

**ANNUAL ANALYSIS OF THE STATUS OF SHOREBIRDS
IN THE PORT OF BRISBANE
BETWEEN SEPTEMBER 2018 & AUGUST 2019**

**Includes an analysis of historical trends in counts and
a comparison with Moreton Bay populations.**

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EXECUTIVE SUMMARY

As in previous reports, the species that are most important at the site are identified and their numbers on Port lands is compared with their numbers across the whole of Moreton Bay. Counts for each subsection of the site for September 2018 to August 2019 are tabulated and comparisons are made with previous years.

The twelve species of particular importance within the Port lands are given most attention. They include the Ruddy Turnstone, four plover species (Lesser and Greater Sand Plovers, Pacific Golden Plover and Grey Plover), three larger sandpipers (Far Eastern Curlew, Bar-tailed Godwit and Great Knot) and four smaller sandpipers (Grey-tailed Tattler, Sharp-tailed Sandpiper, Curlew Sandpiper and Red-necked Stint). Grouped data for all migratory shorebird species and all resident shorebird species are also presented.

Where practical, data are given for each episode of sampling, normally once per month as a complete count of the entire port lands (see Figure 1). Alternatively, mean or maximum count values are given for each of four periods of the year but with an emphasis on the main period of occupancy during the non-breeding season from mid-November to mid-March. Note that for this recent round of sampling only 10 months of data are available for the 12-month period between September 2018 to August 2019, also referred to here as the 2018 “shorebird year”. No sampling was done in July 2019 and the October 2018 fieldwork had to be cancelled at late notice due to heavy rain across the site making it unsafe.

As expected, numbers of migratory shorebirds are highest during the summer months and more than 17 species were regularly recorded at any one time, while 23 species were recorded across the year. Numbers of resident shorebirds are marginally higher during the winter months and eight species were recorded for the year. Over the last decade migratory shorebird numbers have remained at about the same level and the site generally remains the most important single roosting area for shorebirds in the whole of Moreton Bay. Data collected throughout Moreton Bay over a long period of time suggest that the PoB lands have progressively become more important for local shorebird populations, perhaps because other suitable roosting habitat in the Bay has been impacted by disturbance or physical changes.

The location of sites within the Port area being used by shorebirds changes over time. There is a clear pattern of the way in which birds alter their choice of roosting area as reclamation proceeds. They move to where fresh dredge spoil is being deposited and then move on as deposition stops and the spoil is allowed to dry and form a crust.

Taking the Port area as a whole since 2003, the pattern of yearly changes in numbers varies between species. Numbers certainly fluctuate from year to year but without any dramatic or unequivocal trends. However, there is arguably a very long-term reduction in at least the peak number of birds and for some species in particular. These patterns are described and continued sampling will help to establish whether there are cyclical patterns or distinct increasing or decreasing trends in numbers. For example, eight of the twelve important migratory shorebird species at the Port have had maximum summer counts at some time prior to 2006. There is also some suggestion that the importance of the Port lands to the shorebirds of Moreton Bay as a whole may be decreasing.

In contrast, an assessment of average summer values for the eight years after 2002 compared with the eight years prior to 2020 does not substantiate general long-term decline in numbers of shorebirds at the Port, in fact for some species (Bar-tailed Godwit and Lesser Sand Plover) it shows the opposite. However, two species, Far Eastern Curlew and Grey Plover, stand out as being less well represented at the Port as the years go by. A further two species, Red-necked Stint and Sharp-tailed Sandpiper may also be in this category.

The heightened threats to migratory shorebirds from a changing climate and increasing human population throughout the East Asian–Australasian Flyway cannot be underestimated. Local conditions and changes to shorebird habitat in Moreton Bay add to an intricate set of factors that may determine the population size of many of these remarkable migrant species over the coming decades. The shorebird records that are accumulating over a very long period of time at the Port of Brisbane will become more and more relevant to understanding population trends. They will prove invaluable for developing management strategies for the birds, not only within the Port area but more widely in Moreton Bay and possibly elsewhere. It is crucial that the Port of Brisbane gives high priority to managing and monitoring shorebirds, and providing substantial habitat for shorebirds into the future on the Port lands.

A. BACKGROUND

For over 29 years, high numbers of migratory shorebirds have been documented using Port of Brisbane (PoB) lands as high tide roosting habitat (Figure 1). The habitat is primarily being created by pumping of dredge material as infill for ongoing reclamation and the birds respond to varying configurations of suitable habitat, as the landscape changes at the Port.

Since 2003, members of the Queensland Wader Study Group (QWSG), have undertaken regular (almost monthly) counts of birds within the reclamation area as well as on a nearby clay pan and at a purpose-built shorebird roost site. Yearly reports have been supplied to the PoB. At the same time, QWSG members have also regularly counted between 50 and 65 other high tide roosts in Moreton Bay, which is used here as background information in assessing shorebird numbers at the Port.

This is the seventh report in the series since 2013 and, as usual, addresses the following:

1. Bird numbers by species and site (individually and overall) at the Port for the last year (2018-19) presented as a table of raw numbers and suitable graph/s.
2. Comparisons of shorebird numbers for important species at the Port with Moreton Bay sites generally, noting any species showing any striking variation between datasets.
3. Presentation of annual changes in shorebird numbers by species for each site within the Port. Site groupings are also compared, although more recently there is only one group of note, Area D, as well as the artificial roost and the claypan. The sites are ranked for importance to shorebirds.
4. Graphical presentation of long-term trends for shorebird numbers at the Port by species. In this context, hypothesised critically low summer counts are calculated as thresholds to compare with future counts that help indicate if the number of birds is dropping significantly.

As usual, the report will focus on the most important shorebird species at the Port, that is, those with particularly high numbers, or highly threatened species with good representation at the Port. A few techniques are being used consistently to, a) to rank the status of subsites within the PoB, b) to assess changes in the ratio (IRI) of birds using the Port lands versus Moreton Bay as a whole, and c) to evaluate critically low counts of individual species.

B. IMPORTANT MIGRATORY SHOREBIRD SPECIES AT THE PORT OF BRISBANE

The following twelve migratory species of shorebird are the main focus of this report. They have all been recorded at some time or another on Port lands, in numbers exceeding 0.1 % of their flyway populations, and mostly in numbers exceeding 1% of flyway numbers (Table 1).

The data in Table 1 are for summer months since 2003. Of particular note is the Great Knot. Table 1 shows a maximum summer count of 708 in 2013. However, numbers in the early 1990s were much higher with a maximum count of 2600 birds and with five years in the nineties of maxima in excess of 1000 birds. Another seven species have had maximum summer counts earlier than 2006. They include the Far Eastern Curlew (Table 1), Greater Sand Plover (1997), Grey Plover, Lesser Sand Plover, Pacific Golden Plover, Red-necked Stint and Sharp-tailed Sandpiper. In contrast, four species (Grey-tailed Tattler, Ruddy Turnstone, Bar-tailed Godwit and Curlew Sandpiper) have had marginally higher numbers in recent years, 2016 or 2017.

Furthermore, the maximum summer count in the latest year of sampling (Table 1) has generally been well below (<70%) the highest maximum recorded since 2003 for all but the Curlew Sandpiper, Pacific Golden Plover and Bar-tailed Godwit and Ruddy Turnstone

Note that the Sharp-tailed Sandpiper and, to a lesser extent the Grey-tailed Tattler, can be counted in higher numbers during the migration periods than over the austral summer, which is illustrated by average count values for these species in different seasons, presented in Appendix C. Also, refer to Figures 2, 4a and 4b for long term variability in average shorebird counts.



Figure 1. Shorebird count sites and site groupings (Areas) within the Port of Brisbane land reclamation zone. The four-character sites codes are used throughout this and previous reports. The claypan roost (FICP) is in the south east of Fisherman Is. It is not shown but is used in the compilation of results. Red lettering indicates sites that are no longer used by shorebirds due to the process of reclamation, and are no longer sampled.

