ANALYSIS OF THE STATUS OF WADERS

IN THE PORT OF BRISBANE

BETWEEN JULY 2016 AND JUNE 2017

Includes an analysis of historical trend in counts and

comparison with Moreton Bay populations

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EXECUTIVE SUMMARY

2017 Update

The monthly total counts of migratory waders in the POB reclamation in 2016 – 2017 were among the highest made since intensive monitoring began in 2003. The higher overall counts were the result of above average counts of Curlew Sandpiper and Red-necked Stint. The total counts of resident species were similar to the long term average across the 14 years of monitoring. The most important reclamation ponds were PBS3 and PBC3 with other ponds having much fewer waders. The POB reclamation area remains locally, regionally and nationally important for migratory waders. The relative importance of the POB reclamation area in Moreton Bay has stabilised for most species and shows no long term trend. There are only two species that continue to show an increasing trend in the proportion of the Moreton Bay counts present (Great Knot and Greater Sand Plover). One species, Red-necked Stint is now showing a decreasing trend in the proportion of the Moreton Bay population roosting within the POB reclamation area. This species had shown an increasing trend in previous reports. The summer average counts of 10 of the 12 most abundant migratory wader species were below the updated low count thresholds for each species. Greater Sand Plover and Red-necked Stint were the only species that did not have a lower count than predicted in at least one month. These low monthly counts below their threshold during mid-summer were spread across all months (Nov – March) (Table 7). The reasons that counts were below these low count triggers varied between species. For eight of the 10 species, QWSG counts in Moreton Bay suggest that the species has redistributed away from the POB reclamation area. For the other two species (Sharp-tailed Sandpiper and Pacific Golden Plover), the number of birds counted in Moreton Bay by QWSG was also well below the long term average. The long term trends in counts of two other species (Eastern Curlew and Grey Plover) have continued to decrease within the POB reclamation area.

Two wader banding events were undertaken in the POB reclamation area in 2016 – 2017, but only one successfully captured birds. This events caught 48 waders of six species and these were mostly Red-necked Stint. All waders were fitted with individually-labelled lime green leg flags to allow resighting of individual birds. Seven individuals of three species caught in 2016 – 2017 were resighted elsewhere in Moreton Bay during the remainder of 2016 – 2017. Overseas sightings of waders caught in the POB reclamation area continued to increase in 2016 – 2017. A total of 12 resightings of three species have been made during migration. Overseas resightings have now been made in three countries on northward migration: Korea and Taiwan (Great Knot) or Japan (Bar-tailed Godwit, Great Knot and Pacific Golden Plover) and four countries on southward migration: Russia, China, South Korea and Japan (Great Knot and Pacific Golden Plover).

Overall summary

For over two decades, high numbers of migratory waders have used Port of Brisbane reclamation area as high tide roosting habitat. The waders have responded to changing configurations of suitable roosting habitat as the engineering process of bunding, infilling, settlement and capping of subsections of the site have

progressed. This is the fifth annual report on the status of waders in the reclamation area. This report updates the previous report (October 2016) and highlights any changes that have occurred during the year.

POB Pty Ltd has detailed reports on bird usage of the reclamation area throughout the 1990s. Since 2003, the Queensland Wader Study Group have undertaken regular monthly counts of birds in the reclamation area, the nearby claypan and at the purpose-built artificial high tide roost. The species that are most important within the POB reclamation area are identified and their numbers in the POB reclamation area compared with their numbers across the whole of Moreton Bay. Counts made in each pond that is in the process of reclamation between July 2016 and June 2017 are tabulated. Annual changes since 2003 in the distribution of roosting birds across the reclamation area are also presented.

There are twelve important species within the POB reclamation area that include the Ruddy Turnstone, four plover species (Lesser and Greater Sand Plovers, Pacific Golden Plover and Grey Plover), three large sandpipers (Eastern Curlew, Bar-tailed Godwit and Great Knot) and four smaller sandpipers (Grey-tailed Tattler, Sharp-tailed Sandpiper, Curlew Sandpiper and Red-necked Stint).

Where practical, data are presented for each time of sampling. Alternatively, mean or maximum values are given for each of four periods of the year but with a focus on the main period of occupancy during the non-breeding season of the birds from mid-November to mid-March. Grouped data for all migratory wader species and all resident wader species are also presented.

As expected, numbers of migratory waders are highest during the summer months and as many as 18 species were recorded at any one time during the summer. Numbers of resident waders were substantially higher during the winter months in 2016 – 2017. Over the last decade, the numbers of most species of migratory wader have remained stable and the reclamation area remains the most important single roosting area for waders in the whole of Moreton Bay (and south-east Queensland). The data suggest that the relative importance of the reclamation area for two species of wader (Great Knot and Greater Sand Plover) may have increased since 2003. The proportion of Moreton Bay counts of Red-necked Stint roosting within the POB reclamation area has decreased during the same period.

Subsections of the POB land have been used to show changes in the distribution of waders across the reclamation area over time. There is a clear indication of the way in which birds alter their choice of roosting area as reclamation proceeds. They move to where fresh dredge material is being deposited and then move on as deposition stops and the material is allowed to dry and form a crust. For the areas that are currently in use by waders, more detailed spatial records are presented. For individual species it should be possible to relate the choice of habitat to the nature and condition of the substrate but this is beyond the scope of this report.

For the POB reclamation area as a whole since 2003, the pattern of annual change in counts varies between species but without any significant trend in overall abundance of waders. These patterns are described and continued sampling will help to establish whether there are cyclical patterns or distinct increasing or decreasing trends in counts. Eastern Curlew and Grey Plover counts may need closer scrutiny as 2016 – 2017

had the lowest mean summer count since QWSG began monitoring in 2003. Low count thresholds for each of the twelve species that have substantial populations in the POB land are tabulated. A decrease in the counts of birds of any species below the threshold during a November – March survey can serve as a trigger to illicit further investigation and/or management responses at the site.

BACKGROUND

The Port of Brisbane Pty Ltd (POB) reclamation area attracts large populations of migratory waders at high tide. These birds are attracted to the large area of feeding and roosting habitat provided by the pumping of dredge material. Members of the Queensland Wader Study Group (QWSG) have been counting the POB reclamation area and nearby claypan since 1991. These counts have been undertaken monthly since 2003 when POB and QWSG commenced a formal arrangement under a management plan required by the federal government's EPBC Act. The management plan was developed as part of the approval for the development of the port reclamation expansion. These data provide a long time series of wader and waterbird counts with which to examine the relative importance of the reclamation area for waders. At the same time, QWSG members have also made monthly counts at between 50 and 65 other high tide roosts in Moreton Bay.

The Port of Brisbane Pty Ltd approached the Queensland Wader Study Group to undertake an annual assessment of the status of migratory waders within their lands in November, 2012. The fifth of these annual assessments will summarise data collected to June 2017 and include:

1. Bird numbers by species and site (individually and overall) at the Port for the last year presented as a table of raw numbers and suitable graph/s.
2. Comparison of wader numbers by species at the Port with a suitable background site or sites. Identify any species where there has been a significant difference between the Port and the background sites.
3. Graphical presentation of annual changes in wader numbers by species for each subgroup of sites and within the most recently preferred sites (subgroup D).
4. Graphical presentation of long term trends for wader numbers at the Port by species.

For all of the above POB only want a report on the most important species at the port (i.e. high numbers at the Port or highly threatened with relatively significant numbers at the Port).

5. Summary of the recoveries of waders caught and banded on the Port of Brisbane reclamation site.

IMPORTANT MIGRATORY WADER SPECIES AT THE PORT OF BRISBANE

To identify important migratory wader species within the POB reclamation area (including the claypan), we examined all the counts of migratory waders from the POB and found the maximum count of each species. The POB reclamation area held internationally-significant numbers of seven species of migratory wader (> 1% of their flyway population) In order of decreasing importance these are Grey-tailed Tattler, Red-necked Stint, Lesser Sand Plover, Curlew Sandpiper, Sharp-tailed Sandpiper, Eastern Curlew and Pacific Golden Plover. In addition, the POB held > 0.5% of the flyway population of another four species of migratory wader (Great Knot, Greater Sand Plover, Ruddy Turnstone and Bar-tailed Godwit). A further species, Grey Plover was regularly present (> 50% of counts) in > 0.1% of the flyway population. This species was also included as a species of interest as the POB is the most important site for the species in the region. This

makes a total of 12 species of migratory wader (Table 1) that will be examined in greater detail. Most species only occurred within the reclamation area, but the maximum counts of Eastern Curlew and Great Knot also included birds on the claypan. For the collation of maximum counts of these two species, the claypan contributed > 10% of the total count.

Table 1. The maximum count of migratory species of wader present in internationally and nationally-significant numbers (> 0.5% flyway population) within POB land (including the claypan) during the non-breeding season (15 November – 15 March) since 2003. Grey Plover has been included as the POB is the most important site for this species in the region. N = the number of monthly surveys since January 2003 that include each species. Grey counts highlight increased species maximum counts in 2016 – 2017.

Species	Maximum count (% flyway population)	Proportion of POB counts (%) (N)
Grey-tailed Tattler	1296 (2.6)	90 (151)
Red-necked Stint	6803 (2.1)	100 (168)
Lesser Sand Plover	2413 (1.7)	91 (154)
Curlew Sandpiper	2712 (1.5)	98 (165)
Sharp-tailed Sandpiper	1990 (1.2)	79 (134)
Eastern Curlew	473 (1.2)*	71 (102)
Pacific Golden Plover	1090 (1.1)	81 (136)
Great Knot	2600 (0.7)*	88 (148)
Greater Sand Plover	669 (0.6)	84 (141)
Ruddy Turnstone	213 (0.6)	87 (146)
Bar-tailed Godwit	1604 (0.5)	97 (162)
Grey Plover	145 (0.1)	56 (80)

* Counts that included both the reclamation area and the claypan.

Figure 1. Wader count sites and site groupings (Areas) within the POB reclamation area. The ponds are labelled with the same alphanumeric codes that are used throughout this report and in the QWSG database. The claypan roost (FICP) is in the south east of Fisherman Is south of the artificial roost (PBAR), but is not shown.

RECENT COUNTS OF MIGRATORY WADER SPECIES AT THE PORT OF BRISBANE

The numbers of migratory wader species and total migratory and resident birds recorded in each of the sites (subsections of the Port area, see Figure 1) including the claypan (FICP, not shown in Figure 1) on each sampling occasion between July 2016 and June 2017 are presented (Tables 2 and 3). The distribution of counts among ponds for each of the important species (Table 1) is tabulated in Table 4. Two new subsections were added to the sites counted by QWSG since 2013 – 2014 (Fig. 1).

Collectively, Tables 2 – 4 are representative of the last 12 months of high tide counts at the POB. Data has been presented on the basis of the same set of tables in each annual report. Furthermore, the 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 – the middle of the annual 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 wader throughout the year.

The hatching of migratory waders is well synchronised because of the short period available to breed in the far northern hemisphere. Hence, their lives begin in the "Breeding" period. However, juvenile birds that are hatched each breeding season only start to occur on Australia in late September. Hence, from the perspective of the population assessment of waders in Australia, a bird's annual cycle begins in September and ends in August. Such an approach is consistent with techniques of ageing waders and allows a better understanding their population dynamics. Hence, the tabulations given in the tables to follow use "wader" years not calendar years and are labelled accordingly. Hence, the "2016" label represents the period from September 2016 to June 2017.

Based upon Tables 2 – 4, counts of total migratory and total resident waders and the number of species for each group are consistent with data from previous years (see also Fig. 3). There is a wide variation in the numbers recorded in different ponds, which is a reflection of both chance occurrence of the birds and the changing suitability of each pond as roosting habitat. The attractiveness of each pond will vary among the species. More is given on differential use of ponds in the next section.

As expected, numbers of migratory birds were lowest in winter when the numbers of resident birds was highest. Numbers of migratory birds peak through the summer months and can be high also during the period of southward migration. The maximum number of 18 migratory species that was recorded on any single count is of itself significant. Few other sites in Moreton Bay hold as many species and none on a regular basis. The POB reclamation area remains the most important roost for migratory waders in Moreton Bay (Section 2). Since July 2016, there have been significant counts within the POB reclamation area of greater than 1% of the flyway population for Grey-tailed Tattler, Curlew Sandpiper, Red-necked Stint and Lesser Sand Plover. Another three species that previously reached nationally-important numbers (>0.5% flyway population) during the periods of migration now no longer reach these count thresholds. These species were the Bar-tailed Godwit, Sharp-tailed Sandpiper and Pacific Golden Plover. Apart from the species that occur in internationally-significant number, all species were not recorded in the high numbers that they have

occurred in previous years (see Table 1). However, there is a high degree of year to year variability in overall counts and the mean overall summer count were higher in 2016 – 2017 (Figure 6).

Table 2. Counts of all migratory wader species (a) total birds and (b) number of species recorded in each pond in the POB reclamation area between July 2016 and June 2017. The subsection represented by each of the site codes are shown in Figure 1 with the exception of FICP (Fisherman Island claypan), which is the expansive undisturbed claypan to the south-west of Fisherman Island. Seasons are winter (breeding), summer (non-breeding) and migration (south and north migrations). NC = no count due to inclement weather.

(a) Total counts

	Breeding		South migration		Non breeding					North migration		Breeding	
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	Total
FICP	13	92	678	–	1245	445	349	628	2446	39	20	27	5982
PBAR	25	5	9	575	33	145	31	37	6	9	1	–	876
PBC2	59	2	101	4	1050	18	1313	1822	94	83	17	93	4656
PBC3	299	40	17	107	688	66	2482	2997	2116	37	248	48	9145
PBR3	7	83	930	970	995	1156	169	123	282	–	6	5	4726
PBS1	–	2	–	–	321	–	15	1	–	–	–	–	339
PBS2	249	–	–	473	313	2583	2204	477	151	–	–	–	6450
PBS3	244	585	16	4226	15	3396	1151	3989	16	253	34	4	13929
PBS4	365	314	671	246	278	573	772	1341	12	76	136	25	4809
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	–
PFPE	–	63	1813	866	431	64	8	794	1481	18	776	249	6563
Total	1261	1186	4509	7467	8186	8396	8494	12209	6604	515	1252	451	60530

(b) Number of species

	Breeding		South migration		Non breeding					North migration		Breeding
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17
FICP	2	3	7	–	8	3	7	5	9	1	1	3
PBAR	5	3	4	9	5	9	6	7	5	2	1	–
PBC2	1	1	2	1	3	2	6	4	2	2	1	2
PBC3	2	2	1	2	9	3	5	6	5	3	1	1
PBR3	1	1	8	9	12	9	4	4	4	–	1	1
PBS1	–	1	–	–	5	–	2	1	–	–	–	–
PBS2	1	–	4	4	7	7	6	4	4	–	1	–
PBS3	5	2	2	8	4	6	6	7	2	5	3	1
PBS4	3	4	5	5	6	7	8	6	4	6	3	2
PLDE	–	–	–	–	–	–	–	–	–	–	–	–
PFPE	–	2	8	6	8	2	3	11	9	4	5	7
Total no. spp.	10	10	13	15	15	14	13	16	18	9	9	9

Table 3. Counts of all resident wader species (a) total birds and (b) number of species recorded in each pond between July 2016 and June 2017. Refer to Table 2 and Figure 1. Seasons are winter (breeding), summer (non-breeding) and migration (south and north migrations).

