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Dungarvan Harbour SPA: Monitoring of waterbird distribution across the tidal cycle.

2020-2021

Lead Agency: Marine Institute

Authors: ATKINS:

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Summary

This report presents the results of the tidal cycle waterbird monitoring that was carried out at Dungarvan Harbour in the winter of 2020/21. The objectives of the monitoring were to continue the monitoring work carried out in previous winters, and to provide data that could contribute towards the development of the Individual-based Model (IBM) for Dungarvan Harbour.

Six tidal cycle counts were carried out between November 2020 and March 2021. These counts monitored the distribution of Grey Plover, Bar-tailed Godwit, Knot, Dunlin, Ringed Plover and Sanderling across the ebb tide, low tide and flood tide periods. The tidal cycle monitoring protocol was adapted from the version used in previous winters to obtain finer grained data on the percentages of birds feeding, which can then be used to validate the IBM.

The broad patterns of the spatial distribution and movements of the monitored species across the tidal cycle indicated by the counts were generally similar to previous winters.

The overall numbers of most of the species were generally similar to recent winters, and the trends over the monitoring period are generally similar to those shown by I-WeBS data. However, Knot numbers were exceptionally high in 2020/21, while Sanderling numbers have shown an increasing trend across the monitored winters, and the Bar-tailed Godwit population seems to have declined since a period of high numbers in 2011/12-2015/16.

The tidal cycle waterbird monitoring since 2014/15 has added to the evidence base supporting the conclusions about the high sensitivity of Grey Plover, Bar-tailed Godwit, Knot, Ringed Plover and Sanderling to oyster trestle cultivation from previous work. However, the response of Dunlin to oyster trestle cultivation may be more complex than previously indicated.

1. Introduction

1.1. Scope

This report presents the results of the waterbird monitoring that was carried out at Dungarvan Harbour in the winter of 2020/21. The objectives of the monitoring were to continue the monitoring work carried out in previous winters, and to provide data that could contribute towards the development of an Individual-based Model (IBM) for Dungarvan Harbour.

1.2. Context

Research carried out on the interactions between oyster trestle cultivation and waterbirds (the trestle study; Gittings and O'Donoghue, 2012, 2016) showed that various waterbird species appear to be displaced from areas occupied by oyster trestles. Based on this research, an Appropriate Assessment report (Gittings and O'Donoghue, 2014) concluded that oyster trestle cultivation in Dungarvan Harbour may be causing significant displacement impacts to the populations of four of the waterbird species for which the SPA was designated: Grey Plover, Bar-tailed Godwit, Knot and Dunlin. However, from the limited data available, there was no evidence that the long-term population trends of these species were being affected.

Following on from the Appropriate Assessment report, monitoring of waterbird species that are potentially negatively affected by oyster trestle cultivation was carried out at Dungarvan Harbour over five of the six winters between 2014/15 and 2019/20 (Gittings and O'Donoghue, 2015, 2018a, 2018b, 2019; KRC, 2020). This monitoring investigated the distribution and movement patterns of the species sensitive to oyster trestle cultivation in Dungarvan Harbour across the tidal cycle (tidal cycle counts), and the usage of the Bird Corridor, which is an area of intertidal habitat that was cleared of trestles in 2017 (Bird Corridor monitoring). This monitoring has collected a large amount of data on the distribution and movement patterns of these species and has demonstrated varying levels of apparent avoidance of the oyster trestles by these species. However, due to the lack of monitoring data from before the introduction of oyster trestle cultivation, uncertainty remains about the degree to which oyster trestle cultivation is responsible for these patterns, and whether it is having a negative effect on the conservation condition of the Dungarvan Harbour populations of these species. To address this uncertainty, an Individual-based Model (IBM) is being developed.

The objectives of the waterbird monitoring in 2020/21 were to continue the tidal cycle monitoring that had been carried out in previous winters, and to provide additional data relevant for the validation of the IBM. We also carried out additional disturbance studies in March 2020. The results of those studies are included in a separate report (Gittings and O'Donoghue, 2021). We did not carry out Bird Corridor Monitoring in 2020/21, because we considered that the available resources would be better used to collect data that would be directly relevant to the IBM.