C. RECENT COUNTS OF MIGRATORY SHOREBIRD SPECIES AT THE PORT OF BRISBANE.

Table 2 lists the number of shorebird species and total shorebirds recorded in each of the PoB sites (including the claypan FICP, see Figure 1) on each sampling occasion between September 2018 and August 2019. The tabulations are given for migratory and resident species separately. Counts for each of the twelve “important” species is for each site and month during the past year is given in Appendix A. Appendix B gives the counts of each shorebird species, not just the twelve important species, as monthly totals for the latest yearly round of sampling

In Table 2, sampling has been divided into four time periods as follows: “Winter” (June to August – the northern hemisphere breeding season); “South Migration” (September to mid-November); “Summer” (mid-November to mid-March - non breeding period) and “North Migration” (mid-March to May). This is because these time periods generally represent a breakdown of the activity of a migratory shorebird throughout the year. Such an approach is consistent with previous reports and allows a better understanding of shorebird population dynamics. Hence, the tables to follow sometimes use “shorebird” years not calendar years and are labelled accordingly. That is, the “2018” label represents the period from September 2018 to August 2019.

Table 1. *Important species: the maximum summer count of migratory species of shorebird present in internationally and nationally-significant numbers (> 0.5% flyway population) within the POB reclamation area (including the claypan), during the non-breeding season (15 November – 15 March). Grey Plover has been included as the POB is the most important site for this species in the region. There have been 182 Port wide counts since Sept 2003 & August 2019 (all seasons) and N is the number of times each species was recorded. With the exception of Great Knot, Greater Sand Plover and Grey Plover, all species have been recorded on every Port wide summertime count since 2003.*

Species	Latest max. count for 2018-19	Max. count since 2003 (% flyway popn)	Year of maximum	N (out of 182)
Grey-tailed Tattler	710	1296 (1.9)	2016	170
Red-necked Stint	1505	6803 (1.4)	2003	182
Lesser Sand Plover	1140	2433 (1.4) -	2003	167
Curlew Sandpiper	2192	2607 (2.9) -	2017	181
Sharp-tailed Sandpiper	569	2078 (2.4) -	2005	159
Far Eastern Curlew	291	670 (1.2) -	2006	169
Pacific Golden Plover	836	1090 (0.9)	2006	158
Great Knot	186	708 (0.2) -	2013	134
Greater Sand Plover	223	441 (0.2) -	2006	136
Ruddy Turnstone	156	213 (0.7)	2016	165
Bar-tailed Godwit	1499	1529 (0.5)	2017	177
Grey Plover	44	145 (0.2)	2007	124

Based upon Tables 2 & Appendix C, counts of total migratory and total resident shorebirds and the number of species for each group are consistent with data from past years. There is a wide variation in the numbers recorded at different sites, which is a reflection of both chance occurrence of the birds and the suitability of sites as roosting habitat. The latter will vary depending upon the species. More is given on differential use of sites in the next section. Consistent with previous results, migratory bird numbers are lowest in winter when numbers of resident birds are highest. Migratory numbers peak through the summer months but can also be high during the southward, and even the northward migration. As noted in previous reports, the diversity and concentration of shorebirds using Port lands make it the most important area in the Bay for migratory shorebirds.

Nevertheless, during the 2018 shorebird year, there were only two significant counts within the Port area of greater than 1% of the flyway population. One for the Grey-tailed Tattler and one for the Curlew Sandpiper. Furthermore, total shorebird numbers were lower than in the 2017 shorebird year and the lowest since 2007 (Figure 4). Also, within the

context of normal seasonal variation in numbers, a downward trend in total shorebird numbers is apparent over the last 3 years (Figure 2 -monthly count results). Despite this recent trend, numbers have fluctuated over the longer term and the results don't necessarily infer the downward trend will continue.

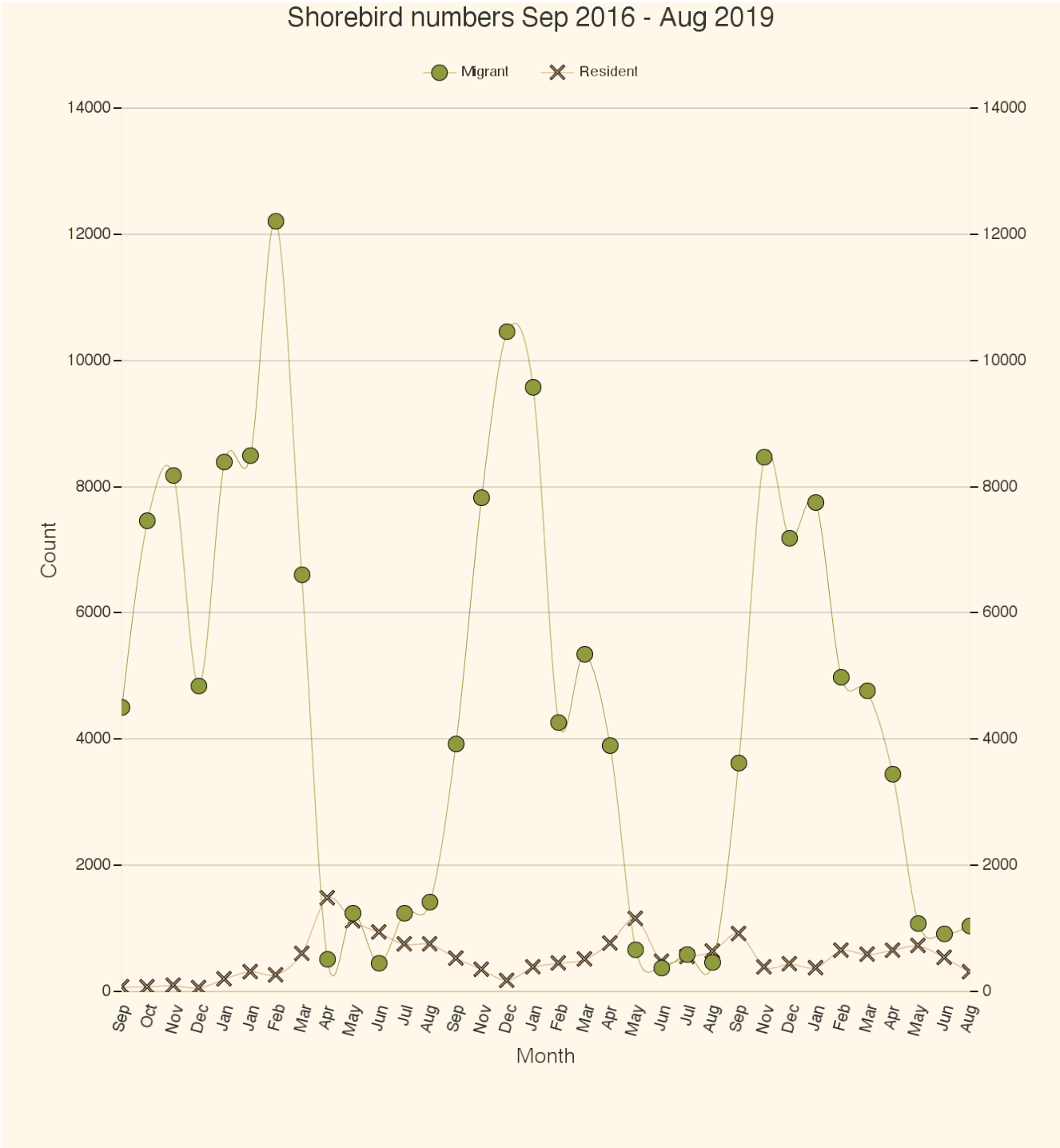


Figure 2. Total shorebird numbers by month between Sep 2016 & Aug 2019 (total monthly Port counts – FITO).

Table 2. Total migratory and resident shorebird counts and species tallies for each PoB site sampled in each month between Sept 2018 and August 2019. The percentage contributions to total number made by each site is included.

