all years, the reclamation

area ponds have supported 88%, the Fisherman Island claypan 8%, the artificial roost 4%, and the visitor centre and rail loop less than 1% of the migratory shorebirds.

All four main roost sites at the Port, three on Fisherman Island together with the Lytton Claypan No. 1 on the mainland, have supported nationally significant (greater than 0.1% of the EAAF population) and two, the reclamation area and Lytton Claypan No. 1 have supported internationally significant numbers (greater than 1% of the EAAF population) of migratory shorebird species within the most recent five years. The reclamation area was nationally significant for 13 species and internationally significant for five species, Lytton Claypan No. 1 was nationally significant for six species and internationally significant for two species, the Fisherman Island claypan was nationally significant for six species and the artificial roost was nationally significant for three species.

Shorebird banding

No catching and banding of shorebirds took place at the Port during the reporting period. There were 16 shorebird flag re-sightings at the Port during the 2022/23 reporting period, including 12 green flags on birds banded in Moreton Bay; one yellow flag on a Pied Oystercatcher banded in northern NSW; one orange flag on a Curlew Sandpiper banded in Victoria; and one yellow over blue flag and one white over blue flag on two Curlew Sandpipers banded in the Northern Territory and Taiwan respectively. 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 north and south of the Port, particularly the Manly Harbour roost site and tidal flats from Sandgate in the north to Manly in the south.

RECOMMENDATIONS

Port of Brisbane Pty Ltd is encouraged to continue to prioritise the management and monitoring of shorebirds at the Port. The monitoring reported here identifies the Fisherman Island claypan and Lytton Claypan No. 1 roost sites as very significant, naturally occurring shorebird roost sites that are important to the network of roost sites in central Moreton Bay. Portions of these roost sites also provide foraging resources for migratory shorebirds when inundated. These two roost sites, together with the artificial roost, are likely to become increasingly relied upon by migratory shorebirds as the availability of roosting habitat in the current Future Port Expansion (FPE) reclamation area diminishes as it approaches the point when it is all expected to be resumed for port infrastructure. Consequently, retaining the Fisherman Island claypan, Lytton Claypan No. 1 and artificial roost sites as part of the conservation buffer land use under the Brisbane Port Land Use Plan 2020 (LUP) can make an important contribution to the sympathetic management of migratory and other shorebirds in Moreton Bay.

There is also a need to continue to explore opportunities to provision or improve roosting habitat for shorebirds within or adjacent to Port lands to compensate for the expected future loss of roosting habitat in the reclamation area. 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. Although the artificial roost has supported only 4% of the migratory shorebirds using Fisherman Island since 2002, it is occasionally used by large numbers of birds, indicating it has potential to support larger numbers of birds once currently preferred alternatives in the reclamation area are lost. There are also opportunities to improve vegetation management at the artificial roost to create a more extensive open area of sparsely vegetated substrate to accommodate larger numbers of migratory shorebirds.

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Glossary of Terms and Acronyms

EAAF	East Asian Australasian Flyway
FPE	Future Port Expansion
IRI	Index of relative importance
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 (McLeod 1974) 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. Includes material © State of Queensland 2023 and © 2023 Google*.

Figure 1.2. *Composite illustration of the development of the reclamation area at the Port of Brisbane site between 2003 and 2023. Includes material © 2023 Google, © 2023 Airbus.*

The reclamation area was expanded considerably during 2004 with the construction of the outer bund rock wall. Between 2004 and 2023, 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: (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.* 2006, 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 northern Asia, 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 on Fisherman Island (**Figure 1.3**): within the reclamation area; a purpose-built shorebird roost site (PBAR); a nearby claypan (FICP); a freshwater lake adjacent to the old visitor centre (FIVC); and an ephemeral freshwater pondage area within a rail loop (PBRL). More recently a claypan roost site on Port lands on the mainland, Lytton Claypan No. 1 (LYN1) has been included in the monthly Port count to survey this site at the same time as the sites on Fisherman Island. 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 2022/23, including seven 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). Also showing the Lytton Claypan No. 1 (LYN1) and Luggage Point (LUPO) roost sites. Includes material © 2023 Google, © 2023 Airbus.*

This is the eleventh 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 2022 to August 2023.

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 2022/23, 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

Thirteen counts were conducted within the reporting period, one per month except for two in January (**Table 2.1**). 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.

During 2022/23, Lytton Claypan No. 1 (LYN1), a roost site on land managed by Port of Brisbane Pty Ltd on the mainland south of Fisherman Island was included in the monthly count schedule. The results for this site are included in the 2022/23 comparisons between roost sites at the Port. However, counts for Lytton Claypan No. 1 are not included in the analyses of seasonal variation and long-term trends since this site has only recently been included in the monthly Port count schedule i.e. counted at the same time as the other Port sites. Lytton Claypan No. 1 is also counted outside of the Port count schedule since it is accessible to the public.

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 2022 to August 2023 reporting period.*

Shorebird activity period	Date	HT height (m)	HT time
South migration	11/09/2022	2.11	10:06
South migration	9/10/2022	2.18	09:03
South migration	6/11/2022	2.20	08:00
Non-breeding	11/12/2022	2.36	11:21
Non-breeding	15/01/2023	1.98	14:54
Non-breeding	22/01/2023	2.77	10:03
Non-breeding	12/02/2023	2.03	13:20
Non-breeding	12/03/2023	2.04	12:14
North migration	2/04/2023	2.20	07:15
North migration	7/05/2023	1.98	10:18
Breeding	4/06/2023	1.92	09:15
Breeding	9/07/2023	1.94	14:33
Breeding	6/08/2023	2.06	13:08

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, one visit was 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 (i.e. excluding Lytton Claypan No. 1) in numbers exceeding 0.2 % of the total Flyway population size, and often in numbers exceeding 1% of the Flyway population (**Table 2.2**). 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 counts of 12 important species on Fisherman Island at the Port of Brisbane also expressed as the percentage of the total population size in the EAAF (Hansen et al. 2016) and year of maximum count between September 2003 and August 2023.*

Species	Maximum count since 2003 (% flyway population)	Year of maximum
Grey-tailed Tattler	1,434 (2.0)	2019
Red-necked Stint	6,803 (1.4)	2003
Lesser Sand Plover	2,433 (1.4)	2003
Curlew Sandpiper	2,607 (2.9)	2017
Sharp-tailed Sandpiper	2,078 (2.4)	2005
Far Eastern Curlew	670 (1.2)	2006
Pacific Golden Plover	1,219 (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	1,572 (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 21-year period of shorebird years 2002 to 2022 were tested using a generalised linear model (GLM). A Quasi-Poisson model was used for each GLM since the count data were over-dispersed i.e. the variance was greater than the mean. Most of the roost sites at the Port are not influenced by the tide; consequently, the Port is thought to be a particularly important roost site for shorebirds in Moreton Bay on king spring tides when many alternative roost sites become unsuitable for roosting due to tidal inundation. To test whether the numbers of migratory shorebirds roosting at the Port are influenced by tide height, tide height was included as a covariate in the GLM. The GLM for resident shorebirds tested for a linear temporal trend in counts, with counts as the dependent variable and year as the independent variable, using all counts and each year defined as the period 1 July-30 June; tide height was not included as a covariate due to the reduction in overall tide heights in winter compared to in summer.

Models were fitted in R (R Core Team 2023) following the methods of Crawley (2002). Model simplification using backward-elimination of non-significant explanatory variables was adopted. Model terms were systematically removed from the model and only put back in if their removal resulted in a significant loss of model explanatory power. The latter was determined by comparing the log-likelihood of the full model to the log-likelihood of the reduced model using the G^2 test, whose sampling distribution approximates a chi-square distribution with one degree of freedom (Quinn and Keough 2002). The significance of each explanatory variable was similarly determined by comparing the log-likelihood of the full minimal model including the variable of interest to the log-likelihood of the reduced model excluding it.

To assess the relative importance of the roosts on Fisherman Island to individual migratory shorebird species in Moreton Bay, an index of relative importance (IRI) was calculated for each species as the ratio of the average annual maximum count at the Port over the period 2003 to

2023 to the maximum count for Moreton Bay since 2008 as reported in Fuller *et al*. (2021), expressed as a percentage:

$$IRI = \frac{Average\ annual\ maximum\ count}{Maximum\ count\ for\ Moreton\ Bay\ since\ 2008} \times 100$$

The significance of the roosts on Fisherman Island collectively and individually was also assessed on the basis of the percentage of the East Asian-Australasian Flyway (EAAF) population that the respective species counts represent, where counts representing greater than 1% of the EAAF population are internationally significant (Ramsar 1971, Clemens *et al*. 2010) and counts representing greater than 0.1% of the EAAF population are nationally significant (Clemens *et al.* 2010).

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 2022/23

A total of 21 migratory shorebird species and seven resident shorebird species were recorded at the Port (**Appendix B**). The total counts of both migratory and resident (non-migratory) shorebirds at each site each month between September 2022 and August 2023 are summarised in **Table 3.1**.