The protocol used for the tidal cycle counts in previous winters comprised repeated ebb/flood tide counts of Whitehouse Bank and the adjacent section of the Inner Harbour, and a single low tide count of the whole of Dungarvan Harbour. For the 2020/21 winter, we adapted this protocol to extend the ebb/flood tide coverage to Ballyrandle Sandflats and to include repeated low tide counts of Ballyrandle Sandflats and the main section of the Inner Harbour. The purpose of these repeated counts was to obtain finer grained data on the percentages of birds feeding, which can then be used to validate the IBM.

Gittings and O'Donoghue (2014) identified four wader species that are Qualifying Interests of the Dungarvan Harbour SPA, and which appear to be negatively affected by oyster trestle cultivation: Grey Plover (*Pluvialis squatarola*), Bar-tailed Godwit (*Limosa lapponica*), Knot (*Calidris canutus*) and Dunlin (*C. alpina*). These species have been referred to as the target species in previous monitoring reports. Another two wader species that are included in the IBM also appear to be negatively affected by oyster trestle cultivation: Ringed Plover (*Charadrius hiaticula*) and Sanderling (*C. alba*). These species are not Qualifying Interests of the Dungarvan Harbour SPA and were referred to as additional monitored species in previous monitoring reports. As all six of these species are equally treated by the IBM, these species are collectively referred to as IBM target species in the present report. Two other additional monitored species were included in the previous monitoring work: Light-bellied Brent Goose and Golden Plover. However, these species are not included in the IBM. Therefore, given the additional monitoring requirements due to the adaptation of the tidal cycle monitoring protocol (see above), these species were not included in the 2020/21 waterbird monitoring.

1.3. Personnel

The survey design, analysis and report writing was carried out by Tom Gittings. Paul O'Donoghue assisted with project design, document preparation and undertook document review. The fieldwork was carried out by Tom Gittings, Lesley Lewis, John Meade, Tony Nagle, Mark Shorten and Pat Smiddy.

2. Methods

2.1. Study area and count sectors

Dungarvan Harbour was divided into three broad zones by Gittings and O'Donoghue (2014) for the purposes of broad-scale analyses of waterbird distribution: the Inner Harbour, the Outer Sandflats and the Outer Bay (Figure 2.1). The Outer Sandflats were also divided into two sub-zones: the Ballyrandle Sandflats and Whitehouse Bank. For the present monitoring work, the Inner Harbour zone was divided into two sub-zones: the Inner Harbour Main and the Inner Harbour Upper. This division reflects the distribution patterns of the target species, which rarely occur in the Inner Harbour Upper.

The Bird Corridor is a 400m wide corridor extending from the upper to the lower edges of the oyster trestle zone in the northern part of sector OY2 (Figure 2.1).

The count sectors used in this study are shown in Figure 2.1. In the Ballyrandle Sandflats and Whitehouse Bank, the counts used the sectors defined for the trestle study (Gittings and O'Donoghue, 2012). However, sector OY2 was subdivided between the Bird Corridor and the remaining area of the sector. In the Inner Harbour, the counts used the NPWS Waterbird Survey Programme subsites.

The oyster trestles occur within the lower part of Whitehouse Bank (sectors OY1-OY4; Figure 2.1). The most recent mapping available of the trestles across the whole of Whitehouse Bank is from 2019, which was provided by the Department of Agriculture, Fisheries and the Marine.

2.2. Survey design

The survey included four components: -

- 30 minute ebb tide counts: a series of four counts at 30 minute intervals across the ebb tide period, covering Ballyrandle Sandflats, Whitehouse Bank and most of the Inner Harbour Main.
- 30 minute low tide counts: a series of up to eight counts at 30 minute intervals across the low tide period (also including the end of ebb/ tide and start of the flood tide), covering Ballyrandle Sandflats, most of the Inner Harbour Main, and part of the upper shore of Whitehouse Bank.
- Single low tide counts: a single low tide count covering the lower shore of Whitehouse Bank, and the other areas not covered by the 30 minute low tide counts.
- 30 minute ebb tide counts: a series of four counts at 30 minute intervals across the ebb tide period, covering Ballyrandle Sandflats, Whitehouse Bank and most of the Inner Harbour Main.