	Month of Survey →	Sep 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2018	May 2019	Jun 2019	Aug 2019		
Migratory shorebird totals													
	Season	Sth Migr.	Sth Migr.	Non Br.	Non Br.	Non Br.	Non Br.	Nth Migr.	Nth Migr.	Breeding	Breeding	Year Total	% total counts
Fish. Is Claypan	FICP	286	32	292	78	814	157	388	4	11	338	2400	5.5%
Artificial roost	PBAR	36	722	1607	1149	63	141	74	11		2	3805	8.8%
Pond C2 (D)	PBC2		11	336								347	0.8%
Pond C3 (D)	PBC3	129	972		1387	2013	2636	912	611	566	275	9501	22.0%
Pond R3 (D)	PBR3	2601	5600	2442	2768	1275	1421	213	33	6	240	16599	38.4%
Pond S1 (D)	PBS1		246	50	19	34	38	44		47		478	1.1%
Pond S2 (D)	PBS2	88	5	1537	2	27		302	13	3	5	1982	4.6%
Pond S3 (D)	PBS3	309	1	80	210	29	3	648	238	44	23	1585	3.7%
Pond S4 (D)	PBS4		605	839	1070	733	346	370	83	80		4126	9.5%
Pond FPE (D)	PFPE	180	277		1074		17	455	96	159	165	2423	5.6%
	Total	3629	8471	7183	7757	4988	4759	3406	1089	916	1048	43246	
Additional:													
Lytton Claypan # 1	LYN1	914	179	201	267	413	1570	201	31	77	312	4165	
Migratory shorebird number of species													
	FICP	5	2	6	2	8	5	8	1	1	1		
	PBAR	2	13	11	11	7	7	5	1		2		
	PBC2		1	5									
	PBC3	2	6		8	8	13	6	6	2	6		
	PBR3	6	12	10	9	12	11	5	3	1	2		
	PBS1		3	2	1	2	2	3		1			
	PBS2	5	1	6	1	5		5	1	2	1		
	PBS3	3	1	2	4	4	1	3	1	1	1		
	PBS4		7	7	8	8	8	8	2	3			
	PFPE	4	7		10		3	10	8	8	8		
	LYN1	9	2	2	3	6	7	8	1	3	9		
Resident shorebird totals													
	FICP	183	4	16	7	88	27	10	18	12	6	371	6.6%
	PBAR	136	129	211	42	82	171	109	161	154	225	1420	25.3%
	PBC2		6	84	24						4	118	2.1%
	PBC3	61	39		81	21	189		95	184	11	681	12.1%
	PBR3	517	134	6	11	218	14	67	11	1	5	984	17.5%
	PBS1	5	2	18	14	8	1	1	7	30	10	96	1.7%
	PBS2		5		1	2		17	6	24	3	58	1.0%
	PBS3	8	12	2	7	4		87	3	2	2	127	2.3%
	PBS4	1	17	10	15	13	98	366	399	33	4	956	17.0%
	PFPE	11	48	96	178	216	89	3	25	102	40	808	14.4%
	Total	922	396	443	380	652	589	660	725	542	310	5619	
	LYN1	258	2		2	19	9	26	8	341	467	1132	
Resident shorebird number of species													
	FICP	3	1	2	1	3	2	1	1	2	2		
	PBAR	6	7	7	6	5	4	5	5	3	4		
	PBC2		1	1	1						1		
	PBC3	1	1		2	1	1		2	1	1		
	PBR3	3	3	2	2	2	1	3	2	1	2		
	PBS1	1	1	1	1	1	1	1	2	2	1		
	PBS2		1		1	1		1	1	1	1		
	PBS3	1	1	1	1	1		2	1	1	1		
	PBS4	1	2	2	3	2	4	4	4	2	1		
	PFPE	2	2	2	2	1	3	2	3	3	3		
	LYN1	4	1		1	3	3	2	2	3	5		

D. ANNUAL CHANGES IN SHOREBIRD NUMBERS BETWEEN SITES WITHIN THE POB

Within the PoB reclamation area, shorebirds are now only using ponds in Area D. Furthermore, over the last few years they have stopped using pond C1 (site PBC) within Area D. Last year's report illustrated the longer-term history of changes in bird use of the Port area as reclamation proceeds. Area D, the artificial roost (PBAR) and the claypan (FICP) now constitute what remain of the PoB shorebird habitat.

However, within Area D, there are 8 subsites that are sampled. This section examines the distribution of shorebirds within area D, together with the other two sites being sampled on Fisherman Islands (PBAR and FICP). The eight sites within Area D are: C2, C3, R3, BS1, BS2, BS3, BS4 & FPE (Figure 1).

Rather than plot the temporal series of count data over several years across the ten sites (see Figure 2 & Appendix C), another approach is taken to understand year to year changes in use of the sites by migratory shorebirds within the PoB. Each of the ten sites was ranked between 1 to 10 in the following categories with high value equating to low rank (1 the best):

- total number of migratory shorebirds recorded for the shorebird year (from Table 2),
- average number of migratory shorebird species recorded for the shorebird year (from Table 2) and
- an average rank for each site based upon individual site rankings using total birds counted throughout the shorebird year for each of the 12 important species (Appendix A).

For each site, the average of these three rankings was used as a measure of the status of the site for a particular year, as shown for the past two years in Table 3. The lower the ranking the higher the status of the site as shorebird roosting habitat.

Table 3. Derived rank of relative importance of the ten sampling sites currently in use at the POB based upon data from Tables 2 & Appendix A. The rankings are for "shorebird" years and the data used for other than the latest year, can be found in previous reports. For each site, a ranking that is better than the other year (s) is colour coded "green" & "yellow" if the ranking is worse.

Site	Site code	Rank 2018	Rank 2019	Change
Area D - R3	PBR3	1.7	1.4	-0.3
Area D - C3	PBC3	3.2	3.0	-0.2
Claypan	FICP	3.3	6.1	2.8
Area D - FPE	PFPE	3.8	4.1	0.3
Area D - BS4	PBS4	5.5	4.3	-1.2
Area D - BS3	PBS3	6.2	7.7	1.5
Area D - BS2	PBS2	6.8	6.6	-0.2
Artificial roost	PBAR	6.9	3.9	-3.0
Area D - C2	PBC2	8.6	9.4	0.8
Area D - BS1	PBS1	9.0	8.5	-0.5

The ranking of sites has changed somewhat between the 2018 and 2019 shorebird years, which is indicated in Table 3. The rankings of the top 4 sites in 2018 remain about the same except that the claypan (FICP) is ranked nearly 3 places lower in 2019. Also, while BS4 has a slightly improved rank at 4.3, the biggest improvement (-3) has been with the artificial roost, which has jumped 3 rankings to about 4th. Nevertheless, migratory shorebirds are still concentrating their roosting activities just behind the front line of reclamation running between the north west in BR3, through BC3 and into BS4 and PFPE. The BS3 site has been slightly less favoured more recently.

The reasons for the lower ranking of the claypan and higher ranking of the artificial roost is at present unclear.

E. COMPARISON OF SHOREBIRD NUMBERS BETWEEN THE POB AND MORETON BAY AS A WHOLE

This section presents a comparison of migratory shorebird numbers between the POB reclamation area (including the claypan) and Moreton Bay as a whole. In order to make temporal comparisons, an index of the relative importance (IRI) of the POB has been developed, which is applied to each of the twelve "important" species (Table 1). Temporal changes in the index for each species are tabulated in Table 4 for the shorebird years 2016 to 2018.

The IRI is calculated for each month between September to April each year (Eq. 1). It is the ratio of counts for the PoB compared with averaged (where more than 1 count a month) and summed counts across the whole of Moreton Bay, including the POB. Usually there is a single count each month at the Port (no average) and sometimes a count is missed. In the latter case, the relevant month is omitted from calculations. For each year, the relevant IRI measures are averaged across months and tabulated for the shorebird years between 2016 to 2018 in Table 4. Temporal changes in the IRI would be expected to reflect local changes in the relative importance to the species of the PoB lands compared with Moreton Bay as a whole.

$$IRI = \frac{\text{Port of Brisbane count}}{\text{Moreton Bay count}} \quad (1)$$

The IRI can vary between zero and one, with a value of 1 meaning all birds of that species were counted within the PoB (10 sites together).