(a)	Breeding		South migration		Non breeding					North migration		Breeding	
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	Total
FICP	1	8	11	3	5	20	9	10	162	147	4	22	401
PBAR	178	78	4	8	6	18	15	42	11	41	124	164	689
PBC2	52	–	24	21	32	1	53	55	64	50	13	25	390
PBC3	10	2	9	19	13	5	125	2	60	19	8	21	293
PBR3	2	12	3	2	16	11	8	6	12	2	10	42	126
PBS1	12	6	8	4	5	8	44	8	7	–	23	15	140
PBS2	1	2	1	–	–	–	34	2	2	18	1	4	65
PBS3	18	16	6	11	–	13	4	6	189	1152	824	615	2854
PBS4	29	36	2	7	9	124	5	18	38	52	69	27	416
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	–
PFPE	9	10	4	2	14	4	22	121	60	4	45	4	299
Total	271	170	72	77	100	204	319	270	605	1485	1121	940	5634

(b) spp	Breeding		South migration		Non breeding					North migration		Breeding
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17
FICP	1	2	3	2	2	1	2	2	2	3	2	4
PBAR	4	4	2	3	2	5	4	4	4	5	4	5
PBC2	1	–	1	1	1	1	2	1	1	1	1	1
PBC3	2	1	1	1	2	1	2	1	1	1	1	1
PBR3	1	1	1	1	2	1	1	1	1	1	3	4
PBS1	1	1	1	1	2	1	1	1	1	–	1	1
PBS2	1	1	1	–	–	–	1	1	1	1	1	1
PBS3	2	4	1	1	–	1	1	1	2	3	3	3
PBS4	3	3	1	2	1	2	1	2	2	2	3	2
PLDE	–	–	–	–	–	–	–	–	–	–	–	–
PFPE	1	2	2	1	2	2	1	2	1	1	2	2
Total	5	6	3	4	3	5	4	4	6	6	6	6

Table 4. Counts of the 12 most abundant migratory wader species recorded in each pond of the POB reclamation area between July 2015 and May 2016. Refer to Table 2 and Figure 1 for details. Seasons are winter (breeding), summer (non-breeding) and migration (south and north migrations). NC = no count due to inclement weather.

Grey-tailed Tattler

	Breeding		South migration		Non breeding					North migration		Breeding	
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	Total
FICP	–	–	–	–	–	–	–	–	–	–	–	–	0
PBAR	–	–	–	–	–	–	–	–	–	–	–	–	0
PBC2	–	–	–	–	–	–	–	–	–	–	–	–	0
PBC3	–	–	–	–	–	–	–	–	–	–	–	–	0
PBR3	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS1	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS2	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS3	–	–	–	–	–	42	–	–	–	–	9	–	9
PBS4	257	273	324	207	250	237	572	929	6	35	–	–	3090
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	0
PFPE	–	–	–	–	–	–	–	367	597	10	68	55	1097
Total	257	273	324	207	250	279	572	1296	603	45	77	55	4238

Red-necked Stint

Site Code	Breeding		South migration		Non breeding					North migration		Breeding	Total
	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	
FICP	9	30	107	–	62	436	89	493	636	39	20	20	1941
PBAR	20	–	–	1	–	8	8	1	–	–	–	–	38
PBC2	59	2	95	4	1018	17	1171	1519	92	82	17	91	4167
PBC3	287	29	17	72	445	54	2018	1346	1652	30	248	–	6198
PBR3	7	83	473	143	224	14	132	4	34	–	–	5	1119
PBS1	–	2	–	–	274	–	14	1	–	–	–	–	291
PBS2	249	–	173	3	1283	1016	129	14	94	–	–	–	2961
PBS3	231	477	7	2100	2	1060	369	1071	3	78	19	–	5417
PBS4	82	32	2	–	19	39	44	187	–	–	–	24	429
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	–
PFPE	–	35	1110	722	5	–	6	30	724	1	101	14	2748
Total	944	690	1840	3045	3377	2644	3980	4666	3235	230	405	154	25210

Sharp-tailed Sandpiper

Site Code	Breeding		South migration		Non breeding					North migration		Breeding	Total
	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	
FICP	–	–	10	–	47	4	–	48	156	–	–	–	265
PBAR	–	–	1	27	10	24	17	26	1	4	–	–	110
PBC2	–	–	–	–	1	–	9	–	2	–	–	–	12
PBC3	–	–	–	–	38	1	112	2	90	–	–	–	243
PBR3	–	–	3	30	7	73	21	13	–	–	–	–	147
PBS1	–	–	–	–	11	–	1	–	–	–	–	–	12
PBS2	–	–	12	–	419	26	28	152	–	–	–	–	637
PBS3	–	–	–	8	4	13	45	54	13	–	–	–	137
PBS4	–	5	4	3	1	19	21	4	–	2	–	1	60
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	–
PFPE	–	–	8	6	4	11	–	5	–	–	–	–	34
Total	–	5	38	74	542	171	254	304	262	6	–	1	1657

Curlew Sandpiper

	Breeding		South migration		Non breeding					North migration		Breeding	
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	Total
FICP	–	–	3	–	69	–	2	–	356	–	–	4	434
PBAR	–	–	–	8	7	3	1	1	–	–	–	–	20
PBC2	–	–	6	–	31	1	124	8	–	1	–	2	173
PBC3	12	11	–	35	46	11	1	2	20	–	–	–	138
PBR3	–	–	408	730	159	18	14	8	14	–	6	–	1357
PBS1	–	–	–	–	23	–	–	–	–	–	–	–	23
PBS2	–	–	33	–	582	68	449	–	3	–	–	–	1135
PBS3	8	108	9	781	3	2273	92	2339	–	64	12	–	5625
PBS4	–	–	320	24	–	69	44	44	–	9	5	–	515
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	–
PFPE	–	–	485	43	–	–	–	2	27	2	511	2	1072
Total	20	119	1264	1621	920	2443	727	2404	420	76	534	8	10556

Great Knot

	Breeding		South migration		Non breeding					North migration		Breeding	
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	Total
FICP	–	–	130	–	1	–	34	–	77	–	–	–	242
PBAR	–	–	–	3	–	10	–	–	–	–	–	–	13
PBC2	–	–	–	–	–	–	–	–	–	–	–	–	0
PBC3	–	–	–	–	21	–	–	–	–	–	–	–	21
PBR3	–	–	–	–	318	190	–	–	–	–	–	–	508
PBS1	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS2	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS3	–	–	–	150	–	–	77	212	–	–	–	–	439
PBS4	–	–	–	–	–	–	–	–	–	–	–	–	0
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	0
PFPE	–	–	–	–	–	–	–	167	–	–	–	–	167
Total	0	0	130	153	340	200	111	379	77	0	0	0	1390

Bar-tailed Godwit

	Breeding		South migration		Non breeding					North migration		Breeding	
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	Total
FICP	–	–	509	–	780	–	38	–	888	–	–	–	2215
PBAR	1	–	4	476	12	78	2	2	–	–	–	–	575
PBC2	–	–	–	–	–	–	–	–	–	–	–	–	0
PBC3	–	–	–	–	51	–	–	–	–	–	–	–	51
PBR3	–	–	72	7	208	810	–	–	–	–	–	–	1097
PBS1	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS2	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS3	–	–	–	150	–	2	560	284	–	81	2	–	1079
PBS4	26	–	21	–	–	16	7	35	3	21	97	–	226
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	0
PFPE	–	–	44	–	50	–	1	164	1	5	–	106	371
Total	27	0	650	633	1101	906	608	485	892	107	99	106	5614

Eastern Curlew

	Breeding		South migration		Non breeding					North migration		Breeding	
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	Total
FICP	4	61	12	–	135	–	131	58	1	–	–	–	402
PBAR	–	2	2	2	2	2	2	3	1	–	–	–	16
PBC2	–	–	–	–	–	–	–	–	–	–	–	–	0
PBC3	–	–	–		–	–	–	–	–	–	–	–	0
PBR3	–	–	–	17	–	1	–	–	–	–	–	–	18
PBS1	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS2	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS3	–	–	–	129	6	–	–	–	–	26	–	–	161
PBS4	–	–	–	–	–	–	–	–	–	7	34	–	41
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	0
PFPE	–	–	–	–	–	–	–	–	–	–	–	22	22
Total	4	63	14	148	143	3	133	61	2	33	34	22	660

Pacific Golden Plover

	Breeding		South migration		Non breeding					North migration		Breeding	
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	Total
FICP	–	–	–	–	–	5	17	14	86	–	–	–	122
PBAR	–	–	2	–	–	2	–	–	2	–	–	–	6
PBC2	–	–	–	–	–	–	–	–	–	–	–	–	0
PBC3	–	–	–	–	–	–	–	–	–	–	–	–	0
PBR3	–	–	12	2	1	1	–	–	–	–	–	–	16
PBS1	–	–	–	–	11	–	–	–	–	–	–	–	11
PBS2	–	–	56	338	213	402	447	263	35	–	14	–	1768
PBS3	–	–	–	8	–	–	–		–	–	–	–	8
PBS4	–	–	–	–	–	–	–	–	2	–	–	–	2
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	0
PFPE	–	–	1	–	2	–	–	42	–	–	–	–	45
Total	0	0	71	348	227	410	464	319	125	0	14	0	1978

Ruddy Turnstone

	Breeding		South migration		Non breeding					North migration		Breeding	
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	Total
FICP	–	–	–	–	–	–	–	–	–	–	–	–	0
PBAR	–	–	–	–	–	–	–	–	–	–	–	–	0
PBC2	–	–	–	–	–	–	1	–	–	–	–	–	1
PBC3	–	–	–	–	2	–	–	3	–	–	–	–	5
PBR3	–	–	1	–	13	10	–	–	–	–	–	–	24
PBS1	–	–	–	–	2	–	–	–	–	–	–	–	2
PBS2	–	–	–	1	1	2	6	–	–	–	–	–	10
PBS3	–	–	–	–	–	6	8	–	–	–	–	–	14
PBS4	–	4	–	11	4	142	79	142	–	–	–	–	382
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	0
PFPE	–	–	–	10	25	53	1	12	49	–	18	19	187
Total	0	4	1	22	47	213	95	157	49	0	18	19	625

Lesser Sand Plover

	Breeding		South migration		Non breeding					North migration		Breeding	
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	Total
FICP	–	–	–	–	–	–	–	–	–	–	–	–	0
PBAR	–	–	–	–	–	–	–	–	–	–	–	–	0
PBC2	–	–	–	–	–	–	7	250	–	–	–	–	257
PBC3	–	–	–	–	76	–	286	1402	312	6	–	–	2082
PBR3	–	–	3	35	23	–	2	98	231	–	–	–	392
PBS1	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS2	–	–	–	131	560	995	1145	48	19	–	–	–	2898
PBS3	–	–	–	900	–	–	–	5	–	–	–	–	905
PBS4	–	–	–	–	3	1	2	–	–	–	–	–	6
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	0
PFPE	–	28	162	79	340	–	–	1	5	–	–	–	615
Total	0	28	165	1145	1002	996	1442	1804	567	6	0	0	7155

Greater Sand Plover

	Breeding		South migration		Non breeding					North migration		Breeding	
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	Total
FICP	–	–	–	–	–	–	–	–	–	–	–	–	0
PBAR	–	–	–	–	–	–	–	–	–	–	–	–	0
PBC2	–	–	–	–	–	–	1	45	–	–	–	–	46
PBC3	–	–	–	–	8	–	65	242	42	1	–	–	358
PBR3	–	–	–	–	1	–	–	–	3	–	–	–	4
PBS1	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS2	–	–	–	–	72	74	–	–	–	–	–	–	146
PBS3	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS4	–	–	–	–	–	–	3	–	–	–	–	–	3
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	0
PFPE	–	–	1	–	4	–	–	–	41	–	–	–	46
Total	0	0	1	0	85	74	69	287	86	1	0	0	603

Grey Plover

	Breeding		South migration		Non breeding					North migration		Breeding	
Site Code	24-Jul-16	21-Aug-16	18-Sep-16	16-Oct-16	13-Nov-16	01-Jan-17	29-Jan-17	26-Feb-17	26-Mar-17	30-Apr-17	28-May-17	25-Jun-17	Total
FICP	–	–	–	–	–	–	–	–	–	–	–	–	0
PBAR	–	–	–	–	–	–	–	–	–	–	–	–	0
PBC1	–	–	–	–	–	–	–	–	–	–	–	–	0
PBC2	–	–	–	–	–	–	–	–	–	–	–	–	0
PBC3	–	–	–	–	–	–	–	–	–	–	–	–	0
PBR3	–	–	6	1	31	38	–	–	–	–	–	–	76
PBS1	–	–	–	–	–	–	–	–	–	–	–	–	0
PBS2	–	–	–	–	–	–	–	–	–	1	–	–	1
PBS3	–	–	–	–	–	–	–	–	–	–	–	4	4
PBS4	–	–	–	–	–	–	–	–	–	–	–	–	0
PLDE	–	–	–	–	–	–	–	–	–	–	–	–	0
PFPE	–	–	2	–	–	–	–	3	2	–	–	–	7
Total	0	0	8	1	31	38	0	3	2	1	0	4	88

COMPARISON OF WADER NUMBERS BETWEEN THE POB AND MORETON BAY

This section presents a comparison of migratory wader numbers between the POB reclamation area (including the claypan) and elsewhere in Moreton Bay. In order to make a valid comparison, an index of the relative importance of the POB was needed. There are no similar single high tide roosts that is comparable with the POB reclamation area. Thus, I decided to compare the monthly counts at the POB with the counts made in the same months in Moreton Bay as a whole. The average count at all high tide roosts including POB were summed for each month. This provided a monthly estimate of the size of the Moreton Bay population of each of the 12 species of migratory wader being examined. The ratio of the POB count to the Moreton Bay count provided an index of the relative importance (IRI) of the POB land to Moreton Bay wader populations (Eq. 1).

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

This ratio can vary between zero and one, with a value of 1 meaning all birds of that species in that month were counted within the POB reclamation area. Temporal changes in the ratio would be expected to reflect local changes in the relative importance of the POB to Moreton Bay wader populations. The temporal trend in the IRI was examined with linear regression. A statistically-significant increase in the IRI was interpreted to mean that the POB reclamation area had increased in importance. Similarly, a significant negative relationship implies a reduction in the importance of the POB. In an initial analysis, the counts from the POB reclamation area appeared to show unexplained differences in site use by some species when the pre and post January 2003 data were compared. For consistency, I decided to restrict the analysis of the temporal trend in the IRI to post January 2003 counts when the POB reclamation area has been most consistently counted.

TEMPORAL TREND IN IRI FOR THE POB RECLAMATION AREA

The relative importance of the POB reclamation area for waders varied widely between months, both within a year and between years. There was a weak statistically significant trend in the IRI for three of the 12 species of wader examined (all $r^2 < 0.20$; Fig. 2). Most species, Bar-tailed Godwit, Curlew Sandpiper, Eastern Curlew, Grey-tailed Tattler, Grey Plover, Lesser Sand Plover, Pacific Golden Plover, Ruddy Turnstone and Sharp-tailed Sandpiper showed no significant temporal trend in the IRI.

The POB reclamation area is the most important high tide roost in Moreton Bay for many of the species migratory wader counted. The mean percentage of the Moreton Bay count of species present in the POB land this year varied between 21% (Bar-tailed Godwit) up to 85% for Grey Plover. Eastern Curlew is an exception as the POB reclamation area only supported a mean of 16% of the estimated Moreton Bay population in 2016 – 2017 (Table 5).

The fit of the significant trends in the IRI were all quite weak, with two species having an increasing trend (Great Knot and Greater Sand Plover), with the best correlation being Greater Sand Plover ($r^2 = 0.21$; $P<0.001$). The correlations for the two other species were less than $r^2 = 0.2$ but were still highly significant ($P<0.001$). Red-necked Stint had a significant decreasing temporal trend in the IRI for the first time this year (Fig. 2). In previous years, the IRI for Red-necked Stint was increasing. This trend stabilised in 2015 – 2016 and now appears to be decreasing as birds disperse to other parts of Moreton Bay. This dispersal is probably related to reduced food availability at high tide within the POB reclamation area since the rate of creation of new habitat has slowed.

Since 2003, the POB land regularly held the entire Moreton Bay count of Greater Sand-Plover, Grey Plover and Ruddy Turnstone. This reflects the quantity of preferred roosting habitat available within the POB for these species. Each species prefers different habitats but there is an excess of these preferred habitats available within the POB land. The availability of habitat and low disturbance rates add to the attractiveness of the POB reclamation area.

Table 5. The estimated mean relative importance (IRI) and its trend (Fig. 2).for each of the 12 most abundant migratory waders counted within the POB lands in 2016 – 2017.