The count periods are shown in Table 2.1. The EBB1-EBB4 and FLOOD1-FLOOD4 counts covered the periods when the tideline on Whitehouse Bank was above the trestle zone but below the top of the beach. The low tide count covered the main period when the tideline was within, or below, the trestle zone. The 30 minute low tide counts did not always include all eight count periods on each date in each location, as counters took breaks during this period.

Table 2.1 Count periods used for the tidal cycle counts.

Period	Count period	Timings		Coverage		
		Start time	Finish time	Ebb/flood counts	30 minute low tide counts	Single low tide count
Ebb tide	EBB1	-04:00	-03:30	√		
	EBB2	-03:30	-03:00	√		
	EBB3	-03:00	-02:30	√		
	EBB4	-02:30	-02:00	√		
	EBB5	-02:00	-01:30		√	
Low tide	LT1	-01:30	-01:00		√	√
	LT2	-01:00	-00:30		√	
	LT3	-00:30	00:00		√	
	LT4	00:00	+00:30		√	
	LT5	+00:30	+01:00		√	
	LT6	+01:00	+01:30		√	
Flood tide	FLOOD0	+01:30	+02:00		√	
	FLOOD1	+02:00	+02:30	√		
	FLOOD2	+02:30	+03:00	√		
	FLOOD3	+03:00	+03:30	√		
	FLOOD4	+03:30	+04:00	√		

2.3. Count dates and timings

The tidal cycle counts were carried out on six dates between November 2020 and March 2021 (Table 2.3). The selection of count dates to allow full tidal cycle counts was constrained by the need to have a low tide in the middle of the day. In midwinter, with the short day length, this meant that there were only a few suitable dates each month. As the timing of the low tide is broadly linked to the spring-neap cycle, this further constrained the range of tidal conditions that could be sampled. The counts were carried out on days with low tides of 0.3-0.8 m (Table 2.3), representing spring-mean low tides (mean low water spring = 0.4 m; mean low tide = 0.75 m).

Table 2.2 Count dates and timings for the tidal cycle counts.

Date	Low tide		Count timings		
	time	height	Ebb	LT	Flood
03/11/2020	12:55	0.8 m	08:55-10:55	11:25-14:25	14:55-16:55
01/12/2020	12:06	0.8 m	08:05-10:05	10:35-13:35	14:05-16:05
31/12/2020	12:30	0.7 m	08:30-10:30	11:00-14:00	14:30-16:30
15/01/2021	13:21	0.5 m	09:20-11:20	11:50-14:50	15:20-17:20
29/01/2021	12:18	0.6 m	08:20-10:20	10:50-13:50	14:20-16:20
01/03/2021	13:15	0.3 m	09:15-11:15	11:45-14:45	15:15-17:15

Low tide data source: Admiralty tidal predictions for Dungarvan (www.ukho.gov.uk/easytide). The ebb and flood timings refer to the EBB1-EBB4 and FLOOD1-FLOOD4 count periods.

2.4. Counter organisation

All the tidal cycle counts were carried out with four counters. The areas covered by each counter on each count are shown in Table 2.5. The two coverage sequences were used on alternate counts to allow the direction of the low tide coverage of Whitehouse Bank to be alternated between working from the north to the south and working from the south to north.

Table 2.3 Coverage of the tidal cycle counts.