The results are colour coded in the table as green for highest, yellow for lowest and graded green to yellow for in between. It is evident that 2016 had the highest IRI for nine of the twelve species, whereas the index was highest for two others in 2017 and for Sharp-tailed Sandpiper highest (marginally) in 2018. Generally, the indices did not vary for each species by more than about 10% between years, the exceptions being the Ruddy Turnstone and the Sharp-tailed Sandpiper. The majority of species showed their lowest recorded IRI for the year in 2017. There was far greater variability between species, not unexpectedly given the varying habitat requirements of the species concerned.

In last year's report, the general drop in the IRI between 2016 and 2017 was noted. It appears that this tendency may not be continuing as the IRI values for 2018 show some improvements. Nevertheless, because the PoB has predominantly transitory habitat there remains the concern that, in the long term, shorebirds may suffer population declines in Moreton Bay generally due to a lack of suitable roosting habitat as land reclamation at the Port proceeds to conclusion.

Table 4. Index of relative importance (IRI) for the POB, average for each of the last three shorebird years for each of the twelve "important" species (Table 1). Colour coding for the three years is green: highest; yellow: lowest and graded green to yellow in between.

	Mean proportion of the Moreton Bay Population (IRI) in succeeding shorebird years (Sept to August)		
	2016	2017	2018
Species			
Bar-tailed Godwit	0.21	0.16	0.15
Curlew Sandpiper	0.68	0.84	0.71
Far Eastern Curlew	0.16	0.07	0.12
Great Knot	0.36	0.35	0.31
Greater Sand Plover	0.72	0.63	0.61
Grey Plover	0.85	0.70	0.79
Grey-tailed Tattler	0.43	0.31	0.36
Lesser Sand Plover	0.71	0.76	0.67
Pacific Golden Plover	0.57	0.44	0.49
Red-necked Stint	0.51	0.51	0.40
Ruddy Turnstone	0.66	0.36	0.54
Sharp-tailed Sandpiper	0.40	0.25	0.42

F. LONG TERM TRENDS IN SHOREBIRD NUMBERS

Data are available since 1991, however consistency in sampling procedures has been best since 2003. The data presented in Figure 3 are for migratory shorebirds for different seasons across the PoB lands, including the claypan (FICP) from 2003 until mid 2019. Mean and maximum values for summer and mean values for other seasons are graphed. Seasons are defined in Section C and the “shorebird” year is the relevant unit of comparison up until “2018” (Sep 2018 to end of Aug 2019). The corresponding values for resident shorebirds are given on a separate graph in Figure 3, however for resident shorebirds, the maxima are for any time of year. Yearly, mean summer counts for each of the twelve “important” migratory species are plotted in Figure 4a and 4b.

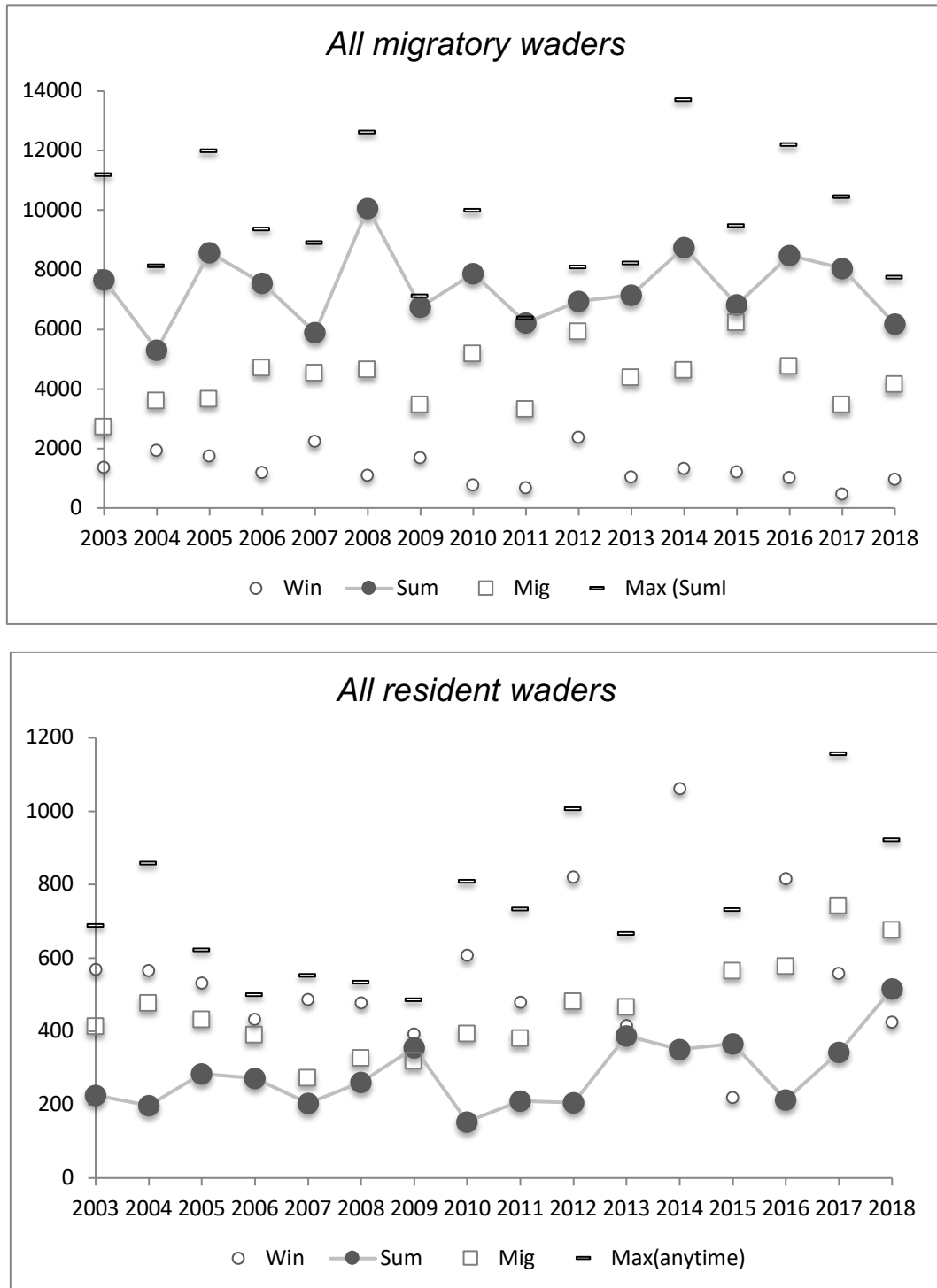


Figure 3. Average counts for each season and “shorebird” year since 2003 for all migratory and all resident shorebirds throughout the Port lands, including the claypan (FICP). Win: winter (Jun to Aug); Sum: summer (mid-Nov to mid-March); Mig: migration periods (south – Sep to mid-Nov and north – mid-March to end of May). The “shorebird: year runs from the southward migration through to winter.