Table 3.1. *Total counts of both migratory and resident shorebirds at each site each month between September 2022 and August 2023. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% of total
	Total migratory shorebirds															
Pond R3	PBR3	407	2053	973	493	4378	4792	4308	2984	330	266	521	390	655	22550	33.7
Pond C3	PBC3	293	784	916	6201	1505	2081	299	845	959	106	137	33	0	14159	21.1
Lytton Claypan No.1	LYN1	1094	1544	1463	1165	2294	2646	1268	1028	579	365	318	58	222	14044	21.0
Pond BS3	PBS3	10	3145	1115	404	2	283	603	409	45	8	3	0	0	6027	9.0
Pond BS4	PBS4	0	25	4	11	784	1,187	857	606	548	0	0	0	0	4022	6.0
FI Claypan	FICP	325	185	940	199	140	22	0	445	309	144	46	191	168	3114	4.6
Pond BS2	PBS2	61	369	0	120	175	523	77	405	148	0	6	0	168	2052	3.1
Pond FPE	PFPE	0	0	93	239	1	21	85	6	4	68	5	10	18	550	0.8
Pond C4	PBC4	0	8	0	89	8	8	77	22	15	0	0	0	7	234	0.3
Artificial roost	PBAR	1	20	6	32	63	2	49	17	0	0	0	0	1	191	0.3
Rail Loop	PBRL	0	0	0	0	0	0	0	42	0	0	0	0	0	42	0.1
Lucinda Dr	PLDE	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0.0
Visitor Centre	FIVC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
	Total	2191	8133	5510	8953	9350	11565	7623	6809	2938	957	1036	682	1239	66986	100.0

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% of total
	Total resident shorebirds															
Lytton Claypan No.1	LYN1	57	10	11	9	20	6	11	20	118	227	253	392	315	1449	26.6
FI Claypan	FICP	53	19	16	7	9	1	2	5	174	260	207	114	249	1116	20.5
Pond R3	PBR3	108	8	10	14	0	18	247	216	59	74	143	42	76	1015	18.6
Pond C4	PBC4	4	7	0	33	142	184	4	3	6	1	0	5	8	397	7.3
Pond FPE	PFPE	15	27	30	42	7	43	7	4	34	59	27	34	23	352	6.5
Artificial roost	PBAR	6	5	8	2	5	0	9	98	23	18	60	27	60	321	5.9
Pond BS2	PBS2	13	14	2	6	27	32	12	38	22	29	59	36	3	293	5.4
Pond BS3	PBS3	11	0	1	15	3	20	44	52	41	16	0	0	0	203	3.7
Pond C3	PBC3	23	8	8	14	0	1	0	0	3	3	22	76	8	166	3.0
Pond BS4	PBS4	1	4	4	1	1	21	6	2	0	0	8	0	7	55	1.0
Rail Loop	PBRL	0	0	0	5	0	3	1	5	9	1	15	0	0	39	0.7
Visitor Centre	FIVC	0	0	0	0	0	0	0	0	5	1	2	1	15	24	0.4
Lucinda Dr	PLDE	1	0	0	0	0	0	0	4	2	2	5	2	1	17	0.3
	Total	292	102	90	148	214	329	343	447	496	691	801	729	765	5447	100.0

The total migratory shorebird count (including LYN1) ranged between 2,191 and 5,510 birds during the south migration period (September to mid-November), between 6,809 and 11,565 birds during the non-breeding period (mid-November to mid-March), between 957 and 2,938 during the north migration period (mid-March to May) and between 682 and 1,239 during the northern hemisphere breeding period (June to August). The total resident shorebird count ranged between 90 and 801 birds (**Table 3.1**).

Three of the Port roost sites supported 76% of the total migratory shorebirds overall (**Table 3.1**): reclamation area ponds R3 (34%) and C3 (21%) and Lytton Claypan No. 1 (21%). Similarly, three of the Port sites supported 66% of the total resident shorebirds overall: Lytton Claypan No. 1 (27%), Fisherman Island claypan (21%) and pond R3 (19%). The artificial roost supported 0.3% of migratory shorebirds and 5.9% of resident shorebirds overall.

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. **Appendix C** summarises the results of all counts at Lytton Claypan No. 1, including counts on dates outside the Port count schedule.

The maximum summer counts recorded on Fisherman Island (i.e. excluding Lytton Claypan No. 1) during the 2022 shorebird year exceeded the overall maximum count since 2003 for one of the 12 important species, namely Curlew Sandpiper, whose maximum counts of between 2,691 and 3,408 on three consecutive surveys in January and February 2023 exceeded the previous maximum count of 2,607 recorded in 2017 (**Table 3.2**). The count of 3,408 Curlew Sandpiper on a king spring tide in January 2023 exceeded the previously recorded maximum count for the whole of Moreton Bay since 2008 of 2,443 (Fuller *et al*. 2021).

Table 3.2. *Maximum summer counts of 12 important species on Fisherman Island at the Port of Brisbane also expressed as the percentage of the total population size in the EAAF (Hansen et al. 2016), year of maximum count, and their frequency of occurrence in all counts between September 2003 and August 2023, including all seasons not just summer.*

Species	Maximum count for 2022	Maximum count since 2003 (% flyway population)	Year of maximum	Frequency (% of all surveys)
Grey-tailed Tattler	1,116	1,434 (2.0)	2019	87
Red-necked Stint	2,750	6,803 (1.4)	2003	100
Lesser Sand Plover	1,845	2,433 (1.4)	2003	92
Curlew Sandpiper	3,408	3,408 (3.8)	2023	100
Sharp-tailed Sandpiper	818	2,078 (2.4)	2005	86
Far Eastern Curlew	335	670 (1.2)	2006	89
Pacific Golden Plover	524	1,219 (1.0)	2019	88
Great Knot	482	708 (0.2)	2013	72
Greater Sand Plover	250	441 (0.2)	2006	74
Ruddy Turnstone	96	248 (0.8)	2020	86
Bar-tailed Godwit	306	1,572 (0.5)	2019	95
Grey Plover	21	145 (0.2)	2007	66

3.2 SEASONAL VARIATION IN SHOREBIRD COUNTS ON FISHERMAN ISLAND

Total migratory shorebird numbers roosting on Fisherman Island have shown the expected cyclical pattern of increasing during the south migration period that extends from September to mid-November, generally reaching peak numbers through the non-breeding period that extends from mid-November to mid-March, before decreasing again during the north migration period that extends from mid-March to May to relatively low numbers during the northern hemisphere breeding period that extends from June to August (**Figure 3.1a**).

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 (**Figure 3.1b**), 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.

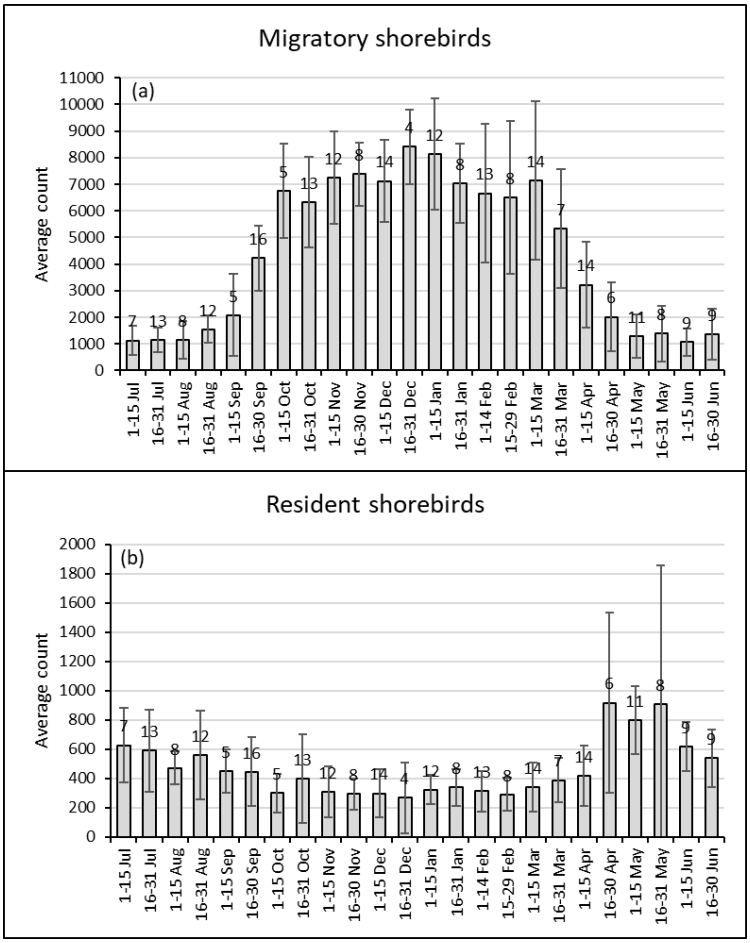

Figure 3.1. *Average (±1 SD) total migratory (a) and resident (b) shorebird counts on Fisherman Island each fortnight through the year over the shorebird years 2002-2022. The total number of counts for each fortnight are shown above the respective column*.

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. Double-banded Plover, which breeds in New Zealand during the austral summer with a portion of the population migrating to Australia for the non-breeding period through the austral winter (Pierce 1999), was generally present from the first half of April through to late August (**Figure 3.2**). Red Knot were 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. A similar pattern of movement of Red Knot has been recorded at the Hunter Estuary in NSW, where Red Knot move through in waves in late September to early October, with most birds staying for less than a week before continuing to New Zealand, and no birds recorded during the return migration (Crawford and Herbert 2017).