Period	Counter	Coverage sequence 1	Coverage sequence 2
Ebb tide	Lesley Lewis	Ballyrandle Sandflats	Ballyrandle Sandflats
	Tom Gittings	Whitehouse Bank (CS3) and Inner Harbour Main (0M419)	Whitehouse Bank (CS1)
	Mark Shorten	Whitehouse Bank (CS1)	Whitehouse Bank (CS2) and Inner Harbour Main (0M427)
	Pat Smiddy	Whitehouse Bank (CS2) and Inner Harbour Main (0M427)	Whitehouse Bank (CS3) and Inner Harbour Main (0M419)
Low tide	Lesley Lewis	Ballyrandle Sandflats	Ballyrandle Sandflats
	Tom Gittings	Whitehouse Bank (OY1-OY4, CS1 and CS4; north to south)	Whitehouse Bank (south to north)
	Mark Shorten	Inner Harbour Main (0M418) and Inner Harbour Upper	Whitehouse Bank (OY1-OY4, CS1 and CS4; south to north)
	Pat Smiddy	Inner Harbour Main (0M418, 419 and 427) and Whitehouse Bank (CS2 and CS3)	Inner Harbour Main (0M417, 418 and 427) and Whitehouse Bank (CS2 and CS3)
Flood tide	Lesley Lewis	Ballyrandle Sandflats	Ballyrandle Sandflats
	Tom Gittings	Whitehouse Bank (CS1)	Whitehouse Bank (CS3) and Inner Harbour Main (0M419)
	Mark Shorten	Whitehouse Bank (CS3) and Inner Harbour Main (0M419)	Whitehouse Bank (CS1)
	Pat Smiddy	Whitehouse Bank (CS3) and Inner Harbour Main (0M419)	Whitehouse Bank (CS2) and Inner Harbour Main (0M427)

Tony Nagle counted the sections normally covered by Mark Shorten on 03/11/2020. John Meade counted the sections normally covered by Lesley Lewis on 31/12/2020.

2.5. Count methods

On each tidal cycle count, all the IBM target species, present were counted. Birds were counted separately in each count sector and in the two sub-divisions of sector OY2. The counters also recorded the behaviour of the birds (feeding, flying or roosting/other), whether birds were in subtidal habitat, on the tideline, or in intertidal habitat away from the tideline, and whether birds were within, or outside, trestle blocks. The counters also mapped the main flock locations during each count, and recorded details of any observations of bird movements between sectors.

The counters mapped the tideline positions during each ebb/flood tide count, and (on Whitehouse Bank) during the low tide counts. On the ebb/flood tide counts the red buoys on Whitehouse Bank were used to guide the mapping of the tideline positions. On the low tide tidal cycle counts, the percentage of the tideline within the trestle blocks in each count sector was estimated (by recording the distances of tideline sections within trestle blocks and/or trestle-free areas along the transect route).

On each count day, the number of tractors in each count sector on Whitehouse Bank was counted at 30 minute intervals centred on low tide throughout their period of occurrence. The tractors were classified as working (parked or active within the trestles), travelling (moving between trestle blocks), arriving (arriving on the beach), or leaving (leaving the beach).

The counters also recorded the nature and location of any other human activity within the intertidal zone and recorded the weather conditions during the counts.

Detailed recording instructions (Gittings and O'Donoghue, 2020) were provided to the counters and the count data was recorded on standard recording forms and maps.

2.6. Data processing

All count data was entered into Excel spreadsheets and the Whitehouse Bank low tide tideline positions were digitised in QuantumGIS shapefiles. In line with internal quality assurance, we double-checked the spreadsheet and shapefile data against the original count forms to pick up any errors in data entry.

The low tide counts this winter included two types of counts: repeat counts at 30 minute intervals of Ballyrandle Sandflats, sectors 0M418, 0M419 and 0M427 in the Inner Harbour Main and sectors CS2 and CS3 on Whitehouse Bank; and single counts across the three hour low tide period of the rests of the Inner Harbour and Whitehouse Bank. To produce overall totals for the low tide period, our general approach was to take the maximum of the 30 minute counts and sum it with the total from the single count. However, we also reviewed the count data for each species to identify potential double counts between the 30 minute counts and the single counts, which could have significantly affected the overall total. In the minority of cases where the totals from the single counts were large relative to the maximum from the 30 minute counts, we reviewed the count timings to assess whether there could have been significant double counting between the single count and the maximum from the 30 minute counts.