Species	**Estimated mean proportion of the Moreton Bay population (IRI) in 2016 - 2017**	**Mean rate of change (%.yr^{-1}) and direction of statistically-significant trends**
Bar-tailed Godwit	0.21	–
Curlew Sandpiper	0.68	–
Eastern Curlew	0.16	–
Great Knot	0.36	↑ 0.8%.yr^{-1}
Greater Sand Plover	0.72	↑ 2.7%.yr^{-1}
Grey Plover	0.85	–
Grey-tailed Tattler	0.43	–
Lesser Sand Plover	0.71	–
Pacific Golden Plover	0.57	–
Red-necked Stint	0.51	↓ 1.1%.yr^{-1}
Ruddy Turnstone	0.66	–
Sharp-tailed Sandpiper	0.40	–

Previous analyses (2014 and 2015) have detected significant trends in the IRI of several other species. The lack of significant trends following the addition of data from another 12 surveys made between July 2016 and June 2017 suggests that the relationships were weak and could be best interpreted as random variation

for most species. There are multiple factors influencing the roost choices of individual birds and these will vary monthly. It would be difficult to measure these factors on an appropriate scale to inform this analysis. Despite this, during 2016 – 2017, the POB is still the most important roost in Moreton Bay for nine species (Curlew Sandpiper, Great Knot, Greater Sand Plover, Grey-tailed Tattler, Grey Plover, Pacific Golden Plover, Red-necked Stint, Ruddy Turnstone and Sharp-tailed Sandpiper).

ANNUAL CHANGES IN WADER NUMBERS BETWEEN PONDS WITHIN THE POB

This section firstly examines annual changes in total migratory wader numbers since 2003 (Fig. 3) for the various areas, or pond groupings within the POB. The areas are selections of neighbouring ponds grouped as areas A to D (Fig. 1). The data are based only on records during the summer period for each year and the years are "wader" years as explained in Section 1. Area A is the purpose built roost site (PBAR) and since 2012, all other available ponds form area D. The claypan roost (FICP) is not included in the data presented in this section.

Similar graphs to Figure 3 for individual species are not displayed. However, they indicated that with just a few exceptions, since 2008 or earlier, species have primarily been using area D for roosting, presumably because other areas have been reclaimed. This progressive replacement of suitable roosting habitat as reclamation continues has long been a feature of the POB reclamation area. Earlier than 2008, area C was being supplanted by area B, which are both now superseded by area D.

The main focus of this section is on the use by birds of individual ponds within area D since 2008. Figure 4 shows data for all migratory waders combined. PBR3 was used by fewer birds in 2016 – 2017 compared to previous years and was not the most important pond for roosting (Fig. 4). In 2014, the new pond PBS4 (see Fig. 1) was enclosed and immediately began being used by birds that have shifted from other ponds (Fig. 4). This pond remains an important roosting site, whereas PBS3 increased in use in 2015 – 2016 and has remained of similar importance in 2016 – 2017. The reasons for these and similar change, especially for individual species are best examined in relation to changes of conditions in the various ponds over time. PBS3 was partly filled with water from heavy rainfall during the year and runoff from capping of PBC2 in November 2016. This change to the mix of habitats increased its attractiveness to migratory waders while the pond retained wet conditions. Another noticeable change in 2016 – 2017 was a reduction in the counts of waders in the outer FPE. The lower counts may be partly a consequence of restrictions in access to the eastern section of the pond due to instability in the outer bund wall. This restriction may have reduced detectability due to the increased viewing distance..

The distribution of summer season counts within area D for individual species illustrate the pond (and habitat) preferences of each species (Fig. 5a – l). The shifts in pond usage reflect the relative mix of habitats within each pond. PBS3 and PBS2 were much more important in 2016 – 2017 than in previous years when PBR3 and PBC3 were the most important ponds for many species.

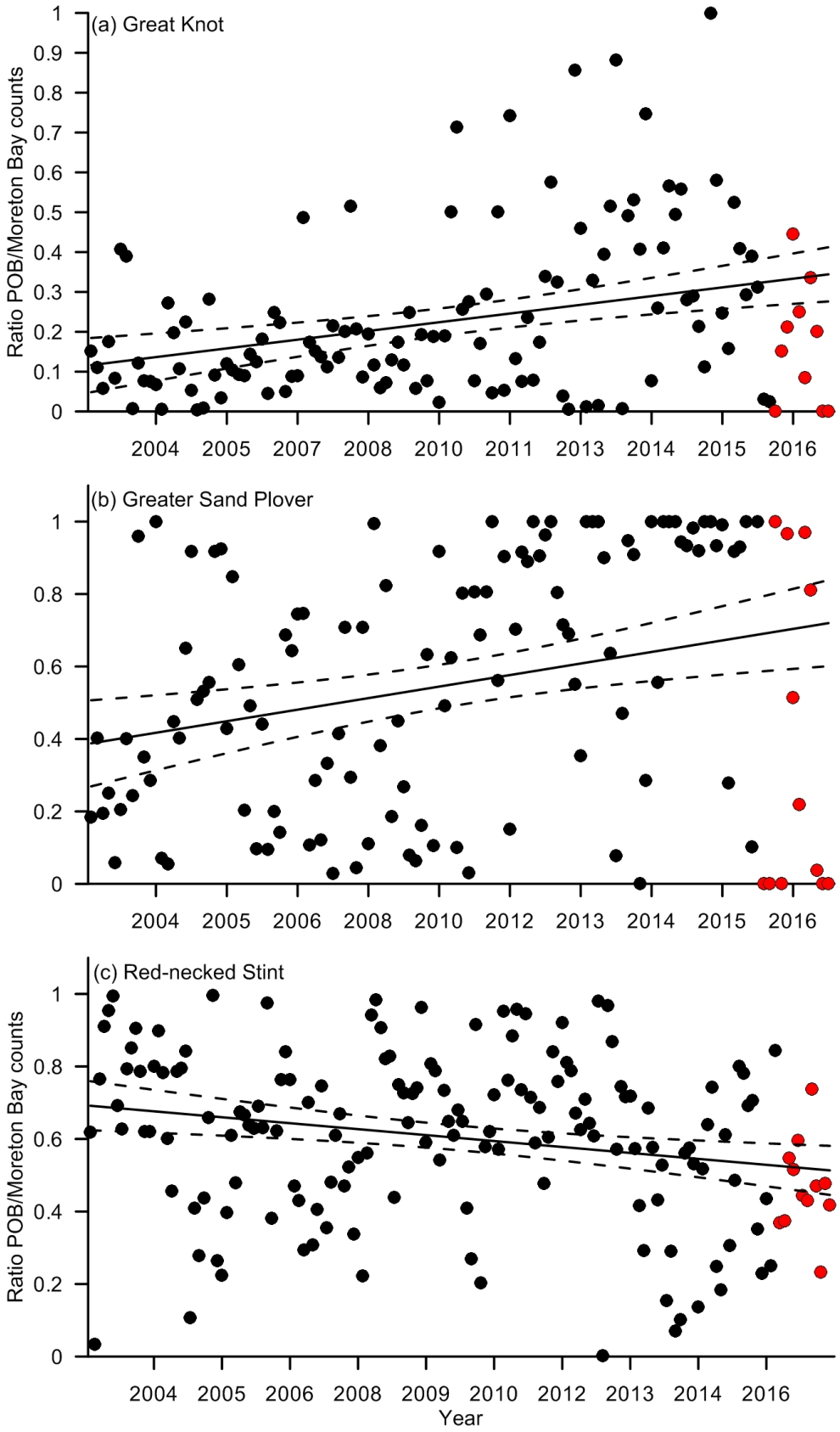


Figure 2. The species of migratory wader that showed a significant temporal trend in the IRI in 2017. The best fit mean and 95% confidence limits (dotted lines) are shown. Only counts made since the start of the comprehensive program by QWSG in January 2003 were analysed. Red points show the data for July 2016 – June 2017.

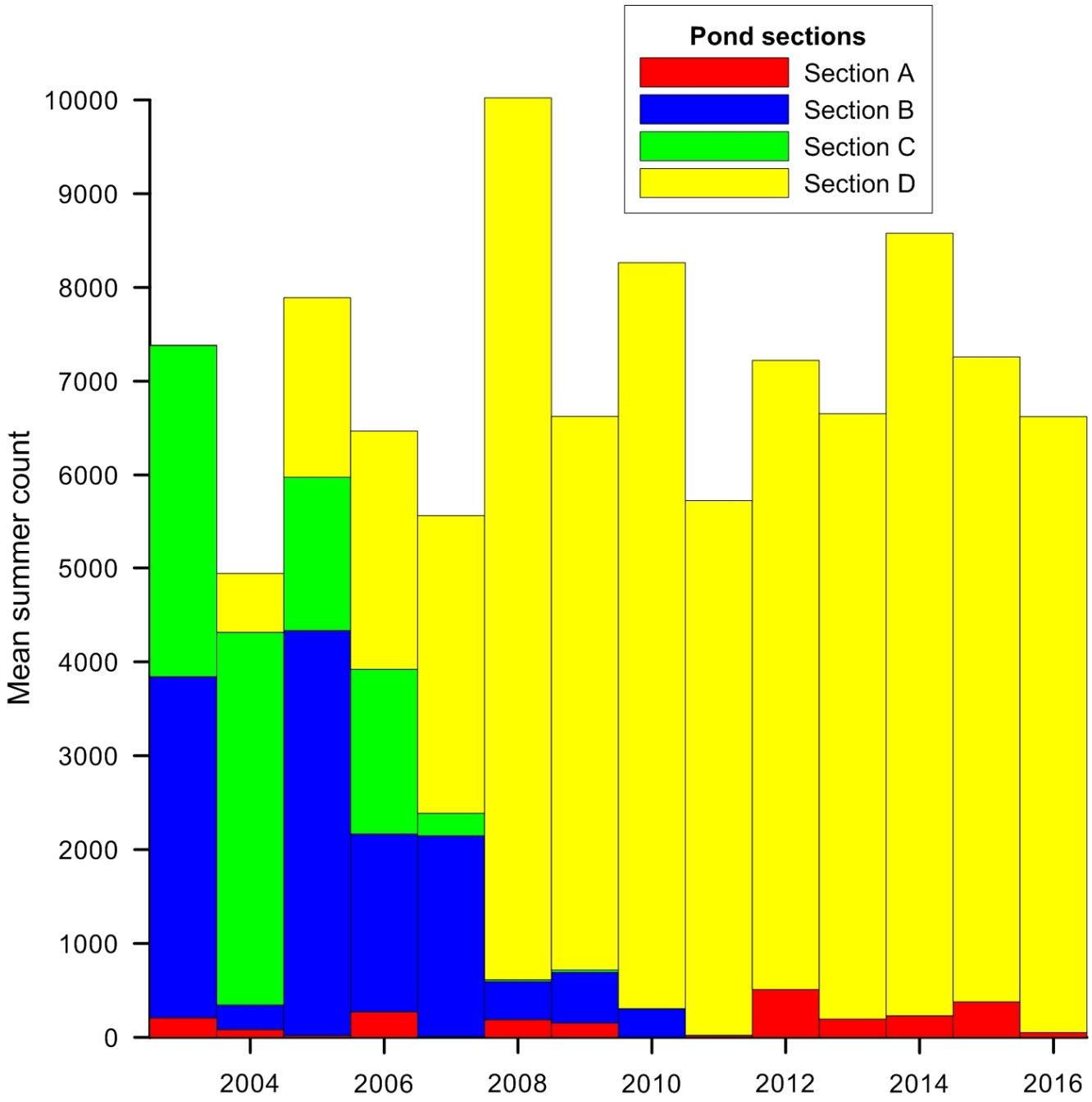


Figure 3. Average counts for the summer period of all migratory waders in four subsections of the Port lands for each "wader" summer since 2003. Area A is the purpose built artificial roost site (PBAR) and the other areas are groupings of ponds (see Fig. 1).