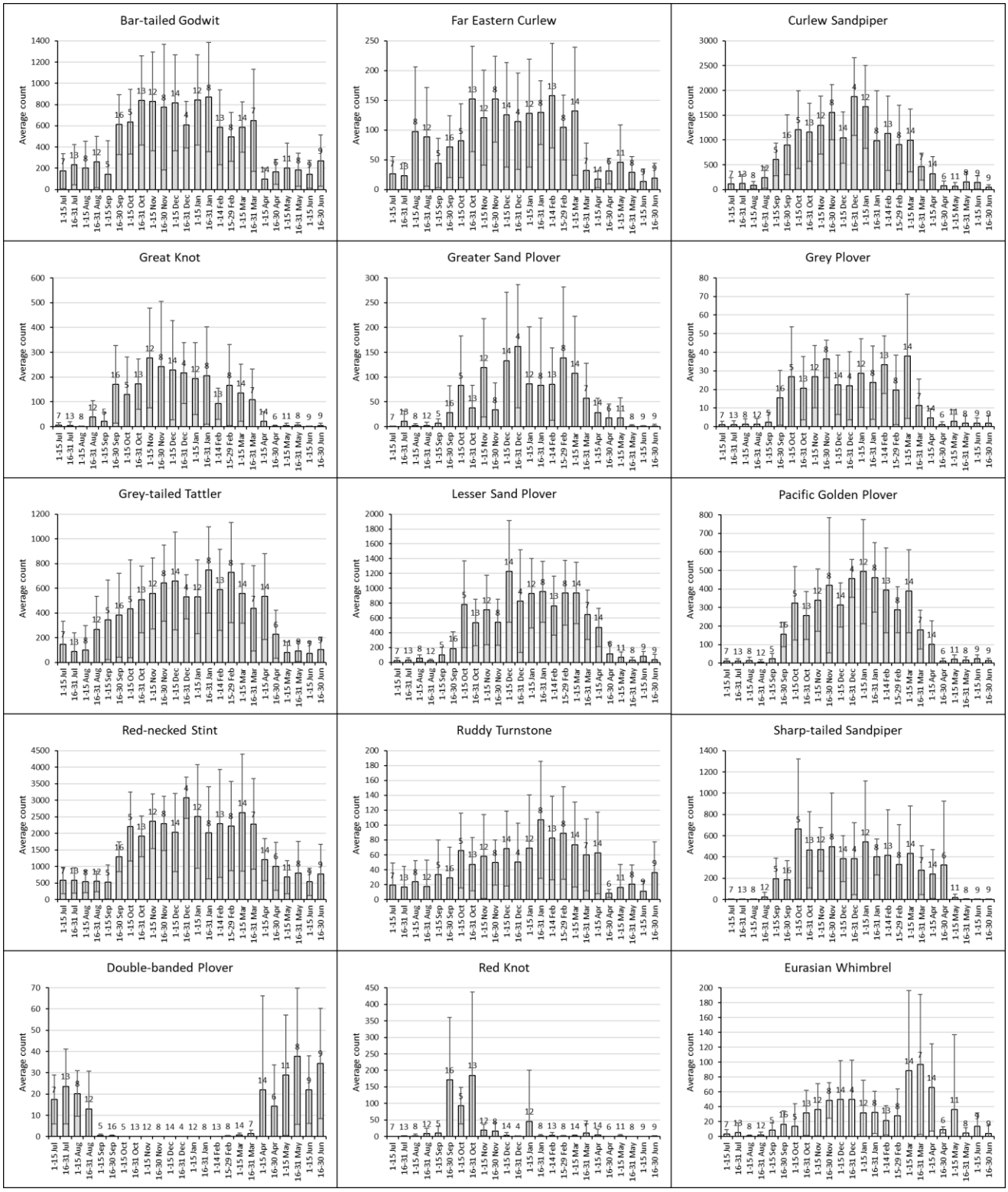

Figure 3.2. *Average (±1 SD) counts for individual migratory shorebird species each fortnight through the year over the shorebird years 2002-2022. The total number of counts for each fortnight are shown above the respective column*.

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**).

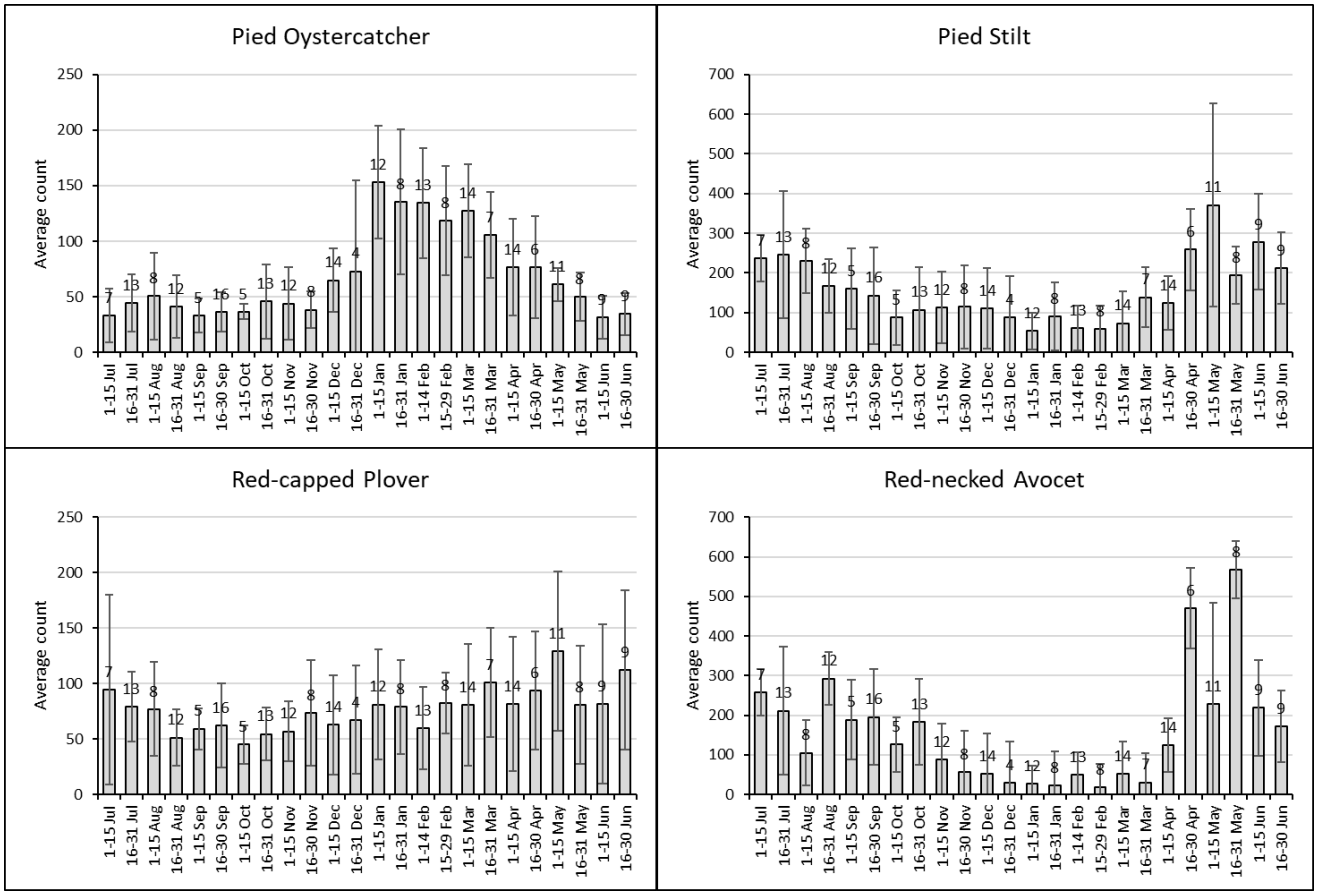

Figure 3.3. *Average (±1 SD) counts for individual resident shorebird species each fortnight through the year over the shorebird years 2002-2022. The total number of counts for each fortnight are shown above the respective column.*

There is seasonal movement of Pied Oystercatchers from summer breeding areas on exposed ocean beaches into sheltered estuaries and bays during the non-breeding winter period in Tasmania and some parts of Victoria (Weston and 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 (Alcorn 1990, Close and McCrie 1986, Stuart 2017, Breed *et al*. 2023).

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 Fisherman Island Claypan (FICP) and reclamation area were surveyed at the same time) and over the shorebird years 2002-2022 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 from 2002 to the present.

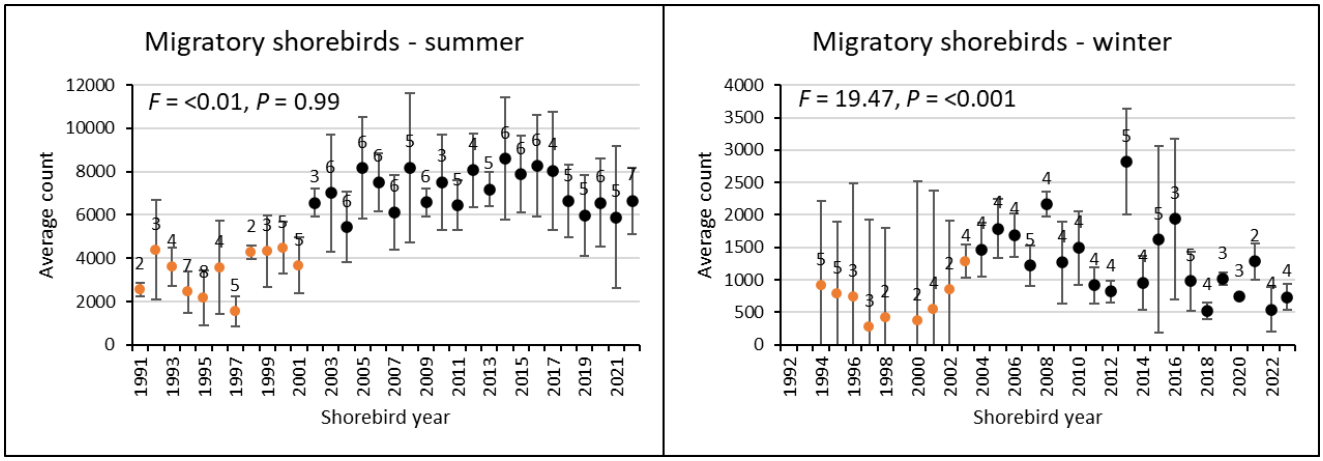

Figure 3.4. *Average total counts (±1 SD) for migratory shorebirds on Fisherman Island during the summer (1 October to 15 March) and winter (1 May to 31 August) periods over the shorebird years 1991-2001 (orange symbols) and 2002-2022 (black symbols). The total number of counts for each shorebird year are shown above the respective average.*

There has been no significant trend in the total migratory shorebird count on Fisherman Island over the past 21 years 2002-2022 during summer (1 October to 15 March: F = <0.01, P = 0.99) but there has been a significant decline in the total migratory shorebird count in winter (1 May to 31 August: F = 19.47, P = <0.001; **Figure 3.4**) controlling for a significant positive relationship between the total winter count and tide height (**Table 3.3**). The average summer count has ranged between 5,436 and 8,607 whereas the average winter count has ranged between 528 and 2,820 birds over the past 21 years.

Table 3.3. Summary of generalised linear models (GLMs) run separately for each species and shorebird grouping to examine temporal trends in shorebird abundance on Fisherman Island, controlling for the potential influence of tide height (migratory shorebirds only); significant relationships in bold text are indicated as either positive (+) or negative (-).