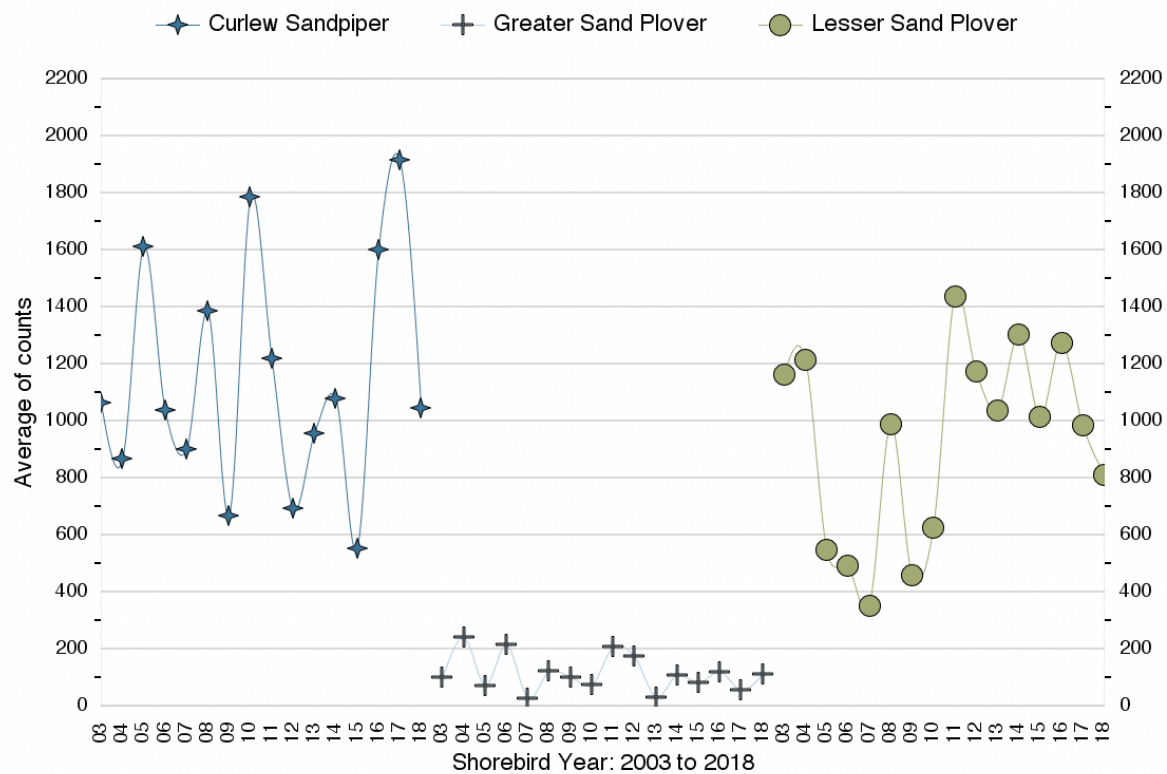
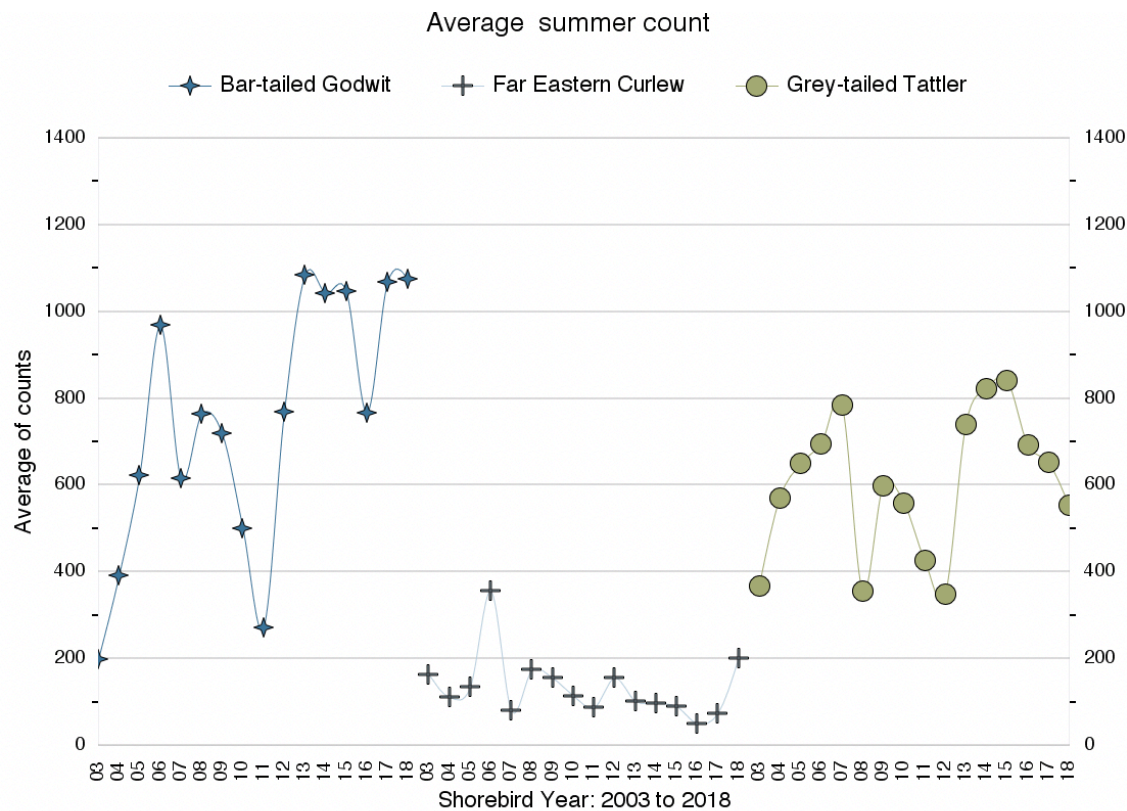


Figure 4a. Temporal variation in PoB average summer counts (mid Nov-mid Mar) for six “important” species. These and maximum counts together with average winter and migration period counts are tabulated in Appendix A for each shorebird year between 2003 and 2018.