Sector 0M418 was included in the 30 minute counts of the Inner Harbour Main by the observer on the Cunnigar. However, as this sector was very distant from the vantage point used for these counts, it was also counted by the roving counter. To avoid double-counting between these counters, we reviewed the low tide count data for this sector. We allocated the roving counter's count of the sector to one of the 30 minute count periods, based on the timing of the count. Where species were recorded in this count period by both the observer on the Cunnigar and the roving counter, we assumed that the count by the roving counter was more accurate and classified the count from the Cunnigar as a double-count. If the count from the Cunnigar had been much larger, we would have assumed that the difference represented bird movements between the exact timings of the two counts, and we would have classified the count from the roving counter as a double-count. However, these circumstances never occurred.

In addition to the above procedures, notes on bird movements, and the timings of counts, were reviewed to identify other potential double-counts. Where double-counts were identified, these were excluded from calculations of count totals.

2.7. Data analysis

Most of the data analyses presented in this report are simple tabular or graphical summaries of the survey results from 2019/20, with more detailed analyses in some cases (described below). Where relevant, we also compare the results from 2020/21 with previous winters. However, we have not included the results from 2019/20 in these comparisons, due to variation on site survey coverage.

We analysed the patterns of husbandry activity on Whitehouse Bank by calculating tractor minutes, where each tractor on each tractor count represent 15 tractor minutes (tractors arriving or leaving), or 30 tractor minutes (tractors travelling or working). The summed total of tractor minutes across the day gives an indication of the intensity of husbandry activity on that day.

We calculated Bar-tailed Godwit densities at low tide to assess their distribution patterns in relation to the presence of trestle blocks. Because, Bar-tailed Godwit mainly occur along the tideline, we used tideline length as the denominator, not intertidal area. We used the mapped tideline alignments and the data recorded on the percentage of the tideline inside the trestle blocks to calculate the tideline lengths within and outside trestle blocks on Whitehouse Bank. The tideline lengths within the relevant areas on Ballyrandle Sandflats were derived from the mapping of tidelines carried out for the AA report (see Appendix D in Gittings and O'Donoghue, 2014). This mapping provides tideline alignments and lengths for representative low tides from extreme neap to spring tide conditions. For each count day, we selected the tideline length for the appropriate tidal condition. We then calculated three sets of Bar-tailed Godwit densities: the densities within the trestle blocks, the densities outside the trestle blocks on Whitehouse Bank, and the densities outside the trestle blocks across the Outer Sandflats

(Ballyrandle Sandflats and Whitehouse Bank). We used Friedman's test to analyse the differences between these densities.

We used the 30 minute counts to analyse the pattern of feeding activity for each of the IBM target species across the tidal cycle. To do this, we summed the total counts across all sectors for each 30 minute count period on each day. We then calculated the number of feeding birds as a percentage of the total count excluding flying birds. Flying birds were mainly birds that had been flushed by tractor activity, or by the surveyor, in the trestle blocks, and may have been feeding before they were flushed, and/or after they resettled, so including them in the totals would have made the calculations of percentages of feeding birds not representative of the typical patterns of activity. We excluded counts where the total numbers of feeding and roosting birds were less than 100 (Dunlin), or less than 25 (the other IBM target species).

2.8. Datasets

The datasets that accompany this report include the full waterbird count data, tractor count data, and tideline data from the winters of 2014/15, 2016/17, 2017/18, 2018/19 and 2020/21. Metadata for these datasets are included in Appendix A.