	Year			Tide height		
Species/group	*F*	*P*	Trend	*F*	*P*	Trend
Migratory shorebirds (summer)	<0.01	0.99		2.41	0.12	
Migratory shorebirds (winter)	**19.47**	**<0.001**	**-**	**12.19**	**<0.001**	**+**
Resident shorebirds	1.38	0.24				
Broad-billed Sandpiper	**20.98**	**<0.001**	**+**	1.17	0.28	
Bar-tailed Godwit	**3.92**	**0.05**	**+**	0.02	0.90	
Curlew Sandpiper	**7.00**	**0.009**	**+**	0.46	0.50	
Double-banded Plover	2.19	0.14		2.94	0.09	
Eurasian Whimbrel	0.68	0.41		0.02	0.89	
Far Eastern Curlew	**6.45**	**0.013**	**-**	0.04	0.84	
Great Knot	**7.73**	**0.006**	**+**	0.08	0.78	
Greater Sand Plover	0.90	0.35		0.52	0.47	
Grey Plover	**14.69**	**<0.001**	**-**	0.74	0.39	
Grey-tailed Tattler	1.46	0.23		0.21	0.65	
Lesser Sand Plover	0.75	0.39		0.01	0.91	
Pacific Golden Plover	0.33	0.57		0.28	0.60	
Red-necked Stint	**8.52**	**0.004**	**-**	**4.68**	**0.033**	**+**
Ruddy Turnstone	1.43	0.23		0.07	0.80	
Sharp-tailed Sandpiper	0.09	0.76		0.85	0.36	
Pied Oystercatcher	2.62	0.11				
Pied Stilt	0.57	0.45				
Red-capped Plover	**12.80**	**<0.001**	**+**			
Red-necked Avocet	0.01	0.96				

The high variability of the summer season counts within each year, evidenced by the large standard deviations, indicates that many of the migratory shorebirds using roost sites on Fisherman Island 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, Manly Harbour and Geoff Skinner Reserve. Satellite tracking and leg flag resighting has confirmed substantial movement of birds between the roosts on Fisherman Island and other roost sites (Coleman and Milton 2012, Coleman and Bush 2020, Lilleyman *et al*. 2020). Unlike roost sites elsewhere in Moreton Bay, most of the roost sites on Fisherman Island are not affected by the relative height of high tides. Contrary to initial expectations, there was limited evidence that the abundance of migratory shorebirds using Fisherman Island for roosting increased with increasing high tide levels; a significant positive relationship between abundance and tide height was detected for only the total migratory shorebird count in winter and the abundance of Red-necked Stint in summer (**Table 3.3**). However, there has been only one count on king spring tides greater than 2.55 m, a targeted count on a tide of 2.77 m in January 2023 (**Figure 3.5**).

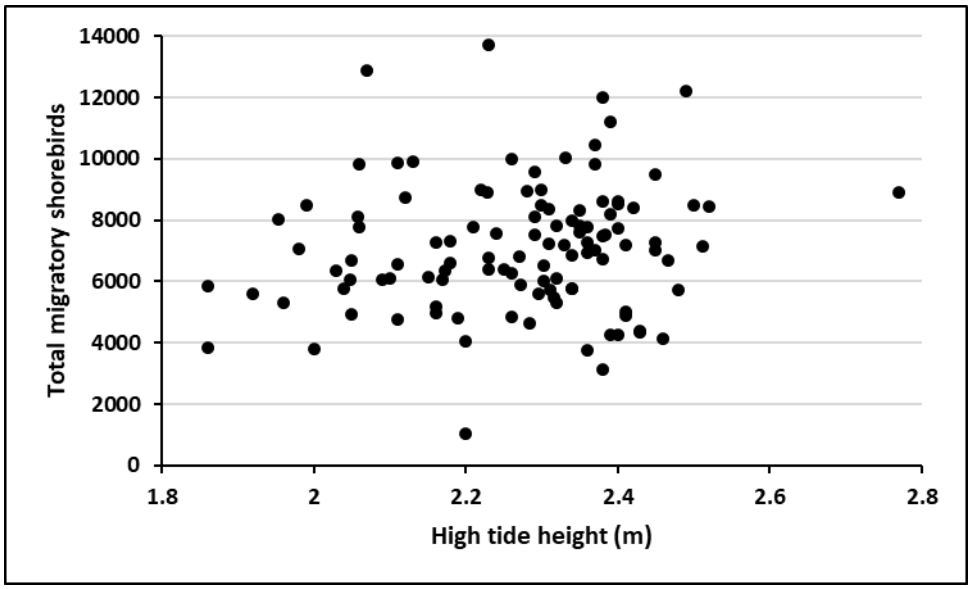

Figure 3.5. *Relationship between total migratory shorebird count on Fisherman Island during the summer months (1 October to 15 March) and height of the high tide over the shorebird years 2002-2022.*

The maximum count of total migratory shorebirds roosting on Fisherman Island each year has ranged between 7,159 and 13,703, with no evidence of a trend in the maximum count during the non-breeding period over the past 21 years (**Figure 3.6**).

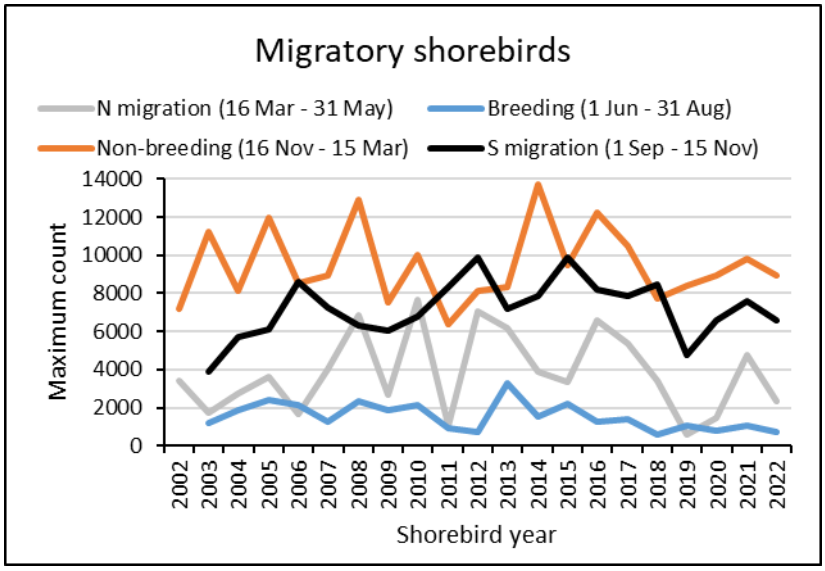

Figure 3.6. *Maximum counts of migratory shorebirds on Fisherman Island during the south migration, non-breeding, north migration and breeding periods over the shorebird years 2002-2022*.

The highest counts were 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 3.6**).

There has been no significant trend in the average annual total resident shorebird count on Fisherman Island over the past 21 years 2002-2022 (F = 1.38, P = 0.24; **Figure 3.7**).

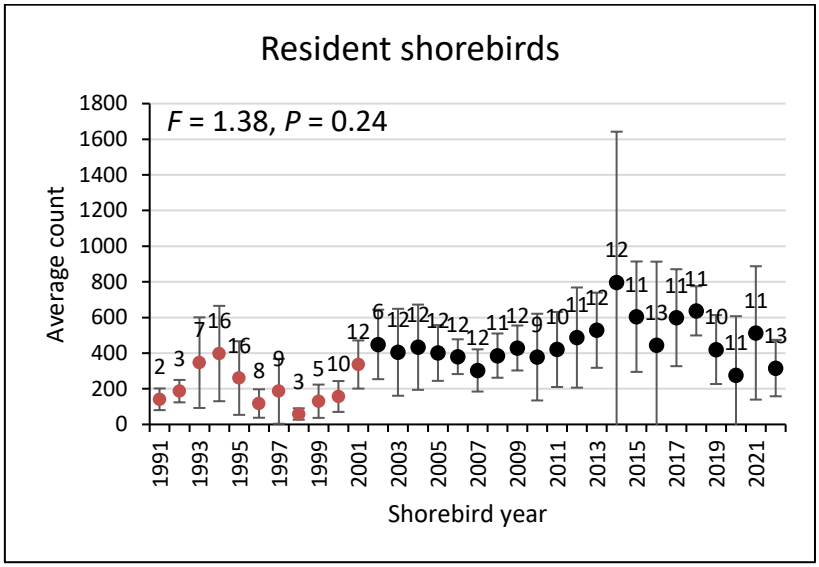

Figure 3.7. *Average total Fisherman Island counts (±1 SD) for resident shorebirds (annual) over the shorebird years 1991-2001 (orange symbols) and 2002-2022 (black symbols). The total number of counts for each shorebird year are shown above the respective column.*

Among individual 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 four species (Bar-tailed Godwit, Great Knot, Curlew Sandpiper and Broad-billed Sandpiper) over the 21-year period 2002-2022 (**Figure 3.8**).

The declines in Far Eastern Curlew and Grey Plover appear to have been gradual, whereas the decline in Red-necked Stint has occurred since 2018; 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 on Fisherman Island since 2002 appears to have been gradual whereas Great Knot counts increased after 2010 (**Figure 3.8**). 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. The substantial decrease in counts of Bar-tailed Godwit in 2022 coincided with generally increased counts of up to 3,010 Bar-tailed Godwit roosting at the nearby Lytton Claypan No. 1 roost site (**Appendix C**); consequently, the reduced counts on Fisherman Island over the most recent shorebird year may be due to birds preferentially roosting at Lytton Claypan No. 1. 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.