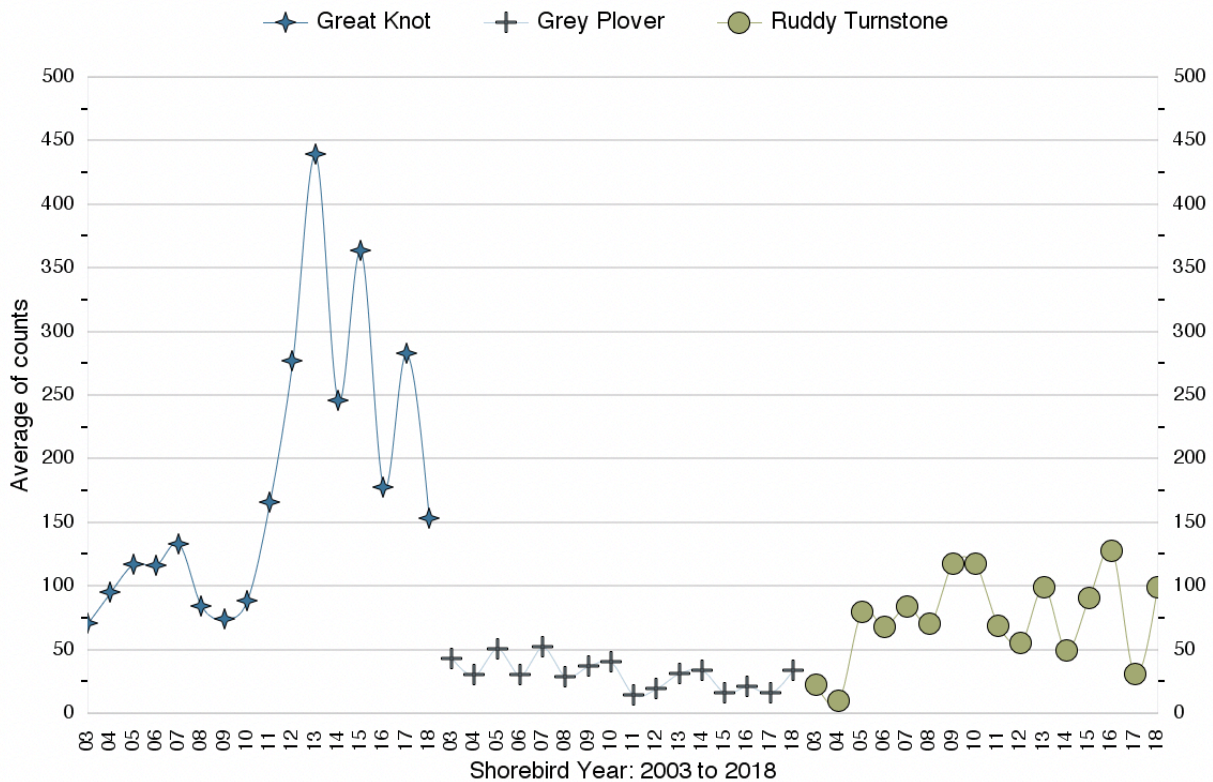
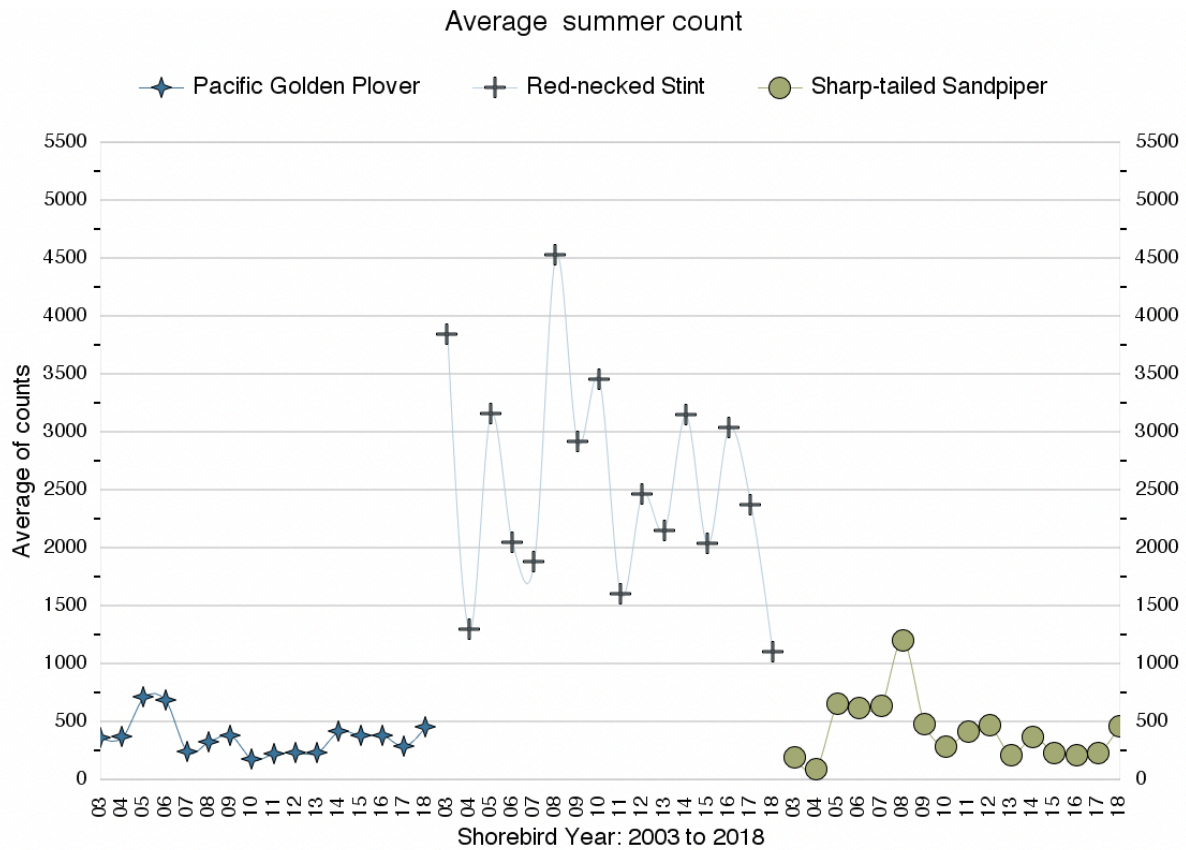


Figure 4b. Temporal variation in PoB average summer counts (mid Nov-mid Mar) for the other six “important” species. These and maximum counts together with average winter and migration period counts are tabulated in Appendix A for each shorebird year between 2003 and 2018.

The mean summer value for migratory shorebirds is the lowest recorded since 2007, and the 3rd lowest since 2003. It is 16% lower than the mean yearly summer value of 7393 birds over 16 years of sampling. As noted earlier in Section C, it remains to be seen if the latest year's results reflect more than "normal" temporal variation in shorebirds at the PoB. In contrast, resident shorebird numbers for both summer and winter have been quite high for the last two years.

The species of migratory shorebird that have dropped in numbers over the last few years include the Grey-tailed Tattler, Lesser Sand Plover, Great Knot, Red-necked Stint and Curlew Sandpiper. In contrast, Bar-tailed Godwit have recently been recorded in higher numbers than in the past. Far Eastern Curlews had their second highest recorded summer average in 2018, although prior to this were showing gradually falling yearly counts. There is a similar suggestion of a pattern of decline and a recent higher count with the Sharp-tailed Sandpiper and Grey Plover. There is no recent indication of a decline in numbers of the Pacific Golden Plover or Ruddy Turnstone, and it is especially difficult to say with the Greater Sand Plover (Figures 4a, 4b)

G. CRITICAL COUNT VALUES OF EACH IMPORTANT SPECIES

The critical low count value for summer counts of each of the "important" species at the PoB have been calculated based upon data for shorebird years between 2003 and 2010, and separately for 2011 to 2018 (Table 5). These threshold values were not used in the last PoB report; however, they were a part of earlier reports from 2013 onwards and are now being re-introduced.

The values are calculated as the lower 90% confidence limit of the samples of all summer counts of each species within time frames as stated above (see Table 5). As is appropriate for raw counts of bird numbers, a natural logarithmic transformation is applied to the sample values to create a "normal distribution" that is needed in deriving a standard deviation, and hence confidence limits of a sample mean. Nil counts have been included in these calculations, which is made possible by uniformly adding 1 to each count before taking the log of the value (the log of zero is undefined mathematically). The 90% lower confidence limit represents a threshold value, below which only 1 in 20 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.

Table 5. "Important" species summer means and lower 90% confidence limits (derived from log transformed data) 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 PoB.

Period (shorebird yrs)->	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

Table 5 uses two periods of sampling, that is, during and before 2010 and after 2010 ("shorebird" year). Both sets of data incorporate eight years of sampling and 2010 does appear to herald some noticeable changes in counts of the important species (Figure 4). For some species the sample mean for the earlier sampling is higher and for some it is lower than for sampling after 2010. Two striking examples of higher sample means after 2010 are for the Bar-tailed Godwit and for the Great Knot. Obvious examples of lower values are for the Far Eastern Curlew and the Grey Plover. Colour coding is used in Table 5 to indicate whether the mean is higher (green) or lower (yellow) than the adjoining

mean for each species. Each mean has an associated threshold value, as noted above, 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 in Table 5. Future counts of each species will be evaluated and reported on if they don't reach the critical threshold value.

H. RECOMMENDATIONS

Because of variability in shorebird counts from month to month and from year to year, long term changes in numbers are difficult to discern. Nevertheless, presentation of the data suggests that numbers of many of the important species are changing over the long term. Several species appear less abundant and some more abundant than they were perhaps a decade ago. However, solid evidence is still lacking and there is the complication that the Port reclamation lands may be attracting birds that previously would have roosted elsewhere in Moreton Bay. There is evidence (not presented here) that this may be the case. It is proposed that this possibility be carefully considered as part of next year's annual report. In the meantime, counts should be monitored for instances of values below the critically low threshold values presented in Section G.