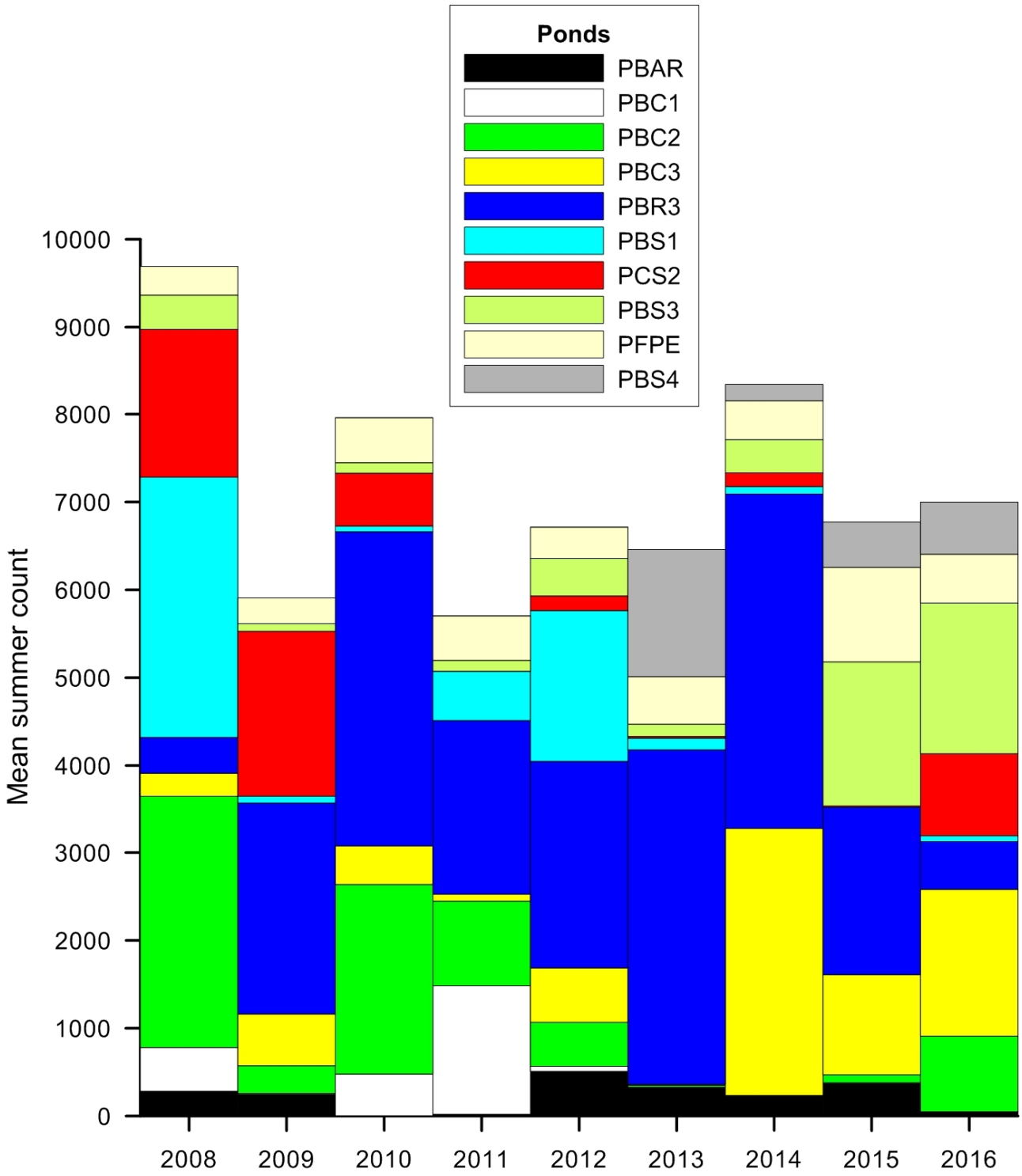
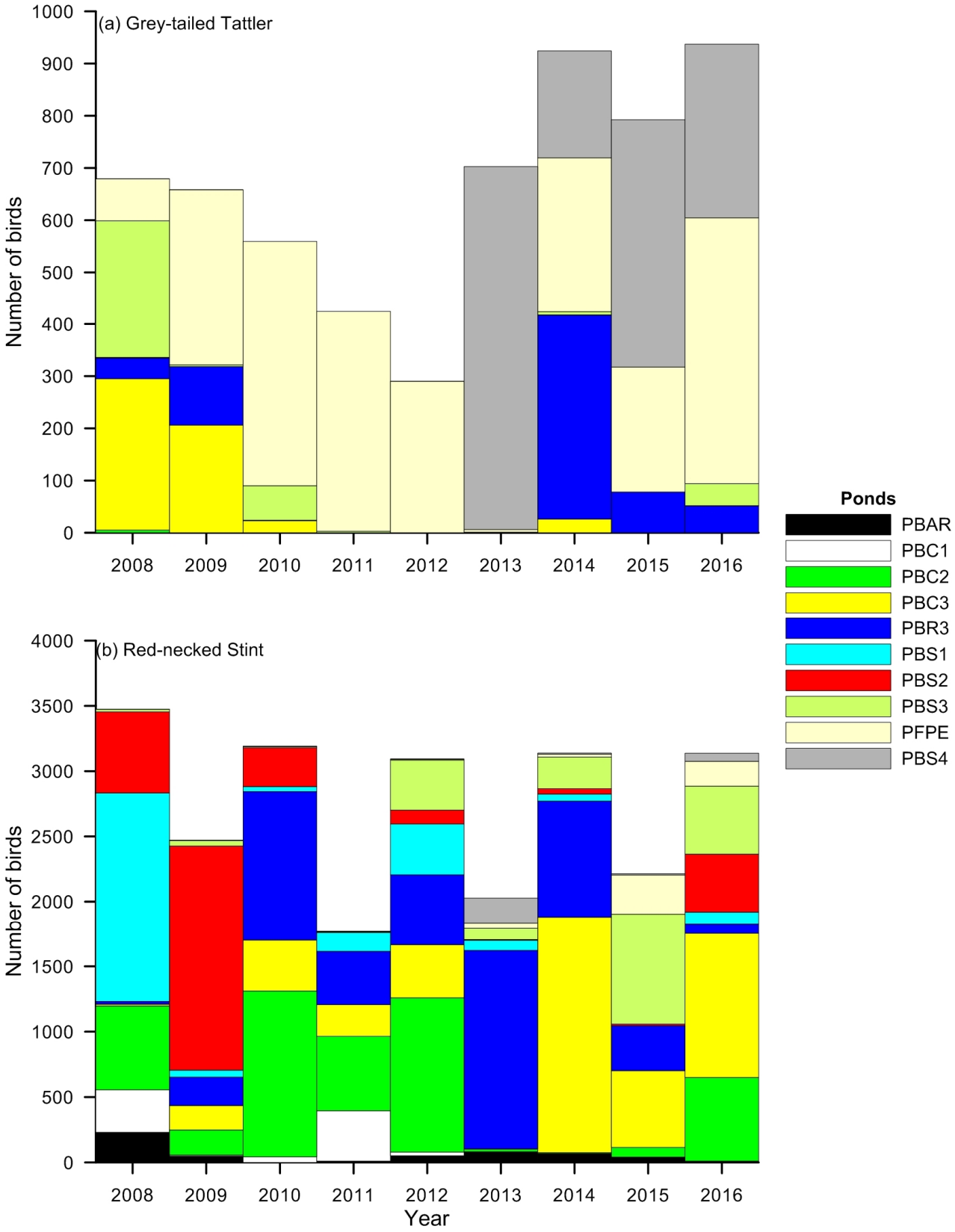
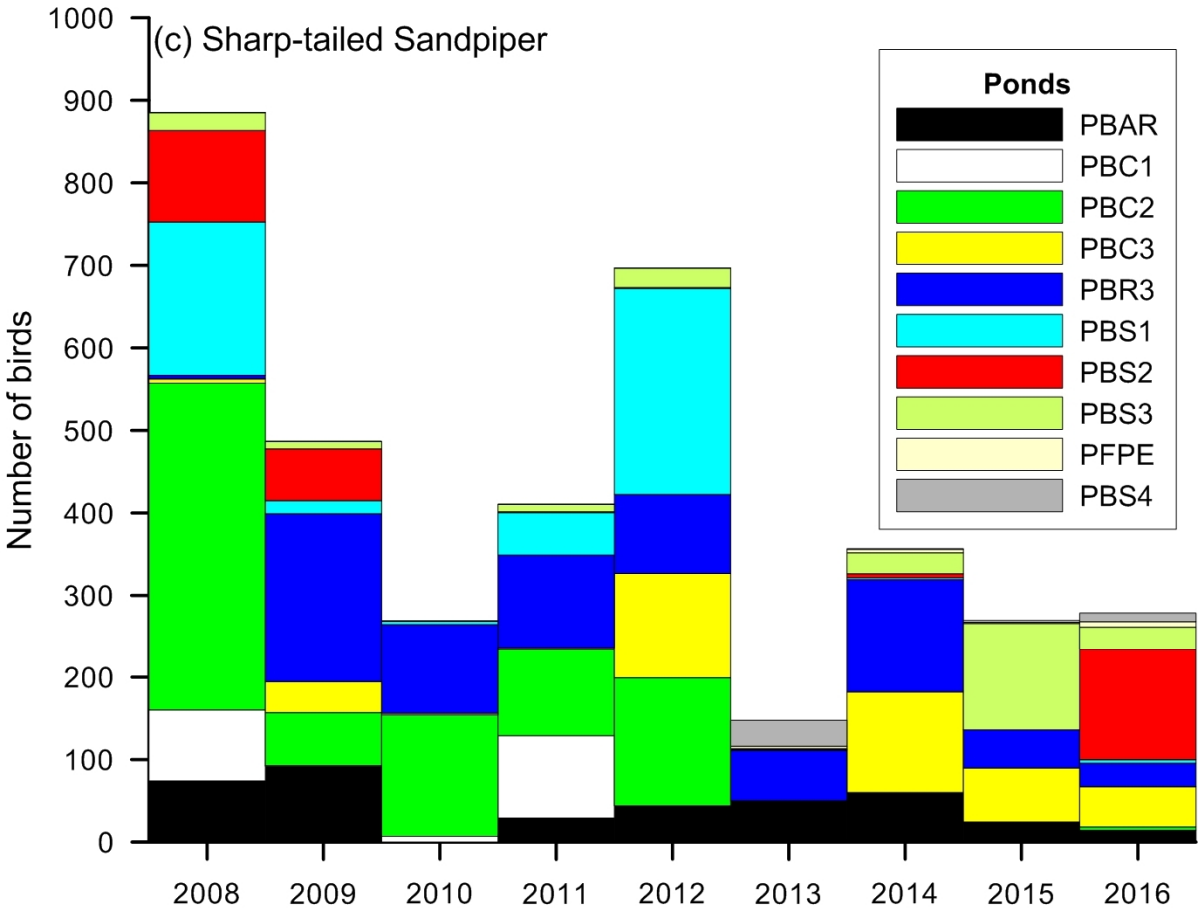
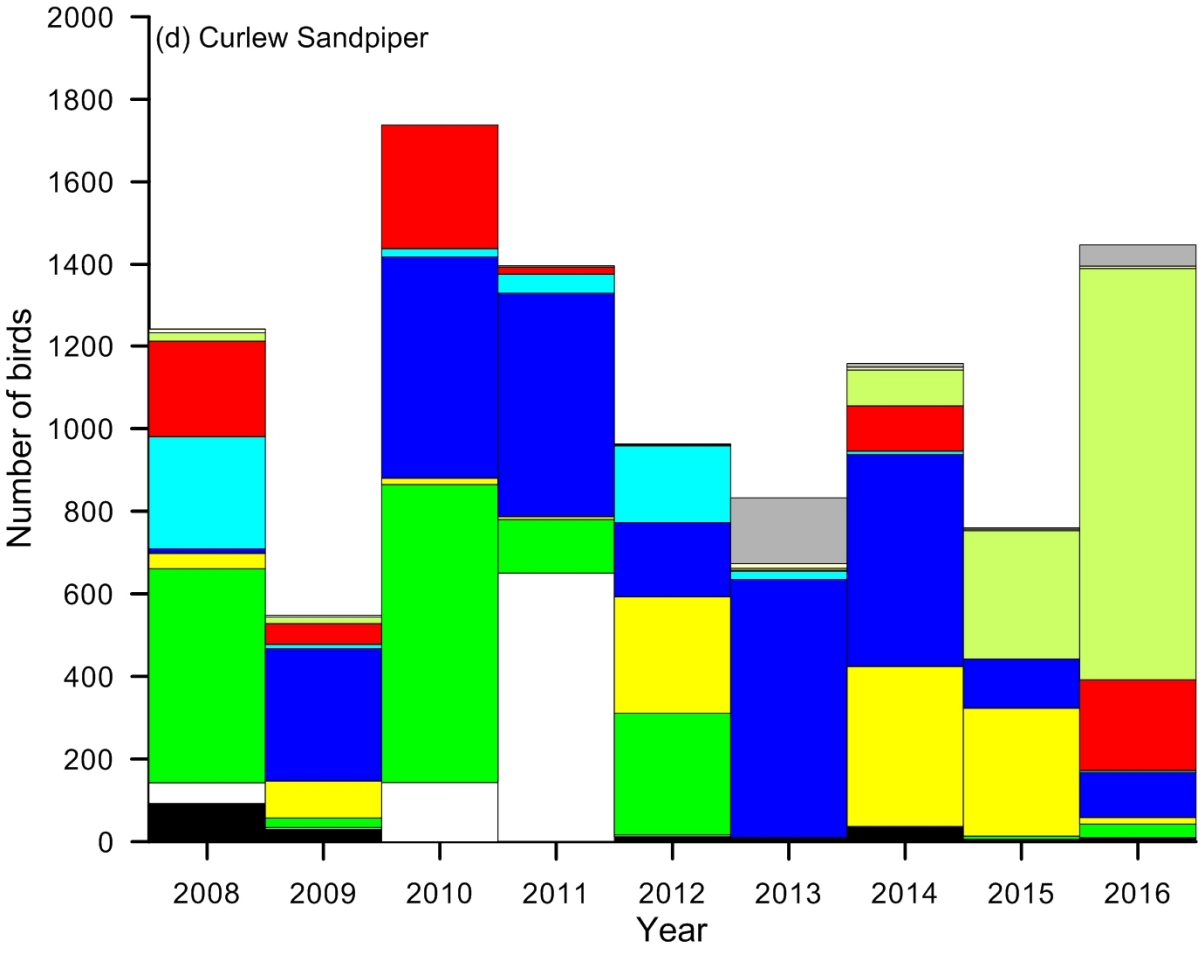
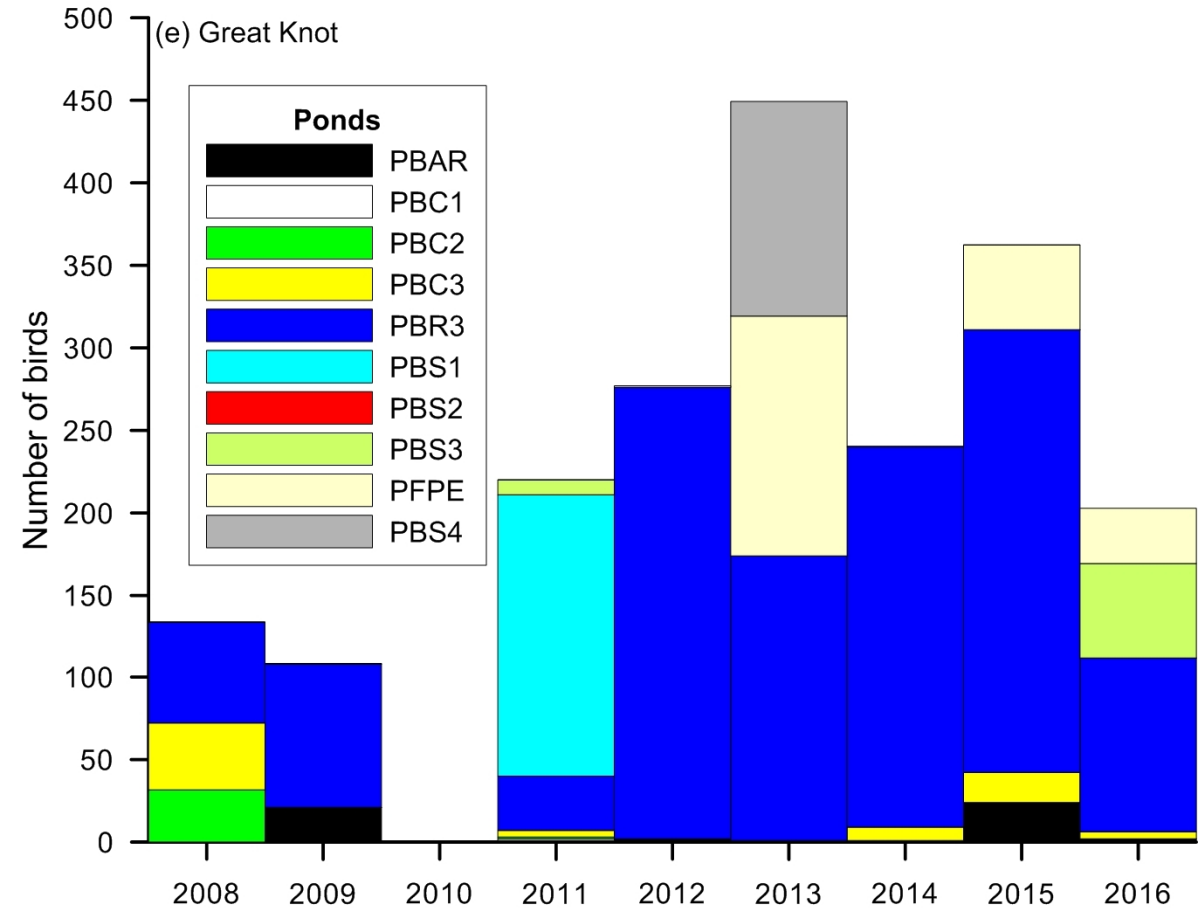


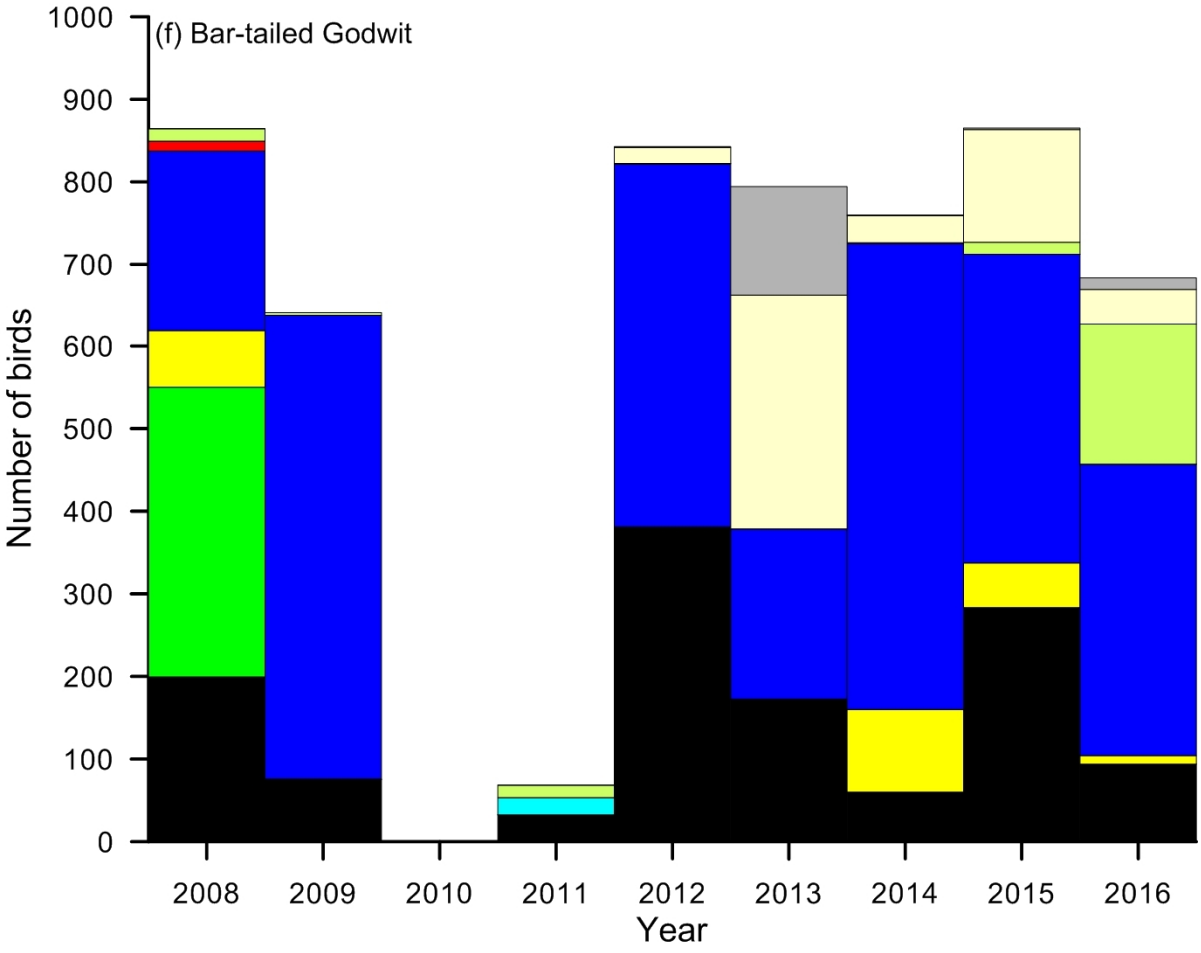
Figure 4. Average counts (summer) of all migratory waders in ponds within Area D (see Fig. 1).