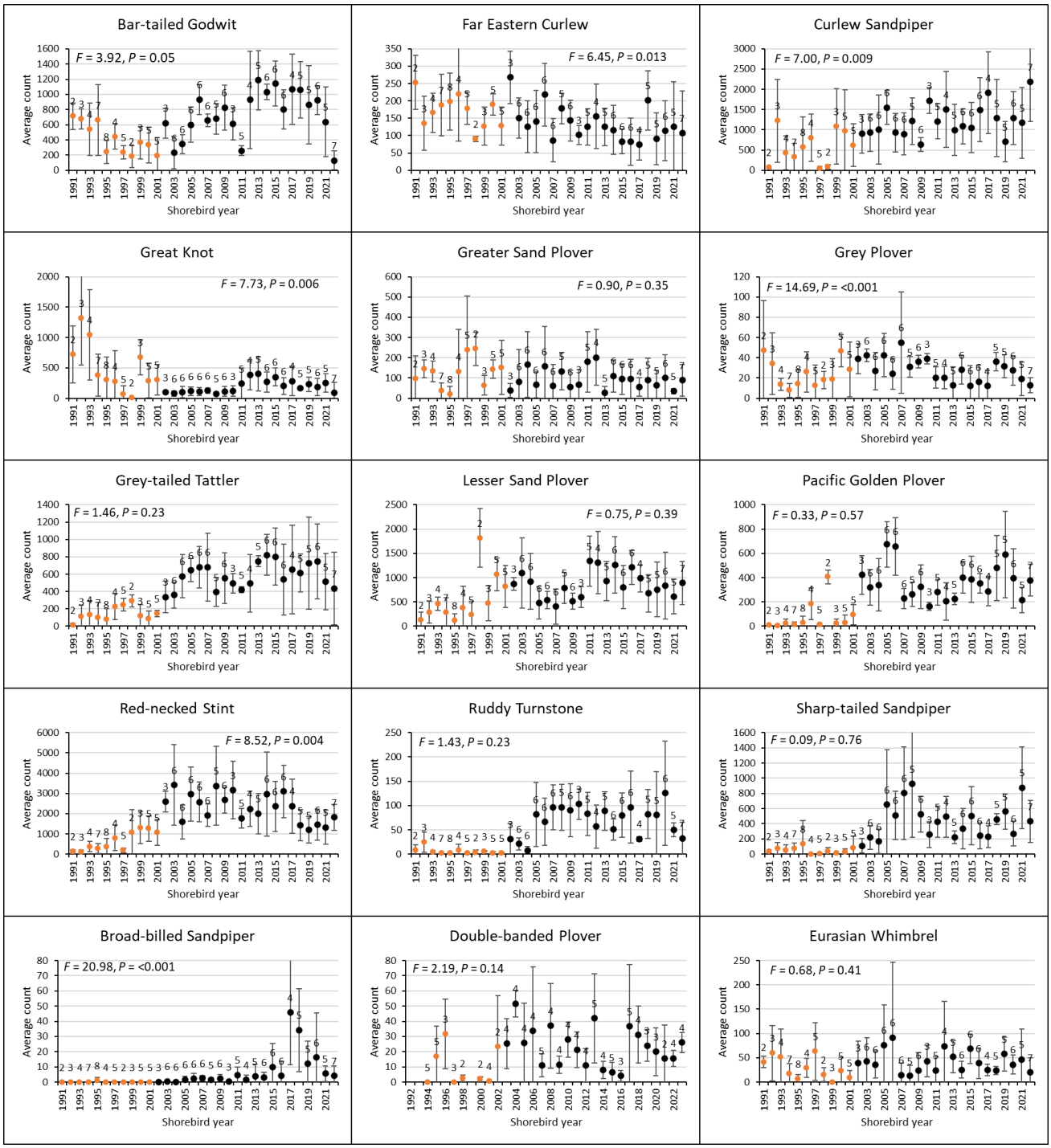

Figure 3.8. *Average total Port counts (±1 SD) for 15 migratory shorebird species during the summer period (1 October to 15 March: 14 species) or winter period (1 May to 31 August: Double-banded Plover) over the shorebird years 1991-2001 (orange symbols) and 2002-2022 (black symbols). The total number of counts for each shorebird year are shown above the respective column.*

The significant decline in Grey Plover roosting on Fisherman Island is consistent with other evidence of a declining (but non-significant) trend in Moreton Bay (Wilson *et al*. 2011) and disappearance of the species from north-east Tasmania (Cooper et al. 2012). Large numbers of Sharp-tailed Sandpiper are known to use inland freshwater wetlands when these are receding after flooding (Higgins and Davies 1996, Lloyd *et al*. 2020). Therefore, one might expect Sharp-tailed Sandpiper numbers visiting coastal wetlands to be variable depending on seasonally and annually variable conditions at inland wetlands. Specifically, one might expect numbers to be higher during the early non-breeding season (October-November) and lower later in the summer wet season once inland freshwater wetlands are more frequently flooded. Sharp-tailed Sandpiper counts were highly

variable both between years (**Figure 3.8**) and through the summer non-breeding season. However, the pattern of seasonal variation was not consistent with a predicted decrease in average numbers through the non-breeding season (**Figure 3.2**).

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 on Fisherman Island in substantially larger numbers during the early 1990s than at any time since then, and while counts of Bar-tailed Godwit roosting on Fisherman Island have increased significantly over the period 2002-2022, they may have decreased over the period 1991-2001 (**Figure 3.8**). Grey-tailed Tattler and Ruddy Turnstone, which roost preferentially on the inside of the outer bund rock wall, appear to have increased in numbers on Fisherman Island only after the outer bund rock wall was constructed in 2004. Pacific Golden Plover, Red-necked Stint and Sharp-tailed Sandpiper also appear to have roosted in relatively low numbers on Fisherman Island prior to 2002.

Among individual resident shorebird species, there has been no significant trend in the average annual count for the four commonly occurring species over the 21-year period 2002-2022 (**Figure 3.9**).

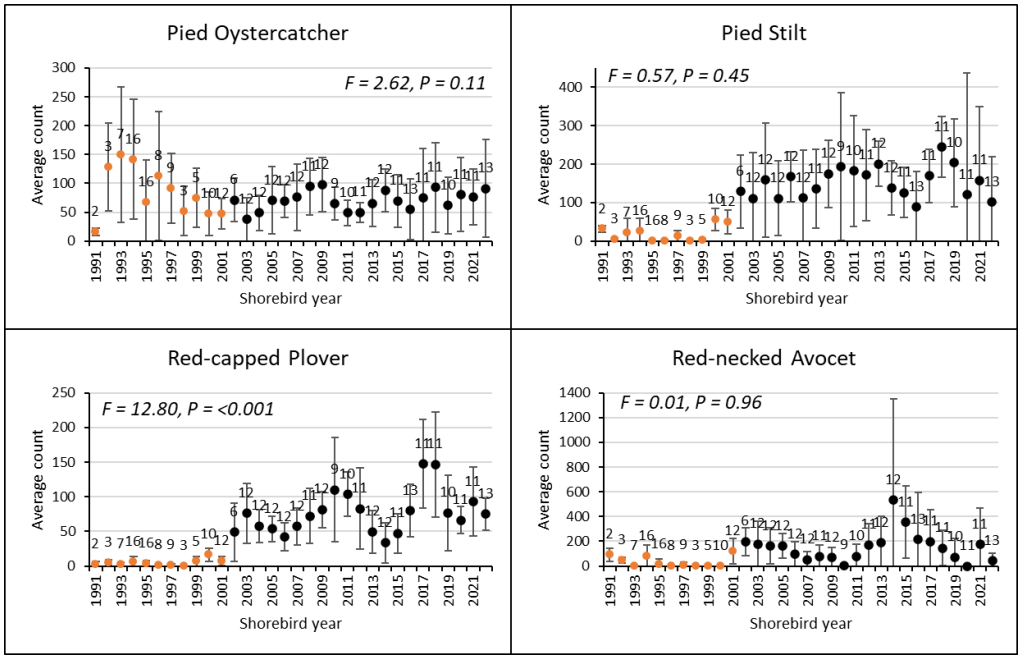

Figure 3.9. *Average annual total Fisherman Island counts (±1 SD) for four resident shorebird species over the shorebird years 1991-2001 (orange symbols) and 2002-2022 (black symbols). The total number of counts for each shorebird year are shown above the respective column.*

The increased average and high variability in the counts of Red-necked Avocet in the 2014 shorebird year (i.e. 2014/15) were due to an influx of up to 2,810 birds to the reclamation area in April-May 2015.

3.4 SITE IMPORTANCE

The index of relative importance of the roosts on Fisherman Island to different migratory shorebird species ranged between 87% for Curlew Sandpiper and <1% for Black-tailed Godwit and Sanderling (**Table 3.4**). Thus, the average annual maximum count of Curlew Sandpiper on Fisherman Island was 87% of the all-time maximum count of Curlew Sandpiper reported by Fuller *et al*. (2021) for the whole of Moreton Bay since 2008. The index of relative importance of Fisherman Island was greater than 50% for seven species and greater than 20% for 12 species (**Table 3.4**). The roosts on Fisherman Island have together supported nationally significant numbers (greater than 0.1% of the EAAF population) of 16 migratory shorebird species and internationally significant numbers (greater than 1% of the EAAF population) of six of these since 2002 (**Table 3.4**).

Table 3.4. *Summary of migratory and resident shorebird species recorded on Fisherman Island at the Port of Brisbane over the shorebird years 2002 to 2022, their average (±1SD) summer (1 October to 15 March, migratory species) and winter (1 May to 31 August, migratory species) or annual (resident species) counts (with percentage of counts the species was present in parentheses), annual maximum counts (with overall maximum count in parentheses), and index of relative importance (IRI). Values that exceed 0.1% of the EAAF population of the species are highlighted in bold and values that exceed 1% of the EAAF population are underlined*.

Common name	Species	Summer (n = 111)	Winter (n = 83)	Annual maximum (max. count)	IRI
Migratory shorebirds					
Curlew Sandpiper	*Calidris ferruginea*	**1216**±717 (100%)	**122**±149 (99%)	**2026**±519 (**3408**)	83%
Lesser Sand Plover	*Charadrius mongolus*	**843**±496 (100%)	48±67 (78%)	**1418**±492 (**2433**)	73%
Greater Sand Plover	*Charadrius leschenaultii*	95±108 (94%)	6±19 (39%)	**240**±119 (**441**)	72%
Red-necked Stint	*Calidris ruficollis*	**2288**±1262 (100%)	**650**±558 (100%)	**3833**±1397 (**6803**)	71%
Pacific Golden Plover	*Pluvialis fulva*	**370**±211 (100%)	14±18 (65%)	**580**±266 (**1219**)	70%
Ruddy Turnstone	*Arenaria interpres*	**69**±56 (98%)	19±29 (69%)	**131**±60 (**248**)	62%
Sharp-tailed Sandpiper	*Calidris acuminata*	**448**±389 (100%)	30±171 (61%)	**922**±535 (**2078**)	59%
Grey-tailed Tattler	*Tringa brevipes*	**591**±316 (97%)	**129**±171 (74%)	**1018**±264 (**1434**)	42%
Grey Plover	*Pluvialis squatarola*	28±20 (93%)	2±3 (27%)	48±24 (**145**)	41%
Great Knot	*Calidris tenuirostris*	186±164 (97%)	8±29 (35%)	379±190 (**708**)	26%
Red Knot	*Calidris canutus*	35±114 (57%)	2±7 (11%)	**236**±221 (**760**)	24%
Broad-billed Sandpiper	*Calidris falcinellus*	7±16 (59%)	<1±1 (6%)	29±38 (**131**)	22%
Double-banded Plover	*Charadrius bicinctus*	<1±<1 (7%)	**24**±22 (93%)	**46**±37 (**172**)	19%
Eurasian Whimbrel	*Numenius phaeopus*	41±53 (91%)	9±38 (49%)	**146**±97 (**405**)	11%
Bar-tailed Godwit	*Limosa lapponica baueri*	**729**±408 (99%)	210±198 (89%)	**1088**±386 (**1633**)	9%
Far Eastern Curlew	*Numenius madagascariensis*	**131**±83 (97%)	**43**±60 (77%)	**247**±72 (**340**)	7%
Common Greenshank	*Tringa nebularia*	4±5 (78%)	1±3 (26%)	11±8 (37)	6%
Marsh Sandpiper	*Tringa stagnatilis*	1±3 (36%)	<1±<1 (6%)	5±5 (18)	2%
Terek Sandpiper	*Xenus cinereus*	3±6 (60%)	1±4 (25%)	11±11 (42)	2%
Black-tailed Godwit	*Limosa limosa*	1±5 (20%)	<1±1 (10%)	6±12 (54)	1%
Sanderling	*Calidris alba*	<1±1 (4%)	<1±<1 (1%)	1±2 (8)	1%
Wandering Tattler	*Tringa incana*	<1±<1 (13%)	<1±<1 (1%)	<1±<1 (3)	
Asian Dowitcher	*Limnodromus semipalmatus*	<1±<1 (5%)	0 (0%)	<1±<1 (1)	
Buff-breasted Sandpiper	*Calidris subruficollis*	<1±<1 (2%)	0 (0%)	<1±<1 (1)	
Common Sandpiper	*Actitis hypoleucos*	<1±<1 (3%)	0 (0%)	<1±<1 (1)	