A list of recommendations is given below, much of which is a reaffirmation of previous recommendations. As each year passes and the Port development proceeds, consideration must be given to the time when reclamation draws to a close with the accompanying decrease in the extent of local shorebird roosting habitat. It is encouraging that recently the artificial roost site recorded an improved ranking as suitable shorebird habitat within the Port lands. Nevertheless, it still ranks only 4th amongst the ten sites that are being monitored. It is recommended that:

- The monitoring of shorebirds within the POB lands continue with the same intensity. From month to month, low counts should be scrutinised to be sure no values are falling below the tabulated critical thresholds.
- There be analysis of patterns of habitat type use by shorebirds based on more specific habitat parameters. Such an analysis would help indicate the appropriate proportion and extent of each habitat that is required to support the existing shorebird populations as reclamation continues. It would help identify those species with less flexibility in habitat choice. It would potentially identify habitat construction/maintenance priorities and options. This type of approach is already being undertaken using anecdotal evidence through consultations between QWSG and POB, especially in the context of management of the artificial roost site (PBAR). Possible relevant habitat features might include wet margins of ponds, dry rubble/broken ground and shallow pools up to 5 cm deep and bund wall. Other considerations are substrate wetting and drying cycles through seasonal effects but also as a response to the mechanics of reclamation.
- Serious consideration be given to the long-term outcome for shorebirds on POB lands once the extensive reclamation project draws to a close, when much of the current habitat will inevitably disappear. All shorebird habitat types must remain available in sufficient quantity over the long term to sustain the numbers, balance and diversity of shorebird species that currently use the Port lands.
- The POB recognise the Port environment as a major component of shorebird habitat in Moreton Bay and undertake more thorough analysis of the shorebird distribution and numbers throughout the Bay in order to better understand the monitoring results that are being collected from within the Port.
- The POB work with other stake holders, including researchers and managers of shorebirds and other relevant organisations and government agencies that operate within Moreton bay, to develop Bay wide strategies to sustain Moreton Bay as a premier shorebird site in Australia.

Appendix A (4 pages): Shorebird counts for each important species at each site within the Port lands during the 2018-19 “shorebird year”. Seasons are winter (breeding), summer (non-breeding) and migration (south and north migrations).

Species group 1 (App B: 1st of 4 pages). Counts of Grey-tailed Tattler, Red-necked Stint and Sharp-tailed Sandpiper.

Season->	Sth Migr.		Non Br.				Nth Migr.		Breeding		
Month of Survey →	Sep 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2018	May 2019	Jun 2019	Aug 2019	Total
Grey-Tailed Tattler											
FICP											
PBAR					7	1					8
PBC2											
PBC3						24					24
PBR3		472				235					707
PBS1											
PBS2											
PBS3											
PBS4		375	710	679	547				3		2314
PFPE		4				10	407		1	5	427
Total		851	710	679	554	270	407		4	5	3480
LYN1 *											
Red-necked Stint											
FICP	28	30	187	72	125	125	156	4	11		738
PBAR		35	26	60	23	52	58	11			265
PBC2		11	248								259
PBC3	104	317		548	483	682	140	541	538	169	3522
PBR3	821	1834	458	167	4	72	16	5	6	190	3573
PBS1		91	3		12		30		47		183
PBS2	1	5	473	2	2		275		1		759
PBS3	101		79	149	21		641	238	44	23	1296
PBS4		179	31	154	60	66	259				749
PFPE	167	204		27			1		4	17	420
Total	1222	2706	1505	1179	730	997	1576	799	651	399	11764
LYN1 *	36			104	74	88	11		56		369
Sharp-tailed Sandpiper											
FICP	3		23	6	6	2	11				51
PBAR	2	113	14	68	18	21	10				246
PBC2			5								5
PBC3				61	65	4					130
PBR3	9	330	469	172	318	269	77	26			1670
PBS1			47	19	22	26	10				124
PBS2					11		2				13
PBS3				12	5	3	1				21
PBS4		4	11	25	31	89	46	79			285
PFPE				10		6			1		17
Total	14	447	569	373	476	420	157	105	1		2562
LYN1 *	34				3	175	1			17	230

Species group 2 (App B: 2nd of 4 pages). Counts of Curlew Sandpiper, Great Knot and Bar-tailed Godwit.

Season->	Sth Migr.		Non Br.				Nth Migr.		Breeding		
Month of Survey ->	Sep 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2018	May 2019	Jun 2019	Aug 2019	Total
Curlew Sandpiper											
FICP			1		3		82				86
PBAR		63	39	29	6	26	3				166
PBC2			53								53
PBC3		20		276	223	101	6	26		29	681
PBR3	1716	2088	917	1725	75	35	19	2		50	6627
PBS1		11									11
PBS2			369		1		3				373
PBS3	207		1	47	1		6				262
PBS4		42	17	107	19	99	23				307
PFPE	1			8			5	6	29	7	56
Total	1924	2224	1397	2192	328	261	147	34	29	86	8622
LYN1 *	17	1		4		704	55		16	107	904
Great Knot											
FICP											
PBAR		2	185	58							245
PBC2											
PBC3						105					105
PBR3	14	194	1	74	130	41					454
PBS1											
PBS2											
PBS3	1										1
PBS4											
PFPE				19			1				20
Total	15	196	186	151	130	146	1				825
LYN1 *	8				3	6	1				18
Bar-tailed Godwit											
FICP	250				402		10				662
PBAR	34	461	1318	893		39					2745
PBC2											
PBC3		10		23	27	88					148
PBR3	28	529		328	519	395					1799
PBS1											
PBS2											
PBS3											
PBS4					8			4	69		81
PFPE		1		255		1	23	26		25	331
Total	312	1001	1318	1499	956	523	33	30	69	25	5766
LYN1 *	285				118	240	1			1	645

Species group 3 (App B: 3rd of 4 pages). Counts of Far Eastern Curlew, Pacific Golden Plover and Ruddy Turnstone.

Season->	Sth Migr.		Non Br.				Nth Migr.		Breeding		
Month of Survey ->	Sep 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2018	May 2019	Jun 2019	Aug 2019	Total
Eastern Curlew											
FICP			64		249	1	17			338	669
PBAR		2	1	1	2	1					7
PBC2											
PBC3				12							12
PBR3		57	4	278	9	182	3				533
PBS1		144									144
PBS2											
PBS3											
PBS4							3				3
PFPE								10			10
Total		203	69	291	260	184	23	10		338	1378
LYN1 *	488	178	199	159	174	321	18	31	5	159	1732
Pacific Golden Plover											
FICP		2	5		9	18	11				45
PBAR		6	5	2	2		2				17
PBC2											
PBC3	25	547		446	815	308	3	21		59	2224
PBR3		1	4		1	1					7
PBS1						12	4				16
PBS2	80		106		9			13			208
PBS3		1									1
PBS4		1		1							2
PFPE	5	6		87			8	29	45		180
Total	110	564	120	536	836	339	28	63	45	59	2700
LYN1 *			2								2
Ruddy Turnstone											
FICP					1						1
PBAR											
PBC2											
PBC3					7	16					23
PBR3		4	20	1	26	123	98				272
PBS1											
PBS2	2		23								25
PBS3											
PBS4		3	30	70	43	17	6				169
PFPE		8		19			6	1	17	11	62
Total	2	15	73	90	77	156	110	1	17	11	552
LYN1 *											

Species group 4 (App B: 4th of 4 pages). Counts of Lesser Sandplover, Greater Sandplover and Grey Plover.

Season->	Sth Migr.		Non Br.				Nth Migr.		Breeding		
Month of Survey ->	Sep 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2018	May 2019	Jun 2019	Aug 2019	Total
Lesser Sandplover											
FICP											
PBAR											
PBC2			27								27
PBC3		68		20	381	1103	716	11		10	2309
PBR3		4	485	18	156	35					698
PBS1											
PBS2	3		386		4		20				413
PBS3					2						2
PBS4				4	2	2	4				12
PFPE	7	52		622			1	1	61	95	839
Total	10	124	898	664	545	1140	741	12	61	105	4300
LYN1 *											
Greater Sandplover											
FICP											
PBAR											
PBC2			3								3
PBC3		10		1	12	195	38	2		1	259
PBR3			40	5	2						47
PBS1											
PBS2	2		180								182
PBS3											
PBS4											
PFPE		2		5			1			3	11
Total	2	12	223	11	14	195	39	2		4	502
LYN1 *											
Grey Plover											
FICP											
PBAR											
PBC2											
PBC3						3					3
PBR3	13	44	44		34	33					168
PBS1											
PBS2											
PBS3											
PBS4									8		8
PFPE				22			2	4		2	30
Total	13	44	44	22	34	36	2	4	8	2	209
LYN1 *											