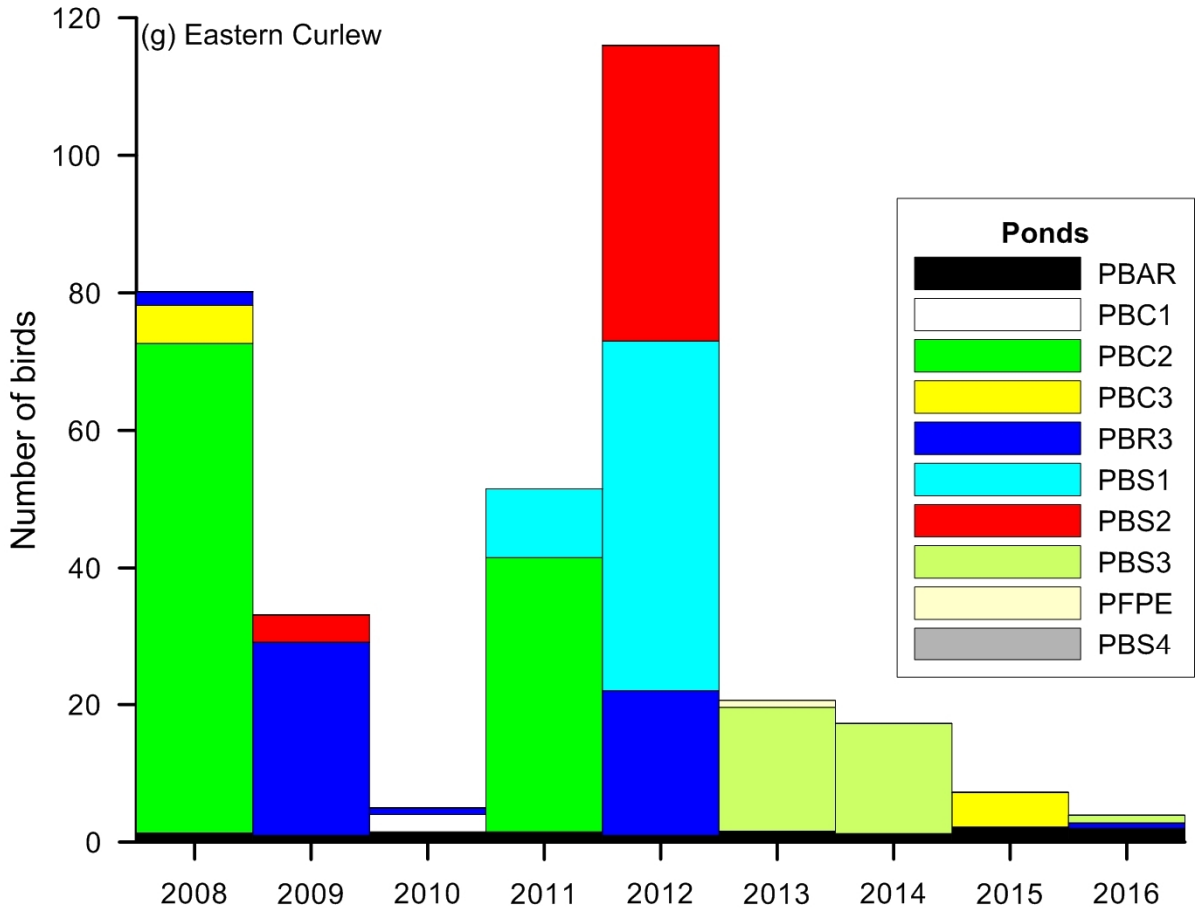

(a) Grey-tailed Tattler
Number of birds
1000
900
800
700
600
500
400
300
200
100
0
2008
2009
2010
2011
2012
2013
2014
2015
2016
(b) Red-necked Stint
Number of birds
4000
3500
3000
2500
2000
1500
1000
500
0
Year
Ponds
PBAR
PBC1
PBC2
PBC3
PBR3
PBS1
PBS2
PBS3
PFPE
PBS4

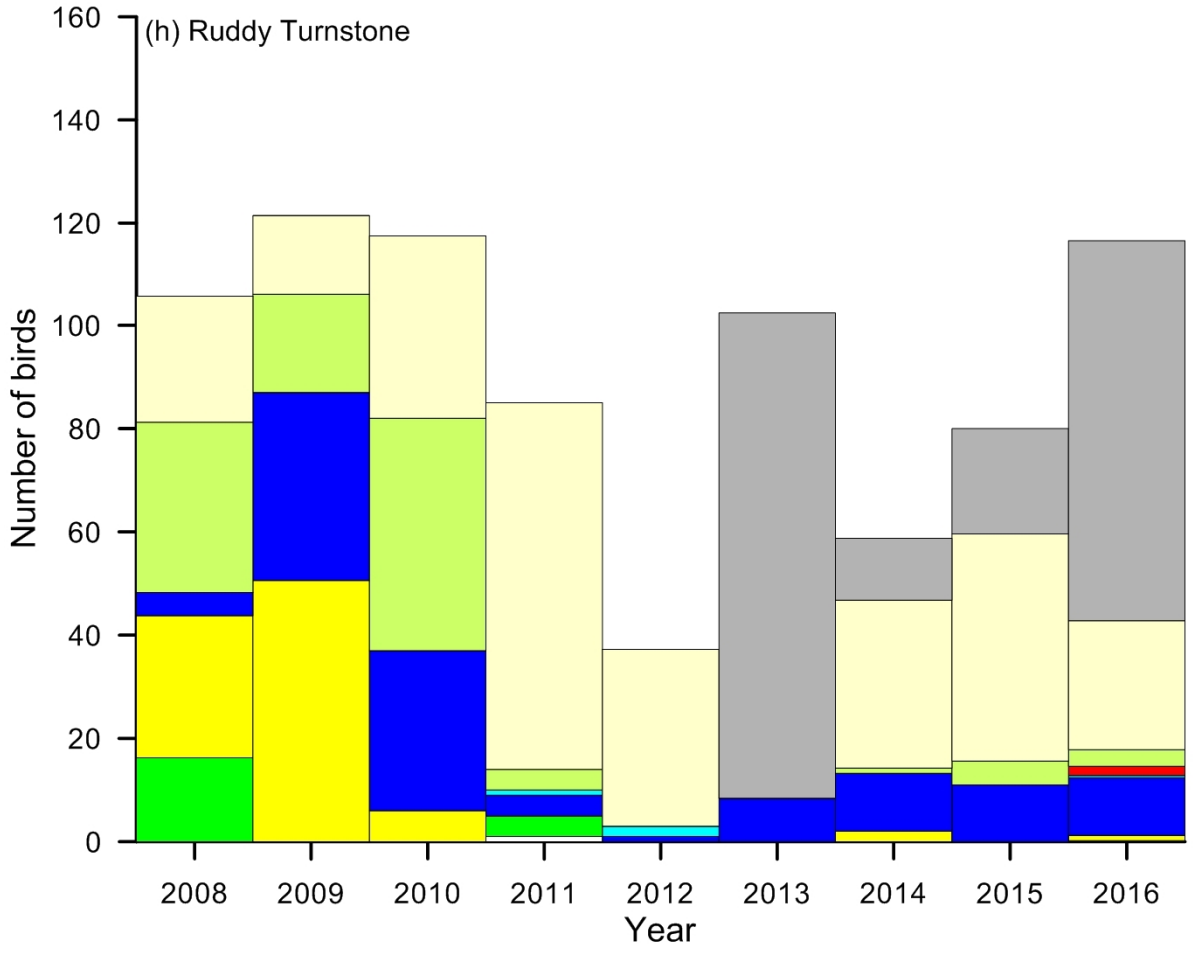

(c) Sharp-tailed Sandpiper
Number of birds
1000
900
800
700
600
500
400
300
200
100
0
2008
2009
2010
2011
2012
2013
2014
2015
2016
Ponds
PBAR
PBC1
PBC2
PBC3
PBR3
PBS1
PBS2
PBS3
PFPE
PBS4

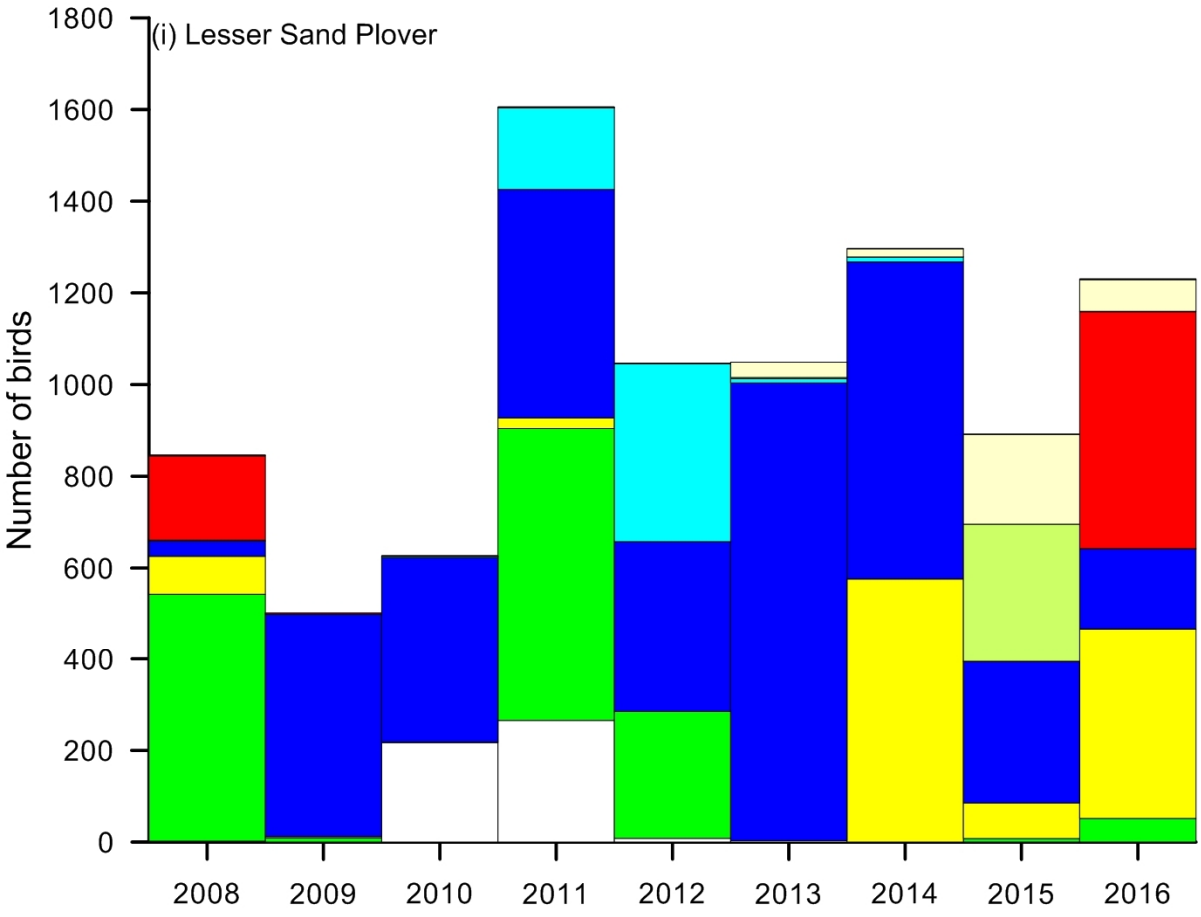

(d) Curlew Sandpiper
Number of birds
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year

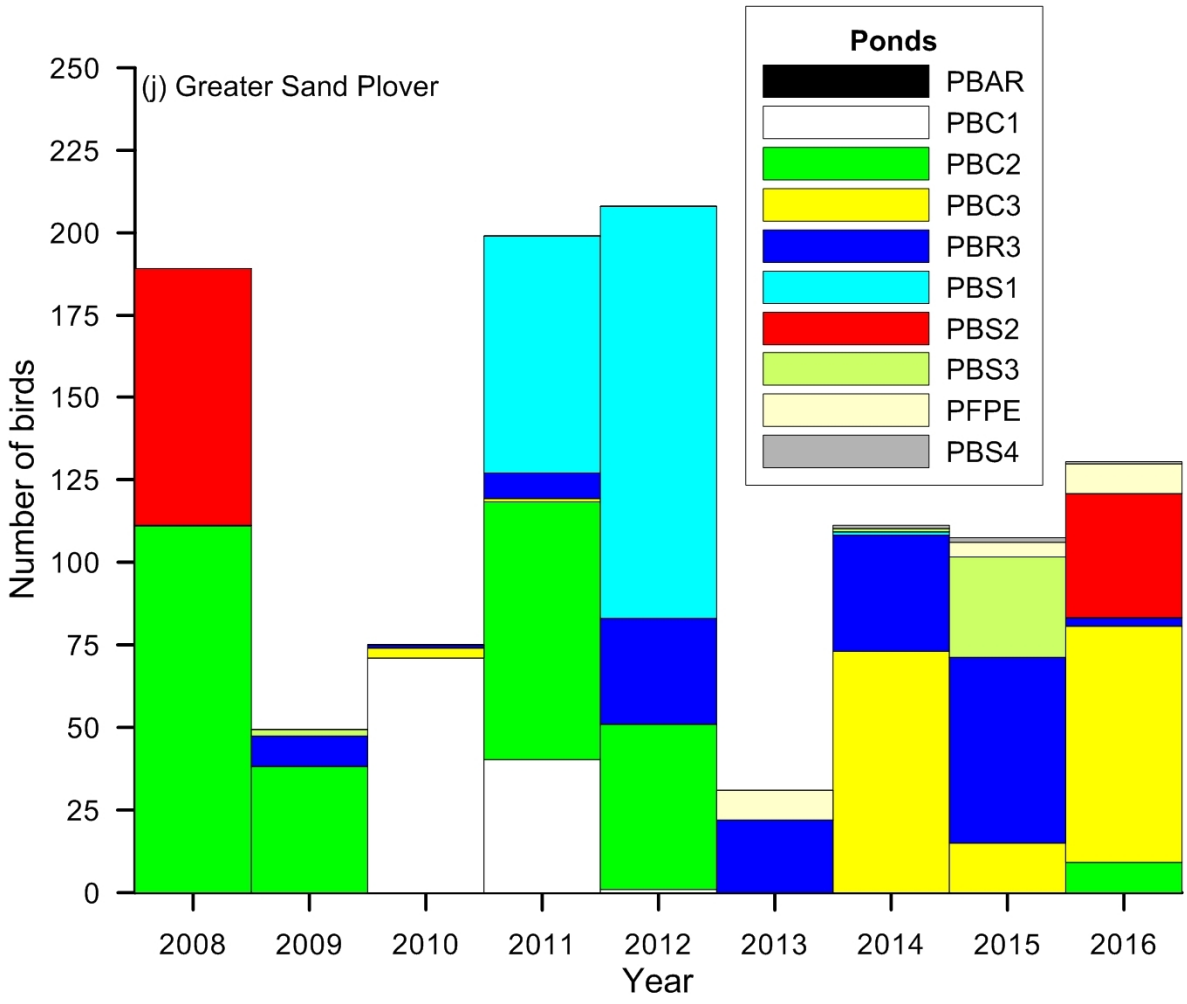

(e) Great Knot
Ponds
PBAR
PBC1
PBC2
PBC3
PBR3
PBS1
PBS2
PBS3
PFPE
PBS4
Number of birds
0
50
100
150
200
250
300
350
400
450
500
2008
2009
2010
2011
2012
2013
2014
2015
2016