Common name	Species	Summer (n = 111)	Winter (n = 83)	Annual maximum (max. count)	IRI
Latham's Snipe	*Gallinago hardwickii*	<1±<1 (5%)	0 (0%)	<1±<1 (1)	
Ruff	*Calidris pugnax*	0	0	<1±<1 (1)	
Total migratory		7110±917	1299±570	9473±1967 (13703)	
Resident shorebirds					
Black-fronted Dotterel	*Elseyornis melanops*	1±20 (41%)		4±3 (13)	
Bush Stone-curlew	*Burhinus grallarius*	<1±<10 (1%)			
Masked Lapwing	*Vanellus miles*	5±30 (89%)		10±3 (14)	
Pied Oystercatcher	*Haematopus longirostris*	70±520 (99%)		160±47 (240)	
Pied Stilt	*Himantopus leucocephalus*	152±1300 (97%)		386±186 (1070)	
Red-capped Plover	*Charadrius ruficapillus*	76±500 (100%)		155±60 (279)	
Red-kneed Dotterel	*Erythrogonys cinctus*	1±60 (14%)		6±15 (53)	
Red-necked Avocet	*Recurvirostra novaehollandiae*	151±2710 (76%)		543±596 (2810)	
Sooty Oystercatcher	*Haematopus fuliginosus*	<1±10 (12%)		1±2 (6)	
Total resident		457±123		981±566 (3126)	

The reclamation area ponds (PBRA) have consistently supported 80-90% of the migratory shorebirds on Fisherman Island over the past 21 years, with the artificial roost (PBAR), Fisherman Island claypan (FICP), visitor centre lake (FIVC) and rail loop (PBRL) sites supporting substantially lower numbers (**Figure 3.10**). Averaged across all years, the reclamation area ponds have supported 88%, the Fisherman Island claypan 8%, the artificial roost 4%, and the visitor centre lake and rail loop less than 1% of the migratory shorebirds. Migratory shorebirds rarely visit the freshwater lake at the visitor centre; small numbers of Curlew Sandpiper, Sharp-tailed Sandpiper, Red-necked Stint and Marsh Sandpiper have been recorded only after the water levels at the lake have declined to very low levels during extended dry periods. The same species are similarly rarely recorded at the rail loop, but in this case only after heavy rainfall has flooded a basin inside the rail loop. The rail loop basin is an artefact of stormwater drainage management that currently allows the basin to flood after heavy rainfall.

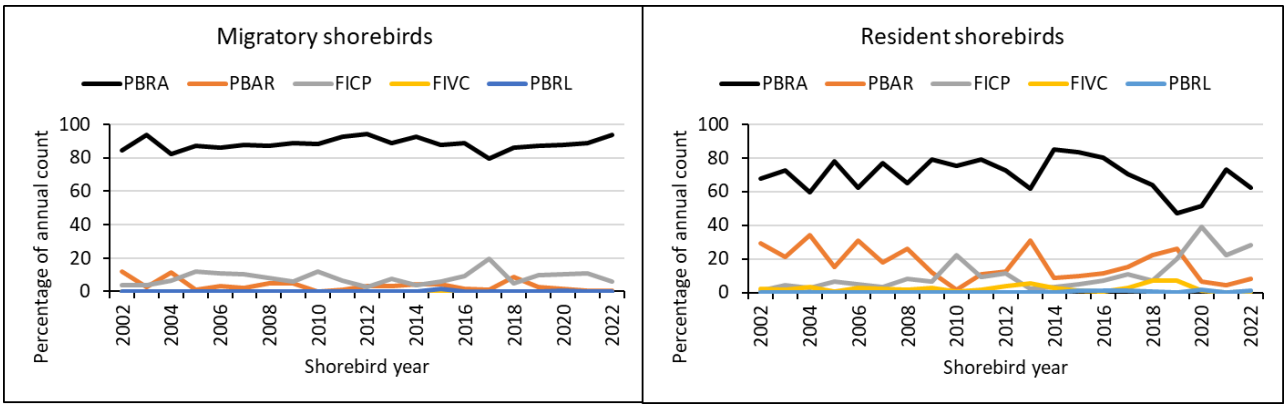

Figure 3.10. *Percentage of the total annual count of migratory and resident shorebirds on Fisherman Island supported by each of the reclamation area (PBRA), artificial roost (PBAR), Fisherman Island claypan (FICP), visitor centre (FIVC) and rail loop (PBRL) sites over the shorebird years 2002-2022.*

Similarly, the reclamation area ponds have consistently supported most of the resident shorebirds over the past 21 years (**Figure 3.10**). Averaged across all years, the reclamation area ponds have supported 70%, the artificial roost 17%, the Fisherman Island claypan 11%, the visitor centre lake 2% and rail loop less than 1% of the resident shorebirds.

All four main roost sites at the Port, three on Fisherman Island together with the Lytton Claypan No. 1 on the mainland, have supported nationally significant numbers (greater than 0.1% of the EAAF population) and two, the reclamation area and Lytton Claypan No. 1 have supported internationally significant numbers (greater than 1% of the EAAF population) of migratory shorebird species within the most recent five years (**Table 3.5**). The reclamation area was nationally significant for 13 species and internationally significant for five species, Lytton Claypan No. 1 was nationally significant for six species and internationally significant for two species, the Fisherman Island claypan was nationally significant for six species and the artificial roost was nationally significant for three species.

Table 3.5. *Summary of migratory and resident shorebird species recorded at the four main roost sites at the Port of Brisbane over the past five years since September 2018, their average (±1SD) summer (1 October to 15 March, migratory species except Double-banded Plover), winter (1 May to 31 August, Double-banded Plover) or annual (resident species) counts, with overall maximum count in parentheses. Values that exceed 0.1% of the EAAF population of the species are highlighted in bold and values that exceed 1% of the EAAF population are underlined*.

Common name	Reclamation Area	Artificial Roost	Fisherman Isl. Claypan	Lytton Claypan No. 1
Migratory shorebirds				
Asian Dowitcher	<0.1±0.2 (1)	0.1±0.3 (1)	0	0
Bar-tailed Godwit	**521**±414.2 (**1567**)	121.6±307.8 (**1318**)	45.1±114.1 (**402**)	**698.3**±563.7 (**3010**)
Black-tailed Godwit	0.1±0.3 (1)	0.3±0.5 (2)	0.1±0.6 (3)	6.7±15.9 (71)
Broad-billed Sandpiper	13.1±21.1 (**76**)	0.6±1.7 (8)	0.1±0.4 (2)	0
Buff-breasted Sandpiper	0	0.1±0.3 (1)	0	0
Common Greenshank	0.1±0.4 (2)	1.5±2 (6)	1.3±6.6 (35)	0.6±1.6 (8)
Common Sandpiper	<0.1±0.2 (1)	0	0	0
Curlew Sandpiper	**1322**±950.7 (**3408**)	20.1±40.8 (**166**)	41.7±82.5 (**289**)	**125.7**±267.9 (**1251**)
Double-banded Plover	**20.6**±10.7 (**37**)	0	0	0
Eurasian Whimbrel	0.1±0.6 (3)	9±14.7 (45)	26.3±38.2 (**157**)	**102.6**±69.8 (**210**)
Far Eastern Curlew	**65.1**±84 (**290**)	1.5±1.2 (4)	**59.3**±99 (**340**)	**198.7**±107 (**438**)
Great Knot	159.6±142.8 (**482**)	11.1±36.8 (185)	5.9±16.4 (71)	63.2±120.8 (**431**)
Greater Sand Plover	77.3±83.4 (**305**)	0	0	0
Grey Plover	24.5±14.1 (49)	0	0	0
Grey-tailed Tattler	**598.3**±392.9 (**1434**)	0.3±1.3 (7)	0	0
Lesser Sand Plover	**764.9**±479.5 (**2053**)	0	0	0
Marsh Sandpiper	0.6±1.4 (5)	<0.1±0.2 (1)	0.1±0.4 (2)	2.2±5.4 (22)
Pacific Golden Plover	**401.1**±244.7 (**1204**)	1.8±2.1 (6)	5.7±8.2 (26)	0.1±0.3 (2)
Red Knot	12.5±30.5 (**152**)	2.1±6.5 (31)	<0.1±0.2 (1)	3.9±8.2 (34)
Red-necked Stint	**1290.2**±701.3 (**2734**)	10.3±17.3 (60)	171±286.2 (**1350**)	43.5±72.8 (286)

Common name	Reclamation Area	Artificial Roost	Fisherman Isl. Claypan	Lytton Claypan No. 1
Ruddy Turnstone	**73.1**±71.6 (**248**)	0	<0.1±0.2 (1)	0
Sanderling	0.1±0.3 (1)	0	0	0
Sharp-tailed Sandpiper	**417.4**±332.1 (**1640**)	25±25 (**113**)	60.1±143.5 (**637**)	66±126.7 (**505**)
Terek Sandpiper	0.6±1.5 (6)	0	0	0
Wandering Tattler	<0.1±0.2 (1)	0	0	0
Resident shorebirds				
Black-fronted Dotterel	0.4±1 (4)	0.6±0.9 (3)	0.4±1.3 (8)	1.1±2.8 (12)
Masked Lapwing	0.9±1.8 (10)	1.2±0.9 (3)	2.7±2.2 (9)	7.2±7.6 (29)
Pied Oystercatcher	79.1±66.3 (240)	1.3±1.1 (4)	0.9±2.1 (11)	6.6±21.6 (189)
Pied Stilt	21.8±36.1 (138)	50.1±62 (229)	76±167.9 (1070)	108.7±165.3 (922)
Red-capped Plover	79.6±49.2 (247)	1.2±1.6 (7)	7.2±8 (44)	6.1±10.1 (41)
Red-kneed Dotterel	0	0.1±0.4 (2)	0	0.4±3.6 (34)
Red-necked Avocet	77.2±162.9 (896)	1.5±5.1 (32)	1.9±14.4 (108)	13.4±39.1 (205)
Sooty Oystercatcher	0.5±1.2 (6)	0	0	0
Total migratory	*5743.5±2057.2 (9646)*	*205.3±379.7 (1607)*	*416.8±424.2 (1459)*	*1322.6±819.4 (3927)*
Total resident	*259.5±180 (1032)*	*56±64 (232)*	*89±174 (1086)*	*143.5±178.4 (944)*

3.5 SHOREBIRD BANDING AND FLAG RESIGHTING

No catching and banding of shorebirds took place at the Port during the reporting period. There were 16 shorebird flag re-sightings at the Port during the 2022/23 reporting period, including:

- 12 green flags on birds banded in Moreton Bay;
- one yellow flag on a Pied Oystercatcher banded in northern NSW;
- one orange flag on a Curlew Sandpiper banded in Victoria;
- one yellow over blue flag and one white over blue flag on two Curlew Sandpipers banded in the Northern Territory and Taiwan respectively.