The count data dataset (Dungarvan_waterbird_monitoring_ 2014_2021_ counts.csv) is an updated version of a dataset (Dungarvan_waterbird_monitoring_2014_2019_counts.csv) that has been previously supplied to the Marine Institute. In addition to adding the data for 2020/21, some corrections have been made to data entry errors in the count data from previous winters. These related to the coding of Location and Trestles fields. In the first monitoring winter, the datasheets used by the counters not covering the OY sectors at low tide did not include fields for recording location in relation to trestle blocks as this was not expected to be relevant. However, on some ebb/flood tide counts, these counters recorded birds within the OY sectors, and, for reasons that are not clear, the location was coded as within trestle blocks (W) for many of these records. The location field for all records by these counters of birds within the OY sectors in 2014/15 have now been recorded as NR (not recorded). There were also other cases where records had been incorrectly coded as within trestle blocks (W) and/or on trestles (OT) when they occurred in sectors without trestle blocks, or in the Bird Corridor after the removal of trestle blocks. These records have all now been recoded as outside the trestle blocks (O) in the Location field, and not on trestles (N) in the Trestles field. Note that these data entry errors do not affect any of the analyses included in the previous monitoring reports.

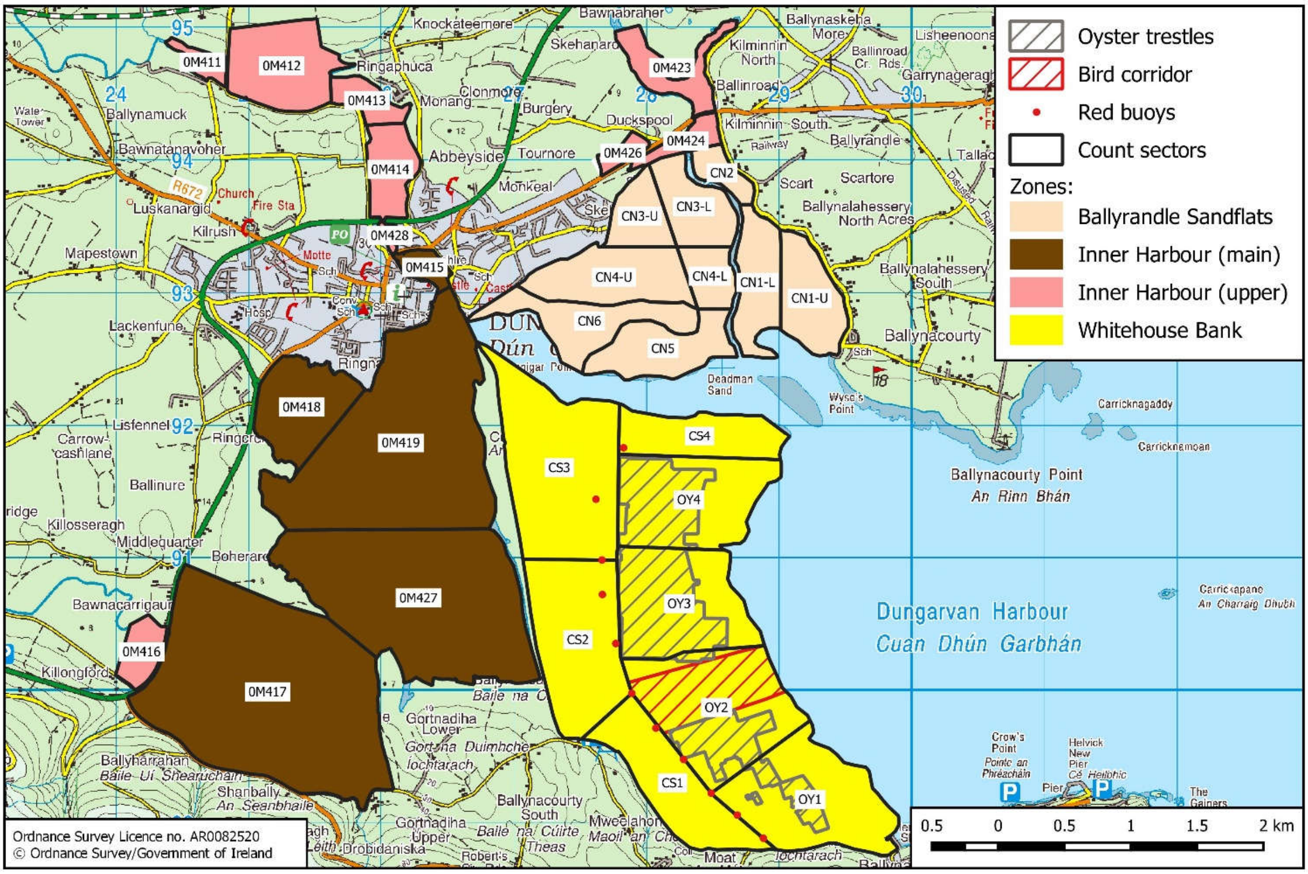


Figure 2.1 Zones and count sectors.