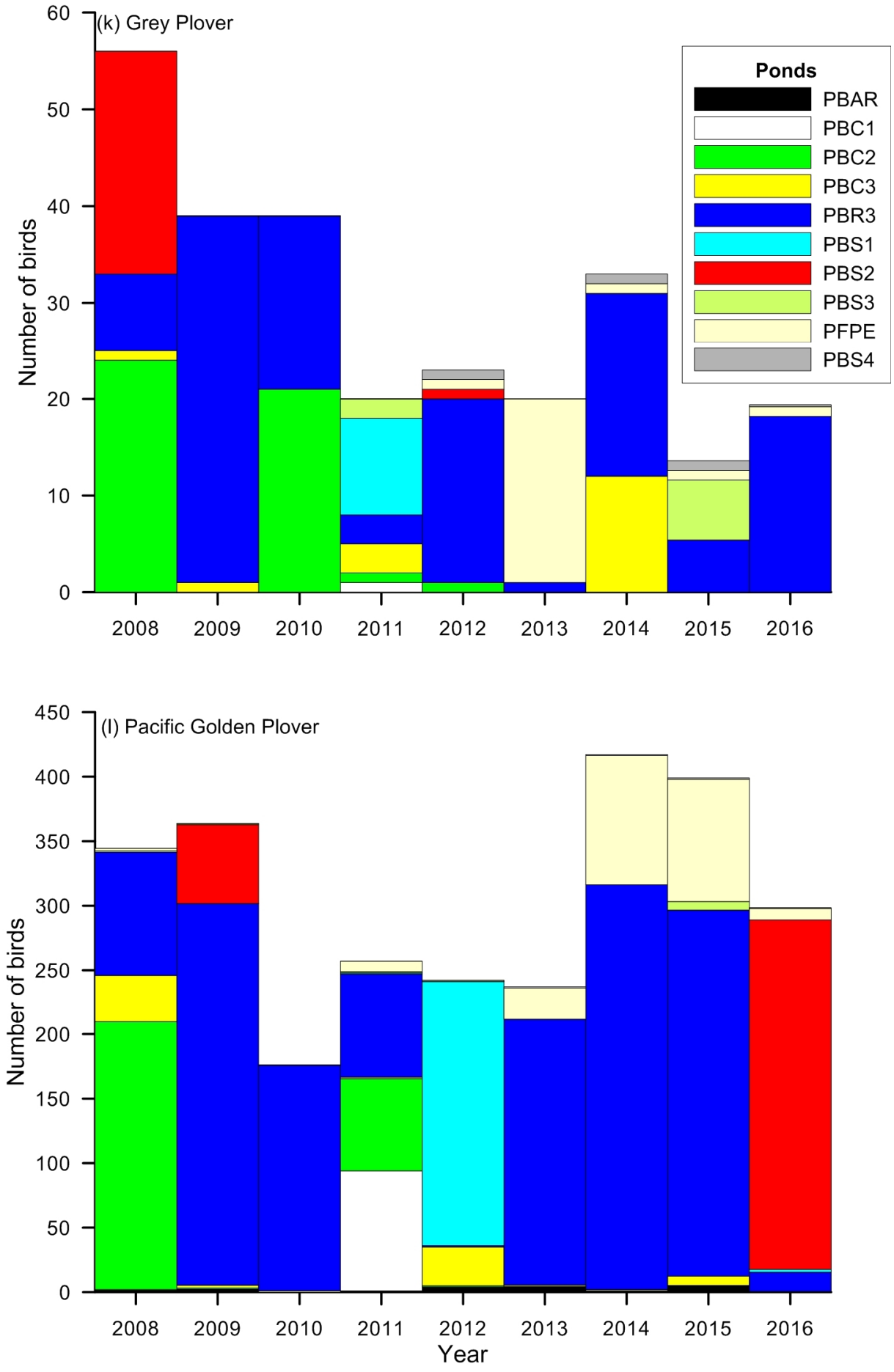

(f) Bar-tailed Godwit
Number of birds
0
100
200
300
400
500
600
700
800
900
1000
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year


(g) Eastern Curlew
Number of birds
120
100
80
60
40
20
0
2008
2009
2010
2011
2012
2013
2014
2015
2016
Ponds
PBAR
PBC1
PBC2
PBC3
PBR3
PBS1
PBS2
PBS3
PFPE
PBS4


(h) Ruddy Turnstone
Number of birds
160
140
120
100
80
60
40
20
0
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year


(i) Lesser Sand Plover
Number of birds
1800
1600
1400
1200
1000
800
600
400
200
0
2008
2009
2010
2011
2012
2013
2014
2015
2016


(j) Greater Sand Plover
Number of birds
250
225
200
175
150
125
100
75
50
25
0
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Ponds
PBAR
PBC1
PBC2
PBC3
PBR3
PBS1
PBS2
PBS3
PFPE
PBS4



Figures 5. Average counts (summer; N = 5) of 12 species of migratory wader in area D ponds (see Figure 1).

LONG TERM TRENDS IN WADER COUNTS WITHIN POB

Overall wader counts

Wader counts have been made within the POB reclamation area since 1991. However, counting methods have been most consistent since 2003. The data presented here are mean counts for different seasons across the POB reclamation area, including the claypan (FICP) from January 2003 until June 2017. Again, seasons are defined as in Section 1 and the "wader" year is the relevant measure of time. On each graph mean values are presented as is the maximum values for the summer season. Mean values for all resident waders are also presented for each season and year but the maximums given are for the winter season (June to August), when resident waders tend to be most abundant.

Figure 6 shows the results for the combination of (a) all migratory waders and (b) the combination of all resident waders. Figure 7a to l present the results for the twelve important species of migratory wader. As noted earlier, average summer counts of total migratory waders do not appear to have changed appreciably over the last 14 years (Fig. 6a). However, two of the three highest single counts of total migratory waders occurred prior to 2009. The average summer count of migratory waders in 2016 – 2017 was the highest since 2006. In contrast, the recent 2014 – 2016 average winter counts of migratory waders were the lowest since 2003. This reflects low counts of most species, with the exception of Grey-tailed Tattler and Red-necked Stint. Winter counts are an index of the relative abundance of non-breeding birds and comprise mostly juveniles and immatures (< 2 – 3 years old). Low counts during this period may reflect poor hatching and fledging success of these species. Further analysis of winter counts from elsewhere in Moreton Bay and other parts of Queensland would be needed in order to assess support for this or alternate hypotheses.

There is no obvious trend in the total number of resident waders within the POB reclamation area, although summer and winter counts decreased in 2016 – 2017 following the high count in 2015 – 2016. This decrease may be related to wetter conditions in inland eastern Australia where many of the birds could normally have lived. Anecdotal observations at other roosts within Moreton Bay have seen increases in counts of resident waders and thus the lower counts could also reflect a reduction in the attractiveness of the POB.

Individual species counts

For individual species, there is some indication of long-term patterns in counts. However, none of these patterns have been investigated statistically, other than through an examination of variances (Table 6). This analysis of variance shows that there is considerable month-to-month count variability. It is unlikely any year-to-year change in mean summer counts will prove to be statistically significant without several more years of data. I suggest that the best approach is to examine the graphs for any possible trends in the data and to watch for any unexpectedly low count as discussed in the next section.

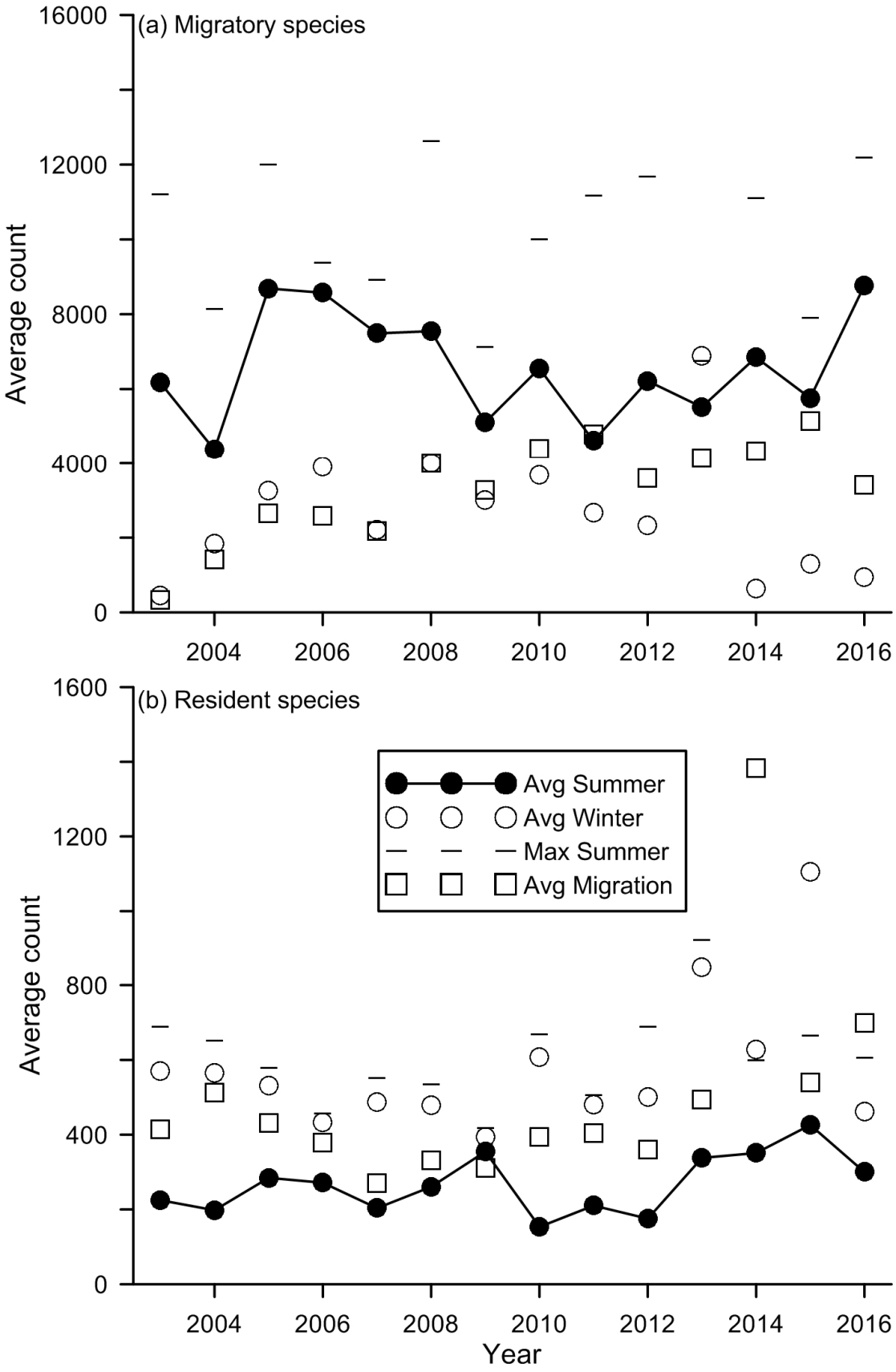
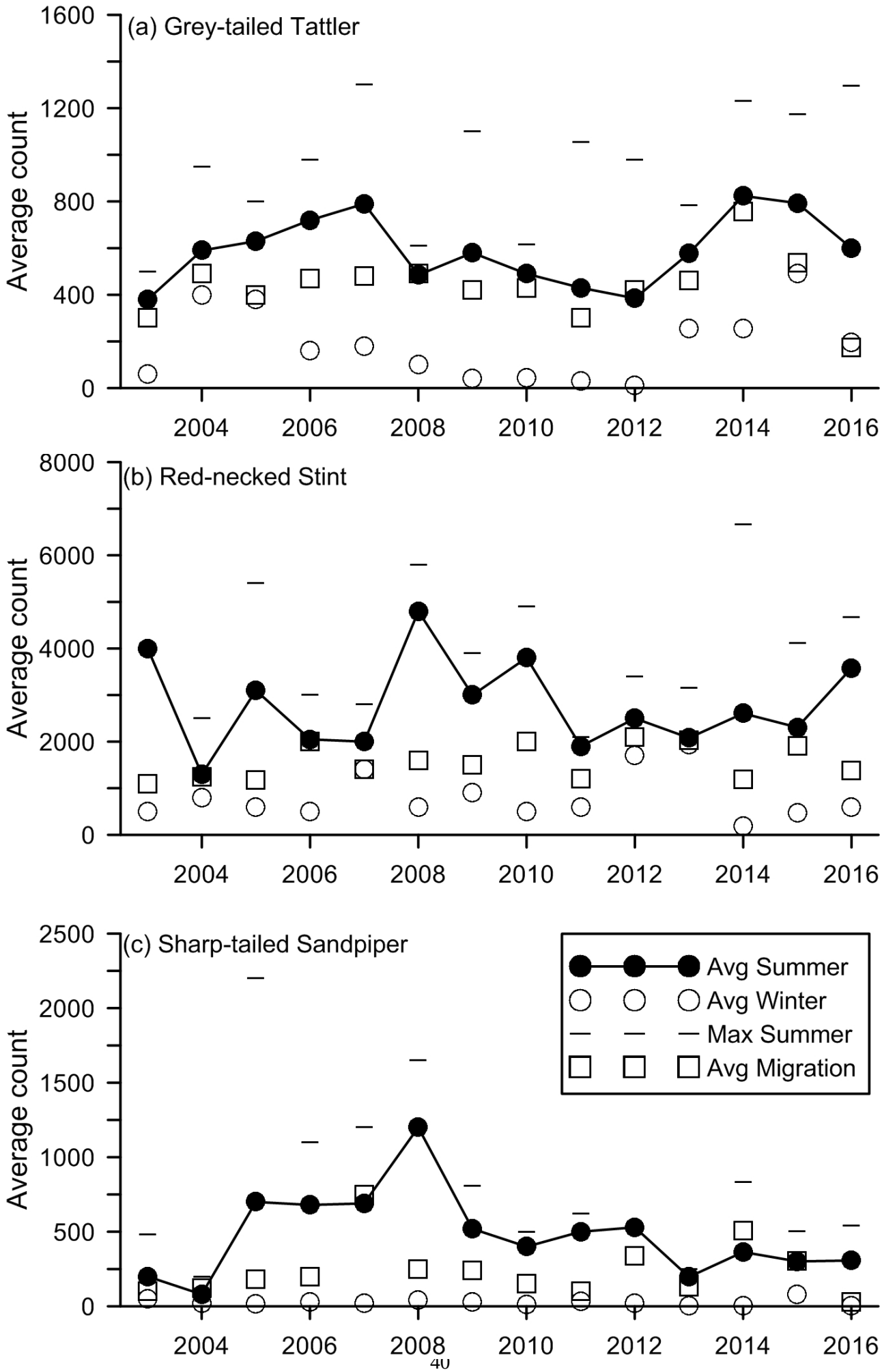
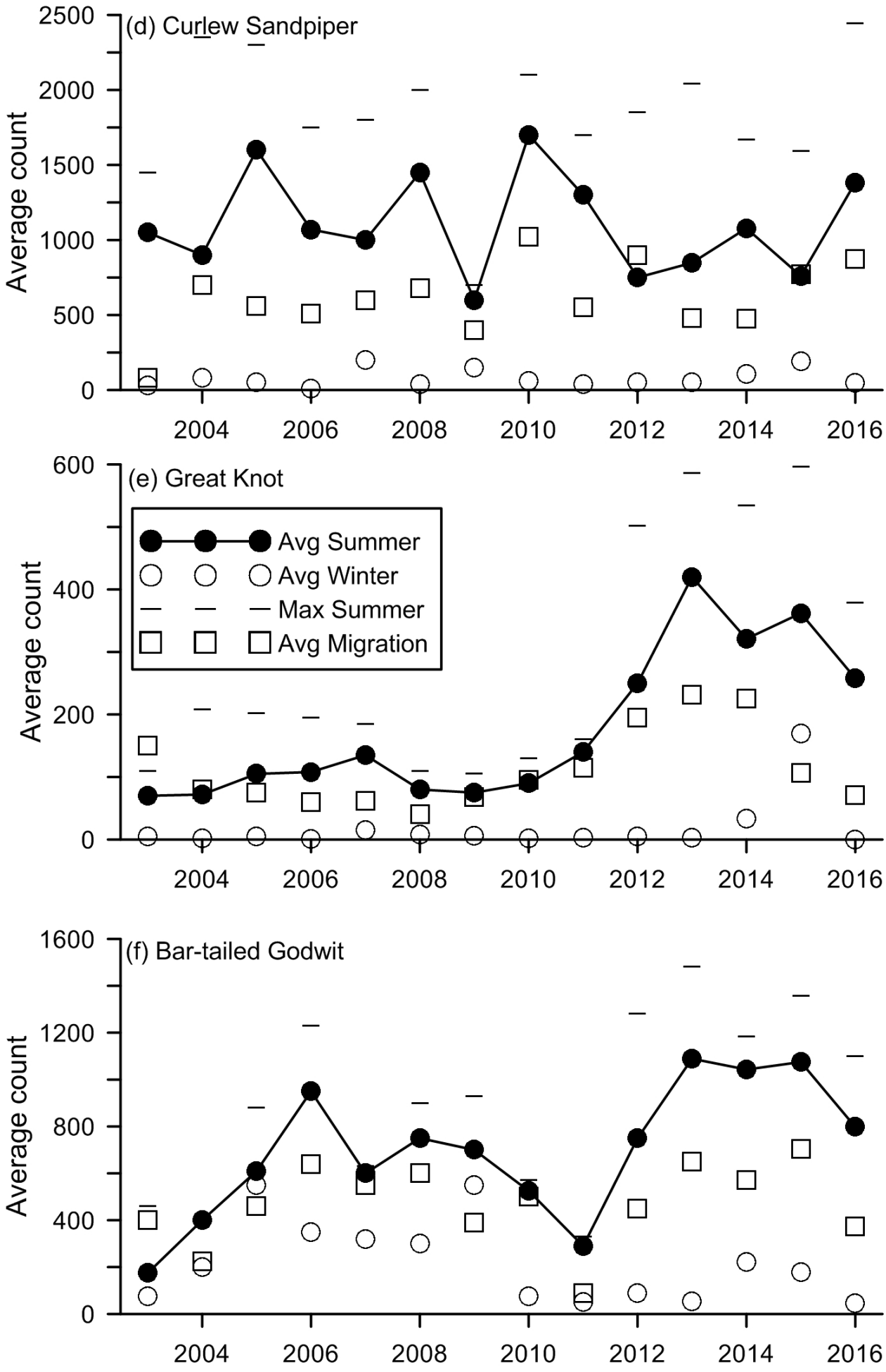
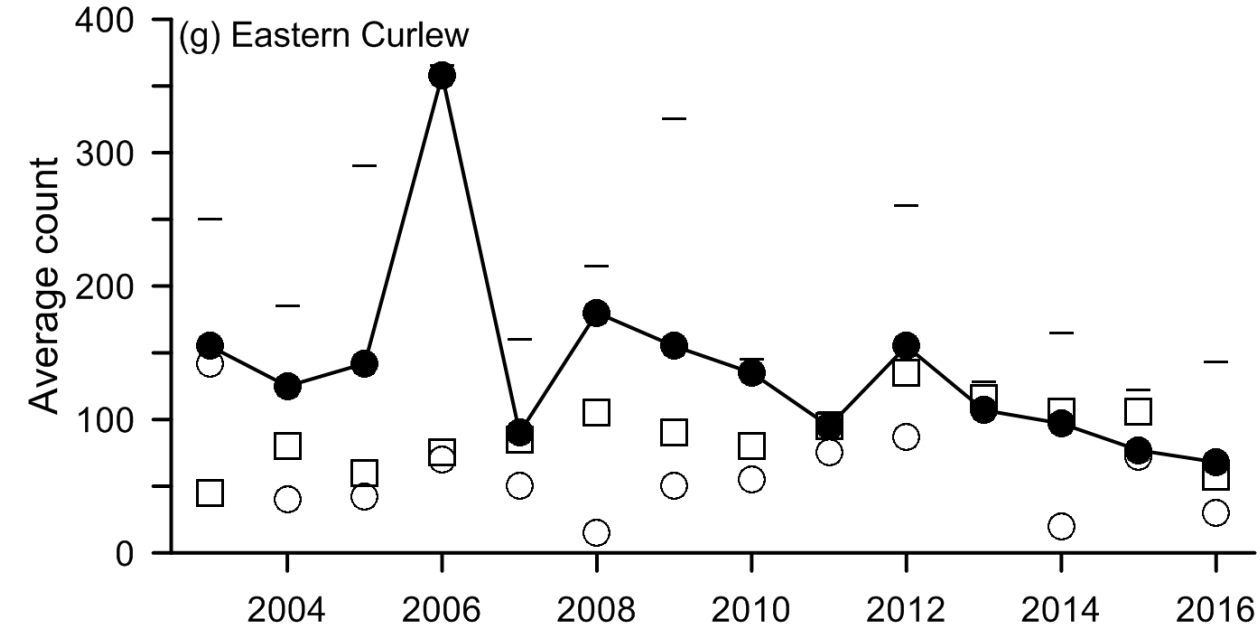
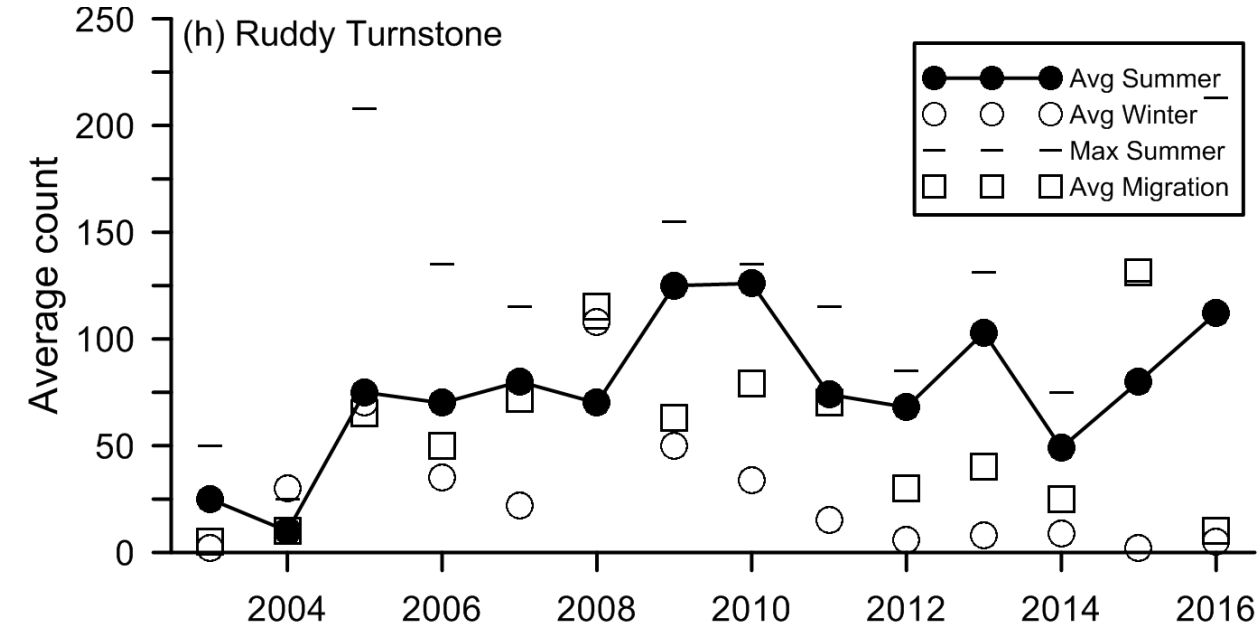