Table 3.6 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 north and south of the Port, particularly the Manly Harbour roost site and tidal flats from Sandgate in the north to Manly in the south.

Table 3.6. *Species composition of the leg-flag re-sightings at the Port in 2022/23 and the locations where the flagged birds were either originally banded or have been observed since they were originally banded*.

Re-sighting location	Distance from Port (km)	Bar-tailed Godwit	Curlew Sandpiper	Lesser Sand Plover	Pacific Golden Plover	Pied Oystercatcher	Pied Stilt	Total
Number resighted		3	4	2	1	2	1	13
Port of Brisbane		6	6	4	2	3	2	23
Luggage Point	4				1			1
St Helena Island	5					2		2
Brisbane Airport	5	1						1
Lytton Claypan No. 1	6	3						3
Jackson Creek Point, Kedron	8	1						1
Wynnum Esplanade	10	3				23		26
Rose Bay, Manly	10					1		1
Manly Harbour	11	2			1	24	1	28
Sandgate	13	5						5
Kakadu Beach, Bribie Island	34	2		1				3
Toorbul Wader Roost	35					1		1
Station Creek Estuary, Yuraygir NP, NSW						1		1
Western Treatment Plant, Werribee, Victoria			1					1
Shellfish Harbour, SOUTH KOREA		1						1
Northern Territory			1					1
Taiwan			1					1

4.0 CONCLUSION AND RECOMMENDATIONS

Port of Brisbane Pty Ltd is encouraged to continue to prioritise the management and monitoring of shorebirds at the Port. The monitoring reported here identifies the Fisherman Island claypan and Lytton Claypan No. 1 roost sites as very significant, naturally occurring shorebird roost sites that are important to the network of roost sites in central Moreton Bay. Portions of these roost sites also provide foraging resources for migratory shorebirds when inundated. These two roost sites, together with the artificial roost, are likely to become increasingly relied upon by migratory shorebirds in future as the availability of roosting habitat in the current FPE reclamation area diminishes as it approaches the point when it is all expected to be resumed for port infrastructure. Consequently, retaining the Fisherman Island claypan, Lytton Claypan No. 1 and artificial roost sites as part of the conservation buffer land use under the Brisbane Port Land Use Plan 2020 (LUP) can make an important contribution to the sympathetic management of migratory and other shorebirds in Moreton Bay.

There is also a need to continue to explore opportunities to provision or improve roosting habitat for shorebirds within or adjacent to Port lands to compensate for the expected future loss of roosting habitat in the reclamation area. 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). Although the artificial roost has supported only 4% of the migratory shorebirds using Fisherman Island since 2002, it is occasionally used by large numbers of birds (see **Table 3.5**), indicating it has potential to support larger numbers of birds once currently preferred alternatives in the reclamation area are lost. There are also opportunities to improve vegetation management at the artificial roost to create a more extensive open area of sparsely vegetated substrate to accommodate larger numbers of migratory shorebirds.

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 fully 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's FPE 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 and associated foraging areas to better understand these local dynamics (e.g. Lilleyman *et al.* 2020).

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APPENDIX A: Monthly count data for the 12 most important migratory shorebird species by site in 2022/23

Table A1. *Monthly counts of Grey-tailed Tattler by site in 2022/23. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% total
Pond R3	PBR3		20	2		8	21	11	10	1					73	79.3
Pond C3	PBC3				3				10						13	14.1
Pond BS3	PBS3			4											4	4.3
Pond C4	PBC4							1		1					2	2.2
	Total	**0**	**20**	**6**	**3**	**8**	**21**	**12**	**20**	**2**	**0**	**0**	**0**	**0**	**92**	

Table A2. *Monthly counts of Red-necked Stint by site in 2022/23. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% total
Pond R3	PBR3	84	516	566	49	1122	1276	1060	426	117	189	230	257	439	6331	41.2
Pond C3	PBC3	134	734	63	1937	395	43	43		166	5		8		3528	22.9
Pond BS3	PBS3	9	1150	40	242	1		242	392	45					2121	13.8
Pond BS2	PBS2	53	334		120	175	523	77	384	148				168	1982	12.9
Fisherman Island claypan	FICP		16	231	65	102			30	216	111		53		824	5.4
Pond BS4	PBS4			2	6	71	19	240							338	2.2
Lytton Claypan No.1	LYN1		2	46				48		33	26	36	2		193	1.3
Pond C4	PBC4				13	2	6	23		6					50	0.3
Pond FPE	PFPE			2					2				5		9	0.1
Artificial roost	PBAR					2									2	0.0
	Total	**280**	**2752**	**950**	**2432**	**1870**	**1867**	**1733**	**1234**	**731**	**331**	**266**	**325**	**607**	**15378**	**100**

Table A3. *Monthly counts of Curlew Sandpiper by site in 2022/23. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% total
Pond R3	PBR3	257	649	93	164	3065	2916	2300	1340	2	52	265	103	144	11350	67.8
Pond C3	PBC3	103	13	255	2053	52	430	127	15		2				3050	18.2
Pond BS3	PBS3		625	430	126	1	33	188	5		7	3			1418	8.5
Lytton Claypan No.1	LYN1	89	192	7	1	6				4	35	51		4	389	2.3
Fisherman Island claypan	FICP	55	45	68						3	31			4	206	1.2
Pond BS4	PBS4		21		5	40	29	39							134	0.8
Pond C4	PBC4		6			5		37	10					7	65	0.4
Rail Loop	PBRL								41						41	0.2
Pond BS2	PBS2	6	25									3			34	0.2
Artificial roost	PBAR					33									33	0.2
Pond FPE	PFPE								2					18	20	0.1
	Total	**510**	**1576**	**853**	**2349**	**3202**	**3408**	**2691**	**1413**	**9**	**127**	**322**	**103**	**177**	**16740**	**100**

Table A4. *Monthly counts of Sharp-tailed Sandpiper by site in 2022/23. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% total
Pond R3	PBR3	60	353	29	260	58	560	400	73	107					1900	49.6
Fisherman Island claypan	FICP	268	121	637	8				9	5					1048	27.3
Lytton Claypan No.1	LYN1	108	144	22	3					2					279	7.3
Pond C3	PBC3		37	12	28		91	5	1	76	1				251	6.5
Pond BS3	PBS3		11	140			44	1	8		1				205	5.3
Artificial roost	PBAR		18		23	21		35	16						113	2.9
Pond BS2	PBS2	2	4						19						25	0.7
Pond C4	PBC4		1					2	4	2					9	0.2
Pond BS4	PBS4		2				1		1						4	0.1
	Total	**438**	**691**	**840**	**322**	**79**	**696**	**443**	**131**	**192**	**2**	**0**	**0**	**0**	**3834**	**100**

Table A5. *Monthly counts of Bar-tailed Godwit by site in 2022/23. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% total
Lytton Claypan No.1	LYN1	392	711	798	895	1185	2080	430	825	243	107	81	50	45	7842	88.1
Pond R3	PBR3	2	306	278		15		112	151						864	9.7
Fisherman Island claypan	FICP				3							17	115	27	162	1.8
Pond BS3	PBS3						35								35	0.4
Pond C4	PBC4							2							2	0.0
	Total	**394**	**1017**	**1076**	**898**	**1200**	**2115**	**544**	**976**	**243**	**107**	**98**	**165**	**72**	**8905**	**100**

Table A6. *Monthly counts of Great Knot by site in 2022/23. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% total
Lytton Claypan No.1	LYN1	145	11			395	286	407	2	27	13				1286	65.5
Pond R3	PBR3	4	64	2		70	1		482	12					635	32.3
Fisherman Island claypan	FICP									35					35	1.8
Pond BS3	PBS3						4	1							5	0.3
Pond C3	PBC3						2								2	0.1
	Total	**149**	**75**	**2**	**0**	**465**	**293**	**408**	**484**	**74**	**13**	**0**	**0**	**0**	**1963**	**100**

Table A7. *Monthly counts of Far Eastern Curlew by site in 2022/23. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% total
Lytton Claypan No.1	LYN1	217	287	376	196	438	155	272	179	57	111	93	1	138	2520	73.1
Fisherman Island claypan	FICP	1	2		78	38	22		327			20	8	137	633	18.4
Pond BS3	PBS3				6		167								173	5.0
Pond R3	PBR3					26		52	7	3					88	2.6
Artificial roost	PBAR	1	2	2	3	2	2	4	1					1	18	0.5
Pond BS4	PBS4						11			3					14	0.4
	Total	**219**	**291**	**378**	**283**	**504**	**357**	**328**	**514**	**63**	**111**	**113**	**9**	**276**	**3446**	**100**