3. Results

3.1. Oyster cultivation activity

The most recent mapping of the trestle blocks that was available was from 2019. Compared to this mapping, there appears to have been an upshore shift of around 100-200m in the lower limit of the trestle blocks in the northern two-thirds of sector OY3 and in most of sector OY4.

The daily mean of 1,525 tractor minutes in 2020/21 was the lowest recorded in the monitored winters (Table 3.1). However, this included an exceptionally low value of 165 tractor minutes on 31/12/2020, when, presumably, most of the oyster farmers were on their Christmas holidays. Excluding this value, the tractor activity levels were very similar to the 2018/19 winter.

Table 3.1. Oyster farming tractor activity on Whitehouse Bank.

Winter	Daily tractor minutes	
	mean	range
2014/15	1,584	900-2,400
2016/17	2,060	1,455-2,625
2017/18	2,182	1,920-2,745
2018/19	1,789	1,335-2,805
2020/21 (all days)	1,525	165-2,355
2020/21 (excluding 31/12/2020)	1,797	1,215-2,355

3.2. Waterbird numbers, distribution and behaviour

The total numbers of the target species recorded across the ebb, low tide and flood tide periods on each count day are shown in Table 3.2. The highest number of peak counts occurred during the ebb/flood tide period (16 count), compared to the low tide (10 counts) and flood tide (10 counts). As in previous winters, Grey Plover often appeared to “disappear” at low tide.

The numbers of most of the IBM target species have remained broadly similar across the monitored winters (Figure 3.1). However, Bar-tailed Godwit numbers appear to have been significantly higher in 2014/15, while Sanderling numbers have shown an increasing trend, and high numbers of Knot were recorded in 2020/21.

The distribution of the IBM target species between the Inner Harbour, Whitehouse Bank and Ballyrandle Sandflats was generally similar to previous winters (Figure 3.2). However, Bar-tailed Godwit numbers on Whitehouse Bank during the ebb/flood tide counts were rather low, with higher numbers usually occurring on Whitehouse Bank at low tide. There was also one count when high numbers of Bar-tailed Godwits occurred in the Inner Harbour. This was on 29th January, when 350-425 Bar-tailed Godwits occurred in sector 0M427 on the LT5 and LT6 counts; no Bar-tailed Godwits were recorded in the Inner Harbour on the earlier low tide counts on that date.

As in previous winters, during the ebb/flood tide tides on Whitehouse Bank, the IBM target species mainly in sectors CS1 and CS2. Apart from small numbers of Bar-tailed Godwit, the IBM target species rarely occurred in sector CS1. However, during the EBB4 count on 1st December, a large mixed flock of Grey Plover, Knot, Dunlin and Sanderling occurred in the northern section of sector CS1.

During the low tide period, Bar-tailed Godwit, Dunlin, Knot, Ringed Plover and Sanderling remained on Whitehouse Bank on most counts, while Grey Plover was more erratic in their occurrence patterns. As in previous winters, Bar-tailed Godwit mainly occurred on the lower shore in sectors OY3 and OY4, while Ringed Plover and Sanderling occurred on the upper shore, mainly in sector CS3. Dunlin also regularly occurred on the upper shore in sectors CS2 and CS3. However, unlike most recent winters, Dunlin did not regularly occur on the lower shore, with only two records from this area: 84 in sectors OY3 and OY4 on 03/11/2020, and 6 in sector OY3 on 01/03/2021.