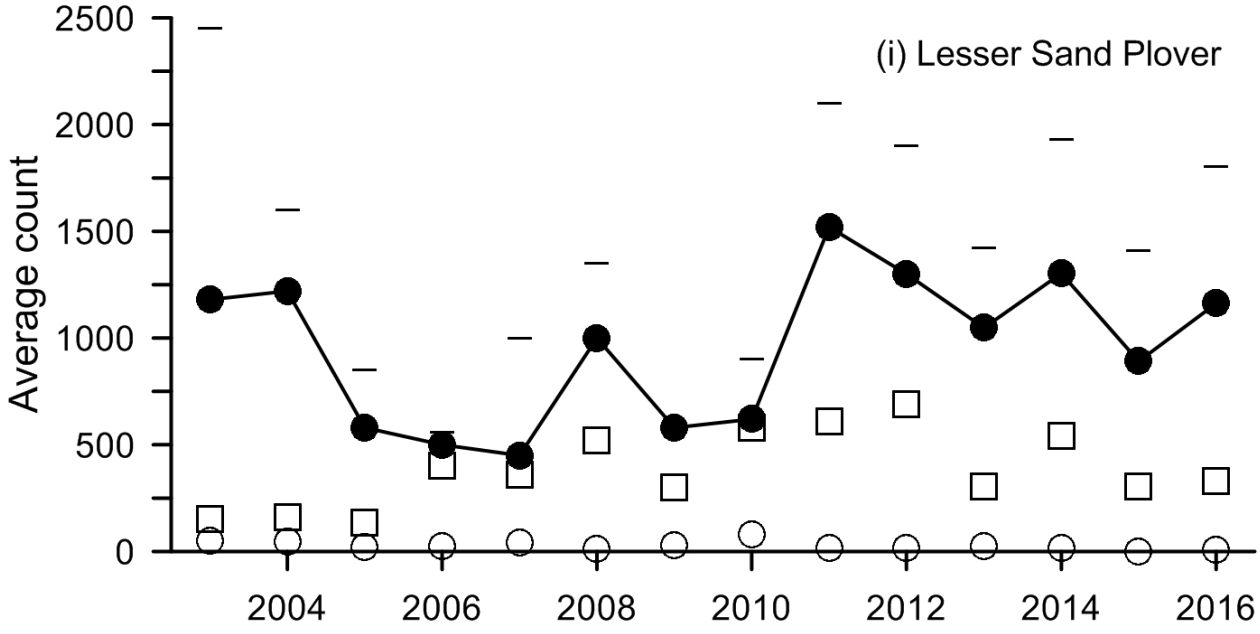
Figure 6. Average counts for each season and "wader" year since 2003 for all migratory and all resident waders throughout the POB lands, including the claypan (FICP). W: winter (June to August); S: summer (mid November to mid-March); M: migration periods (south – September to mid-November and north – mid-March to end of May). The "wader" year runs from the southward migration through to winter.


(a) Grey-tailed Tattler
Average count
1600
1200
800
400
0
2004
2006
2008
2010
2012
2014
2016
(b) Red-necked Stint
Average count
8000
6000
4000
2000
0
2004
2006
2008
2010
2012
2014
2016
(c) Sharp-tailed Sandpiper
Average count
2500
2000
1500
1000
500
0
2004
2006
2008
2010
2012
2014
2016
Avg Summer
Avg Winter
Max Summer
Avg Migration


(d) Curlew Sandpiper
Average count
2500
2000
1500
1000
500
0
2004
2006
2008
2010
2012
2014
2016
(e) Great Knot
Average count
600
400
200
0
Avg Summer
Avg Winter
Max Summer
Avg Migration
(f) Bar-tailed Godwit
Average count
1600
1200
800
400
0


(g) Eastern Curlew
Average count
400
300
200
100
0
2004
2006
2008
2010
2012
2014
2016


(h) Ruddy Turnstone
Average count
250
200
150
100
50
0
Avg Summer
Avg Winter
Max Summer
Avg Migration
2004
2006
2008
2010
2012
2014
2016


(i) Lesser Sand Plover
Average count
2500
2000
1500
1000
500
0
2004
2006
2008
2010
2012
2014
2016

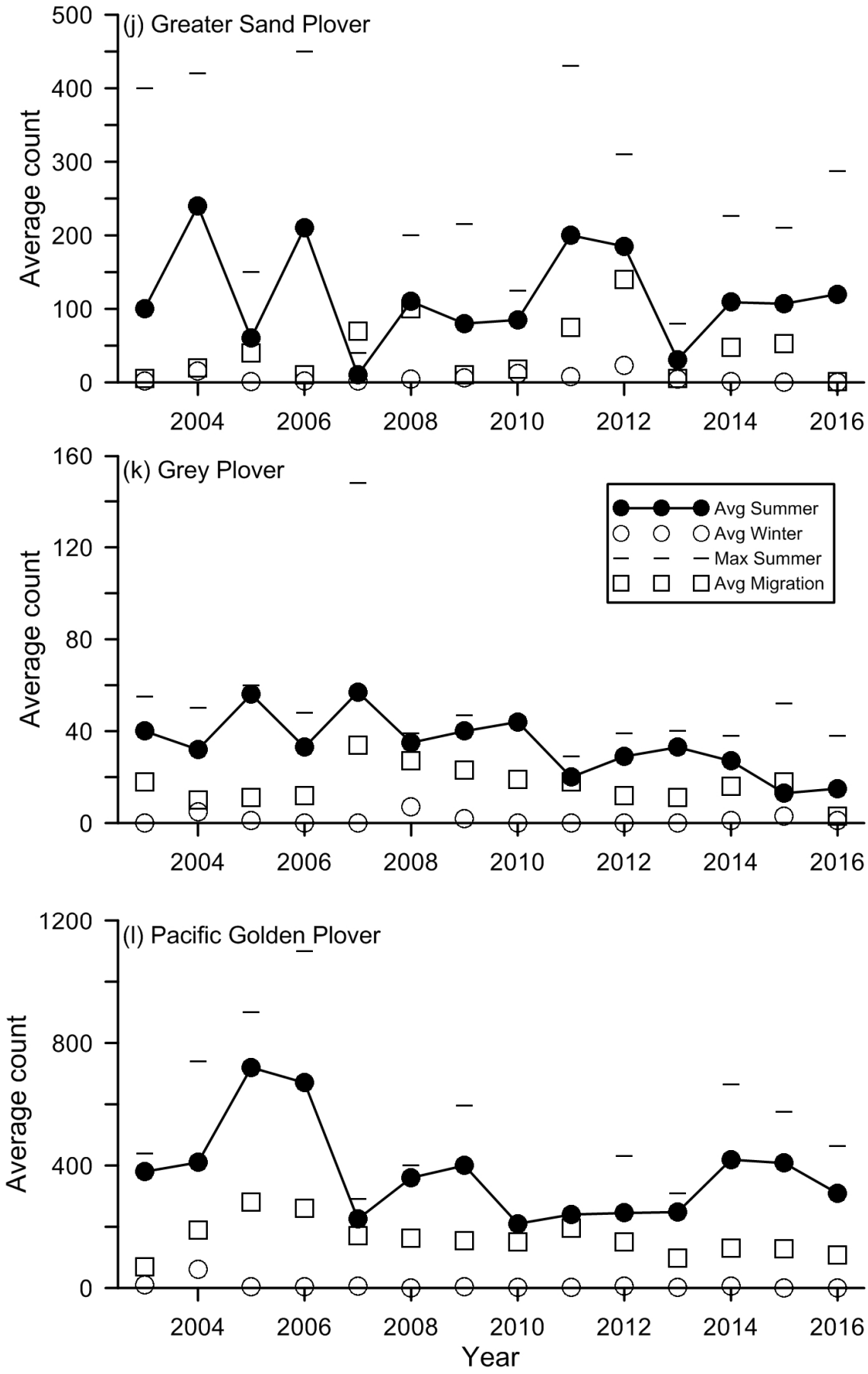


Figure 7. Average annual counts of 12 species of wader in the POB lands (including the claypan) (Fig. 1) for different seasons: Winter (n = 2), Summer (n = 5), and Migration (n = 4)) and maximum summer counts.

Average counts of Grey-tailed Tattler show a steady rise until 2007, then a reduction in 2008 to return to the longer-term average count in 2013. The mean summer count during the last year reduced from the recent highest counts in the previous two years. Numbers of Red-necked Stint have fluctuated from year to year. The mean summer count was similar to those made during the last five years and appear to be a distinct shift to a lower number after the higher counts seen in 2008 – 2010. The mean 2016 – 2017 Sharp-tailed Sandpipers count was similar to that in 2015 – 2016. This was the second lowest count since 2004 and may reflect the continuing lack of surface water in the reclamation ponds during the 2016 – 2017 "wader" year. Other factors known to influence coastal Sharp-tailed Sandpiper counts include the extent of recent inland rain.

Curlew Sandpiper counts have fluctuated with peaks every 2 to 3 years. The mean count increased substantially in 2016 – 2017 and was among the highest observed since 2003. In contrast, Great Knot counts were lower than in recent years. This may reflect a stabilisation of the recent trend of increasing Great Knot counts that has been seen in other regions in south-eastern Queensland such as the Great Sandy Strait (Milton unpubl. data). Bar-tailed Godwit counts reduced from the higher mean counts seen in the previous two years. The mean 2016 – 2017 was similar to the long-term mean of all counts since 2003.