Table A8. *Monthly counts of Ruddy Turnstone by site in 2022/23. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% total
Pond R3	PBR3				18		3		82	27				3	133	44.0
Pond C3	PBC3				11	31	18	5		22	3				90	29.8
Pond FPE	PFPE						21			4		5			30	9.9
Pond BS4	PBS4						8	5	9	4					26	8.6
Pond C4	PBC4		1		4			8	3	5					21	7.0
Pond BS2	PBS2								2						2	0.7
	Total	**0**	**1**	**0**	**33**	**31**	**50**	**18**	**96**	**62**	**3**	**5**	**0**	**3**	**302**	**100**

Table A9. *Monthly counts of Lesser Sand Plover by site in 2022/23. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% total
Pond C3	PBC3	2		330	1762	540	949	77	433	283	48	80			4504	67.1
Pond BS3	PBS3	1	840	350	30			169	4						1394	20.8
Pond R3	PBR3				1			340	294	33	5		13	16	702	10.5
Pond FPE	PFPE			21	52			14	2		10		1		100	1.5
Pond BS4	PBS4							7							7	0.1
Pond C4	PBC4							2	2						4	0.1
Pond BS2	PBS2		1												1	0.0
	Total	**3**	**841**	**701**	**1845**	**540**	**949**	**609**	**735**	**316**	**63**	**80**	**14**	**16**	**6712**	**100**

Table A10. *Monthly counts of Greater Sand Plover by site in 2022/23. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% total
Pond C3	PBC3			45	250	70	18	8	13	95		3			502	68.7
Pond R3	PBR3							33	105	13					151	20.7
Pond BS3	PBS3		72	2				2							76	10.4
Pond C4	PBC4					1									1	0.1
Pond FPE	PFPE			1											1	0.1
	Total	**0**	**72**	**48**	**250**	**71**	**18**	**43**	**118**	**108**	**0**	**3**	**0**	**0**	**731**	**100**

Table A11. *Monthly counts of Pacific Golden Plover by site in 2022/23. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% total
Pond C3	PBC3	54		211	156	416	519	34	373	315	47	54	25		2204	69.2
Pond BS3	PBS3		447	149											596	18.7
Pond FPE	PFPE			8	175			71							254	8.0
Pond C4	PBC4				60		2	2	1	1					66	2.1
Pond R3	PBR3								1	9				19	29	0.9
Fisherman Island claypan	FICP			2	2					15					19	0.6
Artificial roost	PBAR			3	4	2									9	0.3
Pond BS4	PBS4			2		1	3	3							9	0.3
	Total	**54**	**447**	**375**	**397**	**419**	**524**	**110**	**375**	**340**	**47**	**54**	**25**	**19**	**3186**	**100**

Table A12. *Monthly counts of Grey Plover by site in 2022/23. The percentage contributions to total numbers made by each site are shown in the final column.*

Site	Date / Site code	11/09/2022 S migration	09/10/2022	06/11/2022	11/12/2022 Non-breeding	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023 N migration	07/05/2023	04/06/2023 Breeding	09/07/2023	06/08/2023	**Total**	% total
Pond R3	PBR3		20	2		8	21	11	10	1					73	79.3
Pond C3	PBC3				3				10						13	14.1
Pond BS3	PBS3			4											4	4.3
Pond C4	PBC4							1		1					2	2.2
	Total	**0**	**20**	**6**	**3**	**8**	**21**	**12**	**20**	**2**	**0**	**0**	**0**	**0**	**92**	**100**

APPENDIX B: Monthly Port of Brisbane total count data for all shorebird species in 2022/23, including all sites on Fisherman Island and Lytton Claypan No. 1.

Date	11/09/2022	09/10/2022	06/11/2022	11/12/2022	15/01/2023	22/01/2023	12/02/2023	12/03/2023	02/04/2023	07/05/2023	04/06/2023	09/07/2023	06/08/2023
Migratory species	13	13	15	15	16	17	13	17	17	15	11	9	10
Resident species	6	6	4	3	4	4	4	6	6	6	6	6	7
Total migratory	2191	8133	5509	8953	9350	11565	7623	6809	2938	957	1036	682	1239
Total resident	291	102	90	148	214	329	343	447	496	691	801	729	765
Migratory													
Asian Dowitcher	0	0	1	0	0	0	0	0	0	0	0	0	0
Bar-tailed Godwit	394	1017	1076	898	1200	2115	544	976	243	107	98	165	72
Black-tailed Godwit	18	0	0	5	1	19	0	0	0	6	5	5	2
Broad-billed Sandpiper	0	0	0	0	13	14	0	1	2	0	0	0	0
Buff-breasted Sandpiper	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Greenshank	1	0	3	2	0	0	0	0	4	0	0	0	0
Common Sandpiper	0	0	0	0	0	0	0	0	0	0	0	0	0
Curlew Sandpiper	510	1576	853	2349	3202	3408	2691	1413	9	127	322	103	177
Double-banded Plover	0	0	0	0	0	0	0	1	6	20	29	21	34
Eurasian Whimbrel	92	164	212	108	175	100	121	101	244	63	61	15	33
Far Eastern Curlew	219	291	378	283	504	357	328	514	63	111	113	9	276
Great Knot	149	75	2	0	465	293	408	484	74	13	0	0	0
Greater Sand Plover	0	72	48	250	71	18	43	118	108	0	3	0	0
Grey Plover	0	20	6	3	8	21	12	20	2	0	0	0	0
Grey-tailed Tattler	0	0	61	24	673	1116	563	596	530	58	0	0	0
Latham's Snipe	0	0	0	0	0	0	0	0	0	0	0	0	0
Lesser Sand Plover	3	841	701	1845	540	949	609	735	316	63	80	14	16
Marsh Sandpiper	0	0	0	1	0	2	0	1	0	1	0	0	0
Pacific Golden Plover	54	447	375	397	419	524	110	375	340	47	54	25	19
Red Knot	32	186	4	0	4	16	0	11	0	5	0	0	0
Red-necked Stint	280	2752	950	2432	1870	1867	1733	1234	731	331	266	325	607
Ruddy Turnstone	0	1	0	33	31	50	18	96	62	3	5	0	3
Ruff	1	0	0	0	0	0	0	0	0	0	0	0	0
Sanderling	0	0	0	0	0	0	0	0	0	0	0	0	0
Sharp-tailed Sandpiper	438	691	840	322	79	696	443	131	192	2	0	0	0
Terek Sandpiper	0	0	0	0	0	0	0	0	12	0	0	0	0
Wandering Tattler	0	0	0	0	0	0	0	0	0	0	0	0	0
unidentified shorebird	0	0	0	1	95	0	0	2	0	0	0	0	0
Resident													
Black-fronted Dotterel	12	0	3	0	1	0	0	4	8	11	21	17	2
Masked Lapwing	7	4	11	19	12	9	4	6	29	15	17	16	11
Pied Oystercatcher	28	32	37	75	144	240	239	218	45	63	31	16	15
Pied Stilt	77	3	0	0	0	2	8	106	286	425	453	470	575
Red-capped Plover	67	57	39	54	57	78	92	107	127	133	129	183	69
Red-necked Avocet	100	5	0	0	0	0	0	0	1	44	150	27	91
Sooty Oystercatcher	0	1	0	0	0	0	0	6	0	0	0	0	2

APPENDIX C: Summary of 2022/23 count data for Lytton Claypan No. 1.

Table D1. *Count results for each migratory and resident shorebird species at Lytton Claypan No. 1 (LYN1) roost site from September 2022 to August 2023.*

Common name	10/09/2022	08/10/2022	05/11/2022	11/09/2022	09/10/2022	06/11/2022	10/12/2022	11/12/2022	08/01/2023	14/01/2023	15/01/2023	22/01/2023	11/02/2023	12/02/2023	11/03/2023	12/03/2023	01/04/2023	02/04/2023	06/05/2023	07/05/2023	03/06/2023	04/06/2023	08/07/2023	25/07/2023	09/07/2023	05/08/2023	06/08/2023
Tide height (m)	2.03	2.07	2.06	2.11	2.18	2.2	2.41	2.36	2.43	2.09	1.98	2.77	2.17	2.03	2.18	2.04	2.12	2.2	2.07	1.98	1.97	1.92	1.91	1.81	1.94	2.05	2.06
Bar-tailed Godwit	415	696	778	392	711	798	1086	895	3010	1260	1185	2080	954	430	996	825	309	243	93	107	76	81	53	78	50	48	45
Black-tailed Godwit				18				5	46	11	1	19							1	6	5	5	3		5		2
Common Greenshank		3		1					3								2	4	0	0	0	0	0	0	0	0	0
Curlew Sandpiper	20	17	104	89	192	7	19	1	240		6		138					4	69	35	48	51	11				4
Eurasian Whimbrel	51	152	188	92	163	210	134	65	182	166	172	100	154	111	204	22	155	209	34	61	44	52	5	2		26	33
Far Eastern Curlew	122	297	297	217	287	376	248	196	206	332	438	155	263	272	207	179	71	57	83	111	95	93	1	47	1	131	138
Great Knot	95	44	8	145	11				192	431	395	286	353	407	47	2	4	27	15	13							
Marsh Sandpiper		1							1			2							1	1							
Red Knot	5	7	5	32	34	4	24		8	2	3	4	3		2				12	5							
Red-necked Stint			36		2	46			38				112	48	8			33	74	26	45	36	2		2		
Sharp-tailed Sandpiper	31	26	21	108	144	22	8	3	1				64					2									
Unidentified small wader											94																
Total migratory	**739**	**1243**	**1437**	**1094**	**1544**	**1463**	**1519**	**1165**	**3927**	**2202**	**2294**	**2646**	**2041**	**1268**	**1464**	**1028**	**541**	**579**	**382**	**365**	**313**	**318**	**75**	**127**	**58**	**205**	**222**
Black-fronted Dotterel				9														1		11		12	6	10	12		
Masked Lapwing		13	3	2	2	7	16	7	18	4	4	6			2	4	18	23	14	9		5		12	10		10
Pied Oystercatcher	3	2	2	7	2	1	11	2	7				4	4	6	10	1	2	2	2				2		1	3
Pied Stilt	33	3		36	2												222	63	191	137	116	171	243	132	321	75	237
Red-capped Plover			3	3	4	3					16		4	7	16	6	10	29	39	41	40	41	30	12	22	17	22
Red-necked Avocet																			21	27	21	24	32	11	27	21	43
Total resident	**36**	**18**	**8**	**57**	**10**	**11**	**27**	**9**	**25**	**4**	**20**	**6**	**8**	**11**	**24**	**20**	**251**	**118**	**267**	**227**	**177**	**253**	**311**	**179**	**392**	**114**	**315**