Appendix B (1 page): Shorebird counts (all species) for each month on the Port Lands - Sep 2018 to Aug 2019
 2019
 (2018 “shorebird year” and no counts for Oct 2018 or July 2019)

Date	Sep 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2018	May 2019	Jun 2019	Aug 2019	
Migratory wader count (#spp)	3629(12)	8471(19)	7183(18)	7757(16)	4989(17)	4760(18)	3407(17)	1089(11)	916(10)	1048(13)	
Resid. wader count (#spp)	922(6)	396(7)	443(7)	380(7)	652(6)	589(6)	660(7)	725(6)	542(6)	310(6)	
Total waders	4551	8867	7626	8137	5641	5349	4067	1814	1458	1358	Total
Asian Dowitcher		1	1								2
Bar-tailed Godwit	312	1001	1318	1499	956	523	33	30	69	25	5766
Black-fronted Dotterel	2	2	2	1	2		2	2	2	1	16
Black-tailed Godwit		1	1	1	1		13				17
Broad-billed Sandpiper		1	38	33	23	76	30				201
Buff-breasted Sandpiper					1	1	1				3
Common Greenshank		4		6	5	2				1	18
Curlew Sandpiper	1924	2224	1397	2192	328	261	147	34	29	86	8622
Double-banded Plover	1					1	10	29	31	12	84
Far Eastern Curlew		203	69	291	260	184	23	10		338	1378
Great Knot	15	196	186	151	130	146	1				825
Greater Sand Plover	2	12	223	11	14	195	39	2		4	502
Grey Plover	13	44	44	22	34	36	2	4	8	2	209
Grey-tailed Tattler		851	710	679	554	270	407		4	5	3480
Lesser Sand Plover	10	124	898	664	545	1140	741	12	61	105	4300
Marsh Sandpiper										1	1
Masked Lapwing	2	1	1	1	5	6	2	5	5	2	30
Pacific Golden Plover	110	564	120	536	836	339	28	63	45	59	2700
Pied Oystercatcher	9	54	94	183	229	165	148	78	28	33	1021
Pied Stilt	411	235	212	33	145	172	150	219	183	221	1981
Red Knot		44	3								47
Red-capped Plover	117	93	120	142	66	239	32	153	256	51	1269
Red-kneed Dotterel		1	1				1				3
Red-necked Avocet	381	10	13	17	205	4	325	268	68	2	1293
Red-necked Stint	1222	2706	1505	1179	730	997	1576	799	651	399	11764
Ruddy Turnstone	2	15	73	90	77	156	110	1	17	11	552
Sanderling		1									1
Sharp-tailed Sandpiper	14	447	569	373	476	420	157	105	1		2562
Sooty Oystercatcher				3		3					6
Terek Sandpiper			2			2					4
Whimbrel	4	32	26	30	19	11	89				211

Appendix C (1 page): “Important species” average and maximum summer counts, and average winter and migration period counts (north and south) - Sept 2003 to Aug 2019 (shorebird years 2003-2018)

Species	ShBdYear-->	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Bar-tailed Godwit	Sum	198	391	623	968	615	764	718	500	272	768	1084	1042	1047	766	1067	1074
	Max (Sum)	461	401	874	1235	657	913	942	577	344	1283	1481	1185	1356	1066	1529	1499
	Mig	518	260	464	669	547	597	384	511	130	499	742	594	801	581	425	344
	Win	435	397	557	395	342	326	573	88	37	53	292	146	28	132	32	47
Curlew Sandpiper	Sum	1062	865	1612	1037	899	1387	667	1784	1218	691	956	1078	553	1599	1914	1045
	Max (Sum)	1418	2298	2289	1813	1855	2007	768	2086	1746	697	2040	1671	849	2443	2607	2192
	Mig	184	676	530	481	527	620	324	1043	660	880	462	477	937	806	712	1082
	Win	50	160	58	28	244	63	185	96	62	50	101	188	70	477	32	58
Far Eastern Curlew	Sum	163	111	133	355	80	173	155	114	87	156	102	97	90	51	74	201
	Max (Sum)	244	186	280	670	164	212	227	128	105	259	119	165	122	133	117	291
	Mig	38	88	83	63	69	105	83	74	100	153	140	106	91	62	17	79
	Win	134	32	34	67	43	56	59	41	67	107	29	49	34	35	14	169
Great Knot	Sum	71	95	117	117	133	84	74	89	166	277	439	246	363	177	283	153
	Max (Sum)	123	221	210	185	183	111	112	160	180	515	708	534	596	379	580	186
	Mig	304	104	99	115	87	53	103	98	358	203	261	449	156	175	148	71
	Win	1		1		20	10	5	1	3	2	33	86			1	0
Greater Sand Plover	Sum	99	240	71	215	28	121	102	74	207	173	31	109	82	120	56	111
	Max (Sum)	404	415	158	441	42	185	216	146	432	336	80	226	133	287	103	223
	Mig	1	40	37	19	83	129	26	27	82	129	5	64	61	43	48	14
	Win	1	61	1		1		6	50	23	4		1				2
Grey Plover	Sum	43	30	51	30	52	29	37	40	14	20	32	34	16	21	16	34
	Max (Sum)	55	51	59	45	145	32	45	45	23	33	40	38	52	38	33	44
	Mig	21	17	11	13	35	27	23	19	30	10	19	21	12	11	16	16
	Win	5	1	7		9		5					3		4		5
Grey-tailed Tattler	Sum	368	572	649	696	786	356	599	560	428	349	740	824	841	692	653	553
	Max (Sum)	496	890	801	960	1288	584	1105	568	478	413	803	1230	1175	1296	1259	710
	Mig	288	476	415	488	509	527	491	455	271	441	532	577	550	250	89	629
	Win	232	419	360	149	197	362	22	15	33	254	375	357	265	55	11	5
Lesser Sand Plover	Sum	1164	1216	549	493	353	989	461	625	1438	1173	1036	1303	1013	1275	986	812
	Max (Sum)	2433	1664	823	605	954	1256	643	833	1458	1856	1424	1929	1409	1804	1138	1140
	Mig	294	277	212	345	390	479	276	485	550	640	462	543	322	577	553	222
	Win	101	65	37	49	85	12	46	123	19	15	21	41	28	36	3	83
Pacific Golden Plover	Sum	363	367	711	682	242	327	381	175	223	233	233	419	379	384	289	458
	Max (Sum)	455	755	902	1090	303	372	546	201	298	418	301	664	575	464	399	836
	Mig	118	183	276	265	167	117	113	137	148	112	159	175	208	157	117	191
	Win	18	46	20	11	18	9	15	3	6	2	22			4		52
Red-necked Stint	Sum	3841	1294	3153	2043	1882	4525	2914	3451	1602	2463	2151	3145	2033	3040	2369	1103
	Max (Sum)	6803	2383	5239	2978	2623	5586	3547	4791	2015	3323	3143	6669	4111	4666	3902	1505
	Mig	1072	1292	1236	1964	1366	1513	1401	1887	1112	2381	1270	1183	2207	2022	1246	1576
	Win	525	735	591	460	1176	527	709	349	441	1933	153	432	817	332	393	525
Ruddy Turnstone	Sum	23	10	80	68	84	70	118	118	69	56	100	49	91	128	31	99
	Max (Sum)	46	22	207	134	113	104	166	136	104	91	131	75	127	213	37	156
	Mig	5	12	63	47	80	112	55	76	80	28	55	33	56	27	14	32
	Win		31	75	31	108	15	55	28	27	6	11	2	4	19	6	14
Sharp-tailed Sandpiper	Sum	193	97	658	622	641	1208	485	286	421	469	211	367	235	209	228	460
	Max (Sum)	454	226	2078	1082	1201	1680	774	446	610	476	258	832	504	304	434	569
	Mig	90	227	175	217	868	283	279	218	167	388	129	606	465	184	196	181
	Win	4		1	4	14	64	3	1	8	3	7	78	5	1	1	1