Eastern Curlew counts have been showing a fairly consistent downward trend since the unusually high count in 2006. The mean Eastern Curlew count in 2016 – 2017 was among the lowest since 2003. This trend may be due to reductions in the availability of their preferred roosting habitat within the POB reclamation area or the result of the documented regional and national decreases in counts (Wilson et al. 2011; Clemens et al. 2016). In contrast, Ruddy Turnstone numbers appear to be stable, following the two lowest average counts recorded in 2003 and 2004. The mean summer 2016 – 2017 count was higher than the low 2014 – 2015 count. Lesser Sand Plover continues to occur on the POB reclamation in internationally-significant numbers. The mean summer counts appear to be fluctuating around the long-term mean. By comparison, the counts of Greater Sand Plover are much more variable than for Lesser Sand Plover. The count in 2013 – 2014 was the lowest since the program began in 2003. However, the mean summer count since 2014– 2015 have been closer to the long-term mean.

The mean summer count for Grey Plover continues to show a slow overall downward trend that began in 2007 – 2008. The mean Grey Plover summer counts in 2015 – 2016 was the lowest since intense monitoring began in 2003 and the 2016 – 2017 counts were similarly low. There is some evidence that Grey Plover are using alternate roosts within Moreton Bay (Tables 5 and 7). The POB reclamation area regularly held the entire Moreton Bay population of Grey Plover and this has reduced to an average of 85% in 2016 – 2017 (Table 5). In contrast, the mean summer count of Pacific Golden Plover has reduced in 2016 – 2017 from recent years. However, the mean summer count still remains relatively stable around the longer term mean since 2007 – 2008.

LOW COUNT THRESHOLDS FOR EACH IMPORTANT SPECIES

Low summer count thresholds for individual counts made on the POB land (including the claypan) were calculated as the lower 90% confidence limit of the sample mean of all post 2002 summer counts (November – March) excluding the period being considered (November 2016 – March 2017) (Table 6). These values were calculated with the natural log transformed non-zero counts for each summer survey in the POB area since 2003. This figure is the lower threshold of any single count that may be expected to occur by chance on average once in ten counts (every two years).

Table 6. Low count thresholds (see text) and standard deviation of the untransformed non-zero summer counts since 2003. Survey months in 2016 – 2017 when counts of the twelve important migratory wader species were below the Low count threshold are also provided.

Species	Low count threshold	standard dev.	Triggers in 2016 – 2017
Grey-tailed Tattler	700	483	November – January, March
Red-necked Stint	2403	2207	–
Sharp-tailed Sandpiper	293	665	December, January, March
Curlew Sandpiper	938	984	January, March
Great Knot	120	260	January, March
Bar-tailed Godwit	602	522	February
Eastern Curlew	101	121	December, February, March
Ruddy Turnstone	60	93	November, March
Lesser Sand Plover	804	782	March
Greater Sand Plover	58	201	–
Grey Plover	26	26	February, March
Pacific Golden Plover	363	258	November, February, March

Ten of the 12 important migratory species of shorebird had at least one count below the Low count threshold during the 2016 – 2017 summer (Table 6). Many species had extended periods when counts were below the threshold. Examining the Index of Relative Importance (IRI; Fig. 2) for the 10 species with counts below the Low count threshold suggests that most species have roosted at other sites within Moreton Bay (Table 7). However, for some species such as Sharp-tailed Sandpiper and Pacific Golden Plover, counts were also low in Moreton Bay during 2016 – 2017. Recent analysis of national trends in counts of waders found that both of these species had populations that were significantly decreasing (Clemens et al. 2016). Low coastal counts of Sharp-tailed Sandpiper occur during years when ephemeral inland wetlands have water. However, this is not the case for Pacific Golden Plover and the cause of lower counts in Moreton Bay are unclear.

Table 7. The months and the number of species each month that had counts below the Low count threshold (<90% long-term expected mean count) based on counts made since January 2003 within the POB Pty Ltd land, including the claypan. Two possible explanations are highlighted: grey = moved to other roosts within Moreton Bay; blue = overall below longer term mean count for the species at high tide roosts in Moreton Bay that were surveyed by QWSG.

Species	Month below Low count threshold				
	November	December	January	February	March
Grey-tailed Tattler					
Red-necked Stint					
Sharp-tailed Sandpiper					
Curlew Sandpiper					
Great Knot					
Bar-tailed Godwit					
Eastern Curlew					
Ruddy Turnstone					
Lesser Sand Plover					
Greater Sand Plover					
Grey Plover					
Pacific Golden Plover					
Number of species	**3**	**3**	**4**	**4**	**9**

For the other species that have chosen to roost elsewhere within Moreton Bay, the values below the trigger should be used to stimulate a closer examination of the data. A few species have been showing a reducing trend in their IRI and/or overall count in the POB reclamation area for some time (Eastern Curlew, Red-necked Stint, Sharp-tailed Sandpiper). Roosting locations are usually close to feeding areas (Zharikov and Milton 2009), so one possible explanation of the reductions in counts of birds roosting at the POB reclamation area by these species may be reduced local food supply. Red-necked Stint and Sharp-tailed Sandpiper opportunistically take advantage of the enriched food supply in newly-pumped dredge spoil. The slowing of the rate of reclamation within the POB land has probably reduced the attractiveness of the reclamation area to these species. In the case of Eastern Curlew, the majority roost in the claypan as they are the most wary migratory wader and prefer to roost on open habitats surrounded by mangroves (Zharikov and Milton 2009). The reduced use of the claypan by Eastern Curlew suggests that it may be becoming too vegetated as small mangrove seedlings colonise the claypan or it has been drier for longer periods than in the past. Birds appear to be choosing alternate roosts such as the nearby claypan at Lytton or Geoff Skinner Reserve further south at Wellington Point.

Overall, the results show an increase in the number of months with unpredicted low counts for most species compared with previous years. The first year when there was an unpredicted increase in the number of low counts was in 2015 – 2016. This has further increased in 2016 – 2017 and the number of months that each species had low counts also increased (Tables 6 and 7). This contrasts with increased counts of most of these species elsewhere in Moreton Bay. It suggests that the conditions in the POB reclamation area are becoming less attractive than previously and so most species are dispersing to other parts of Moreton Bay. The two exceptions appear to be Sharp-tailed Sandpiper and Pacific Golden Plover (Table 7). Sharp-tailed Sandpiper counts were below the long term mean in Moreton Bay, suggesting they may have dispersed inland or further south in Australia due to the dry conditions in south-eastern Queensland. In the case of Pacific Golden Plover, the cause of the lower counts within Moreton Bay are less clear and would require additional more detailed analysis.

BANDING RECOVERIES

There have now been 259 birds of 11 species of migratory waders caught and banded in the POB reclamation area between 2014 and 2017. There was only one successful catching event in the POB reclamation area in 2016 – 2017. Most of the banding activity in the POB reclamation area in 2016 – 2017 was focussed on capturing Pacific Golden Plover in order to attach satellite transmitters. This meant that opportunities to catch other species were forgone during other catching events. The only successful catch was made on 27 November 2016 when 48 birds of six species were caught. Most of these birds were Red-necked Stint, although the catch also included six Ruddy Turnstones. These were the first Ruddy Turnstone caught in the POB reclamation area.

There were 10 resightings from the 63 birds banded in 2014 – 2015 up to 29 August 2015 (16%). Since then, the number of resightings has greatly increased and there have now been 139 resightings (54%) of the 259 banded birds up to the end of June 2017. All resightings in 2014 – 2015 were in Moreton Bay, including four within the POB reclamation area. In 2015 – 2016, there have been multiple resightings of three species overseas (Table 8). A Bar-tailed Godwit was seen in Japan on northern migration, as was a Great Knot and Pacific Golden Plover. Other Great Knot were also seen on northern migration in Korea and Taiwan in early to mid-April.

QWSG member Robert Bush was part of an expedition team that resighted three Great Knot banded in the POB reclamation area during southward migration in July 2016 (Table 8). The birds were seen on the western coast of the Kamchatka Peninsula in eastern Russia at an estuary that is close to their breeding grounds in north-eastern Siberia. This suggests that these were adults that had either just completed nesting or had failed breeding and commenced southern migration back to Australia.

The increasing number of local resightings of flagged birds provides insight into the movement and feeding patterns of these species. The large number of resightings of several species at the Wynnum Esplanade suggests that the intertidal areas south of the POB are a major feeding area for birds roosting within the POB reclamation area. Other large intertidal areas north of the mouth of the Brisbane River from Luggage Point

to Nudgee and Sandgate appear to be important for Pacific Golden Plover roosting at the POB. Observer coverage along this part of the western Moreton Bay foreshore is low, mostly due to restricted access around the airport. This will lead to under-estimating the relative importance of these intertidal areas to waders roosting at the POB reclamation area.

As more waders are banded within the POB reclamation area, additional resightings would be expected during their migrations through eastern Asia. Three of the nine overseas resightings were from Japan. Although Japan is considered an important migration stopover location, the main stopover for most birds of these species is believed to be in the Yellow Sea along the Chinese and Korean coasts.

RECOMMENDATIONS

The analysis does not identify any clear trends in changes in the count of each wader species in the POB reclamation area since 2003, with the possible exception of Eastern Curlew Grey Plover. However, these data and the experience of QWSG members during the 14 years of intensive monitoring of the site do suggest some recommendations that maybe helpful in maintaining the wader populations within the POB land.

1. The monitoring of waders and waterbirds within the POB reclamation area continues with the same intensity and data recording detail. These data should be sufficient to inform the POB of substantial changes in counts of the most abundant species.

2. The POB consider an analysis of patterns of habitat type use by waders based on the accumulated 14 years of hard-copy records of the existing habitat types recorded each month on the data sheets. This analysis will better inform the proportions of each habitat required to support the existing wader populations as the POB approaches full reclamation. It will also identify those species with less flexibility in habitat choice and help explain changes in species abundance or composition. It would also potentially identify habitat construction/maintenance priorities and options.

3. Sufficient quantity of each of the roosting habitat types preferred by the 12 species that are present in nationally and internationally-important numbers should be maintained. These habitats include wet margin of ponds, dry rubble/broken ground, shallow pools up to 5 cm deep and bund wall. As natural wetting and drying occurs throughout the year changes the availability of the most widely preferred shallow ponded habitat type, the POB could attempt to ensure all habitat types remain available in sufficient quantity.

4. The POB currently provides the majority of roosting habitat in Moreton Bay for four species of migratory wader that occur in internationally or nationally-significant numbers within the POB reclamation area. The POB needs to better understand the habitat use of the reclamation area by these species (Curlew Sandpiper, Greater and Lesser Sand Plovers and Ruddy Turnstone) in order to plan for the future when the redevelopment of the site is complete.

Table 8. Details of the captures and resightings of waders caught and banded in the POB reclamation area in 2014 – 2017. N = number captured or resighted on each date.

Species	Capture date	Captured (N)	Resighting date	Resightings (N)	Resighting location	Leg flag code
Bar-tailed Godwit	22 November 2015	1	–	–	–	–
	28 February 2016	13	6 March 2016	1	Manly Harbour	CPT
			20 March 2016	1	Manly Harbour	CPT
			5 April 2016	1	Oyster Point, Cleveland	CPT
			19 April 2016	1	Manly Harbour	CPT
			10 April 2016	1	Saga, JAPAN	CPC
			6 August 2016	1	Wynnum Esplanade	CPD
			August 2016 – June 2017	13	Manly Harbour (3 different birds)	
			29 November 2016	1	Toorbul roost, Pumicestone Passage	
			20 December 2016	1	Brisbane airport mudflat	
	27 November 2016	1	–	–	–	
Broad-billed Sandpiper	30 November 2014	2	–	–	–	–
	28 February 2016	1	–	–	–	–
Curlew sandpiper	30 November 2014	1	12 March 2016	1	Sandgate	ASC
	1 March 2015	2	–	–	–	–

Species	Capture date	Captured (N)	Resighting date	Resightings (N)	Resighting location	Leg flag code
	22 November 2015	1	–	–	–	–
	27 November 2016	1	20 December 2016	1	Brisbane airport mudflat	AZA
			24 March 2017	1	Stockton Bridge, Newcastle, NSW	AZA
Great Knot	22 November, 2015	83	30 January 2016	1	Wynnum Esplanade	BRY
			2 April 2016	1	Wynnum Esplanade	CMY
			14 February 2016	2	Port of Brisbane outer FPE	BRY, CMJ
			24 January 2016	1	Kakadu Beach, Bribie Is	BRP
			30 January 2016	1	Toorbul, Bribie passage	BRJ
			22 – 24 March 2016	2	Oyster Point, Cleveland	CMX
			8 April 2016	1	Alphae Island, KOREA	BNL
			13 April 2016	1	Asa R estuary, Yamaguchi-shi, JAPAN	CMC
			17 April 2016	1	Geumdeung-ri, Jeju Is, KOREA	BTS
			19 April 2016	1	Zhuangwei Yi-lan County TAIWAN	CNP
			23 April 2016	1	Toorbul, Bribie passage	BTL
			4 July 2016	1	Northern Kamchatka Peninsula, RUSSIA	BTK
			9 July 2016	1	Northern Kamchatka Peninsula, RUSSIA	BTJ
			26 July 2016	1	Northern Kamchatka Peninsula, RUSSIA	BNJ

Species	Capture date	Captured (N)	Resighting date	Resightings (N)	Resighting location	Leg flag code
			1 August 2016		Northern Kamchatka Peninsula, RUSSIA	CMM
			6 September – 5 March 2017	27	Manly harbour roost (15 birds)	
			6 September – 5 March 2017	10	Wynnum Esplanade (8 birds)	
			15 September 2016	1	Maaroom, Great Sandy Strait	CMB
			27 September 2016	2	North Pine River wetlands	CMP, CNH
			28 September 2016	1	Thorneside Esplanade	BRY
			6 March 2017	1		BTT
			1 April 2017	1	Wenzhou Bay Zhejiang China	BNP
			13 April 2017	1	Aphae Island (south) South Korea	CMX
			29 April 2017	1	Torinoumi Wafari Miyagi Japan	BRJ
Greater Sand Plover	30 November 2014	1	–	–	–	–
	1 March 2015	1	–	–	–	–
Grey-tailed Tattler	22 November 2015	1	–	–	–	–
	27 November 2016	4	28 December 2016 – 10 April 2017	4	Manly harbour	BHE
Lesser Sand Plover	30 November 2014	19	8 February 2015	3	PBAR, PBC3	APZ
			7 March 2015	1	Wynnum Esplanade	APT
			28 March 2015	1	Wynnum Esplanade	APT

Species	Capture date	Captured (N)	Resighting date	Resightings (N)	Resighting location	Leg flag code
			4 April 2015	1	Wynnum Esplanade	APT
			12 December 2015 – 4 April 2016	6	Wynnum Esplanade	APT
			5 – 28 March 2016	3	Wynnum Esplanade	ALU
			20 Dec 2016 – 25 March 2017	5	Manly harbour	APT
	1 March 2015	18	20 May 2015	1	Geoff Skinner Reserve, Wellington Pt	AKY
			26 Dec 2016 – 21 February 2017	6	Manly harbour	AKX, ALU, ALR
	22 November 2015	9	–	–	–	–
	27 November 2016	3	9 January 2017	1	Reef Point, Scarborough	AST
Pacific Golden Plover	30 November 2014	7	14 December 2014	1	PBR3	–
			11 January 2015	1	Sandgate	BVA
			12 March 2015	1	Sandgate	BVA
			18 March 2016	1	Sandgate	BVD
			19 January 2017	1	Clontarf west claypan	BTA
	22 November, 2015	4	17 January 2016	1	Nudgee Beach	BTC
	28 February 2016	34	18 March 2016	8	Sandgate	various
			24 April 2016	1	Oosukatsu, Ibaraki, JAPAN	BUA
Red-necked Stint	30 November 2014	2	–	–	–	–

Species	Capture date	Captured (N)	Resighting date	Resightings (N)	Resighting location	Leg flag code
	1 March 2015	7	16 November 2016	1	North Pine River wetlands	L3
	22 November 2015	4	–	–	–	–
	28 February 2016	1	–	–	–	–
	27 November 2016	30	30 April 2017	1	Wynnum Esplanade (low tide)	S5
Ruddy Turnstone	27 November 2016	6	13 March 2017, 30 May 2017	2	Manly harbour	APJ
Sharp-tailed Sandpiper	1 March 2015	3	11 April 2015	1	Wynnum Esplanade	AEP
TOTAL		259		136		

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