During the low tide counts in sectors OY1-OY4, total counts of 8-39 Bar-tailed Godwit were recorded within the trestle blocks, compared to 2-219 Bar-tailed Godwit outside the trestle blocks (Table 3.3). The densities of Bar-tailed Godwit along the tideline in each season are shown in Figure 3.3. The median density outside the trestle blocks was usually substantially higher than within the trestle blocks. Across all seasons, there was strong evidence that Bar-tailed Godwit densities were higher outside the trestle blocks (Friedman's test: $\chi^2 = 45.7$, Kendall's $W = 0.508$, $p < 0.001$). The mean density of Bar-tailed Godwit along the tideline was 12 birds/km within the trestle blocks, 67 birds/km outside the trestle blocks on Whitehouse Bank, and 63 birds/km outside the trestle blocks in the Outer Sandflats

Three of the IBM target species were recorded in the Bird Corridor. These records included significant flocks of Knot on two dates, and of Grey Plover and Bar-tailed Godwit on single dates (Table 3.4).

The proportions of feeding birds in the 30 minute counts in the ebb tide, low tide and flood tide periods in 2020/21, and across all counts in the previous winters, are shown in Figure 3.4. Bar-tailed Godwit, Grey Plover and Knot often had high proportions of roosting birds on the ebb tide counts. As might be expected, the proportions of feeding birds were generally highest on the low tide counts. Ringed Plover had high proportions of roosting birds on the flood tide counts, when roosts often formed on the upper shore in sector CS3. Sanderling had high proportions of feeding birds across the tidal cycle.

Table 3.2 Maximum counts of the four target species recorded during ebb, low and flood tide periods on each count day.

Species	Date	Maximum count			Daily maximum
		EBB	LT	FLOOD	
Grey Plover	03/11/2020	9	14	45	45
	01/12/2020	67	70	69	70
	31/12/2020	133	79	60	133
	15/01/2021	174	47	115	174
	29/01/2021	162	20	120	162
	01/03/2021	101	54	44	101
Bar-tailed Godwit	03/11/2020	206	195	226	226
	01/12/2020	342	403	382	403
	31/12/2020	600	371	411	600
	15/01/2021	422	336	227	422
	29/01/2021	615	678	501	678
	01/03/2021	198	265	82	265
Knot	03/11/2020	115	39	167	167
	01/12/2020	657	427	726	726
	31/12/2020	98	210	806	806
	15/01/2021	446	613	829	829
	29/01/2021	731	302	670	731
	01/03/2021	470	644	294	644
Dunlin	03/11/2020	778	602	740	778
	01/12/2020	1773	1167	1757	1773
	31/12/2020	2295	2134	1100	2295
	15/01/2021	2484	981	2122	2484
	29/01/2021	2199	1893	942	2199
	01/03/2021	1000	884	686	1000
Ringed Plover	03/11/2020	146	144	72	146
	01/12/2020	108	135	97	135
	31/12/2020	56	76	60	76
	15/01/2021	89	87	69	89
	29/01/2021	68	107	112	112
	01/03/2021	61	62	68	68
Sanderling	03/11/2020	60	103	119	119
	01/12/2020	73	92	77	92
	31/12/2020	22	39	20	39
	15/01/2021	88	63	54	88
	29/01/2021	96	126	83	126
	01/03/2021	91	91	142	142

Table 3.3 Bar-tailed Godwit counts within, and outside, trestle blocks in sectors OY1-OY4.

Date	Tideline percentage	Bar-tailed Godwit counts	
		Within trestle blocks	Outside trestle blocks
03/11/2020	75%	9	76
01/12/2020	89%	22	35
31/12/2020	91%	39	2
15/01/2021	78%	11	69
29/01/2021	84%	39	185
01/03/2021	58%	8	219

Table 3.4. Records of IBM target species in the Bird Corridor.

Species	Date	LT	FLOOD0
Grey Plover	01/12/2020	24	
	29/01/2021	1	
Bar-tailed Godwit	01/12/2020	10	
	15/01/2021	3	
	29/01/2021	4	200
	01/03/2021	10	
Knot	01/12/2020	170	
	29/01/2021		670
	01/03/2021	4	

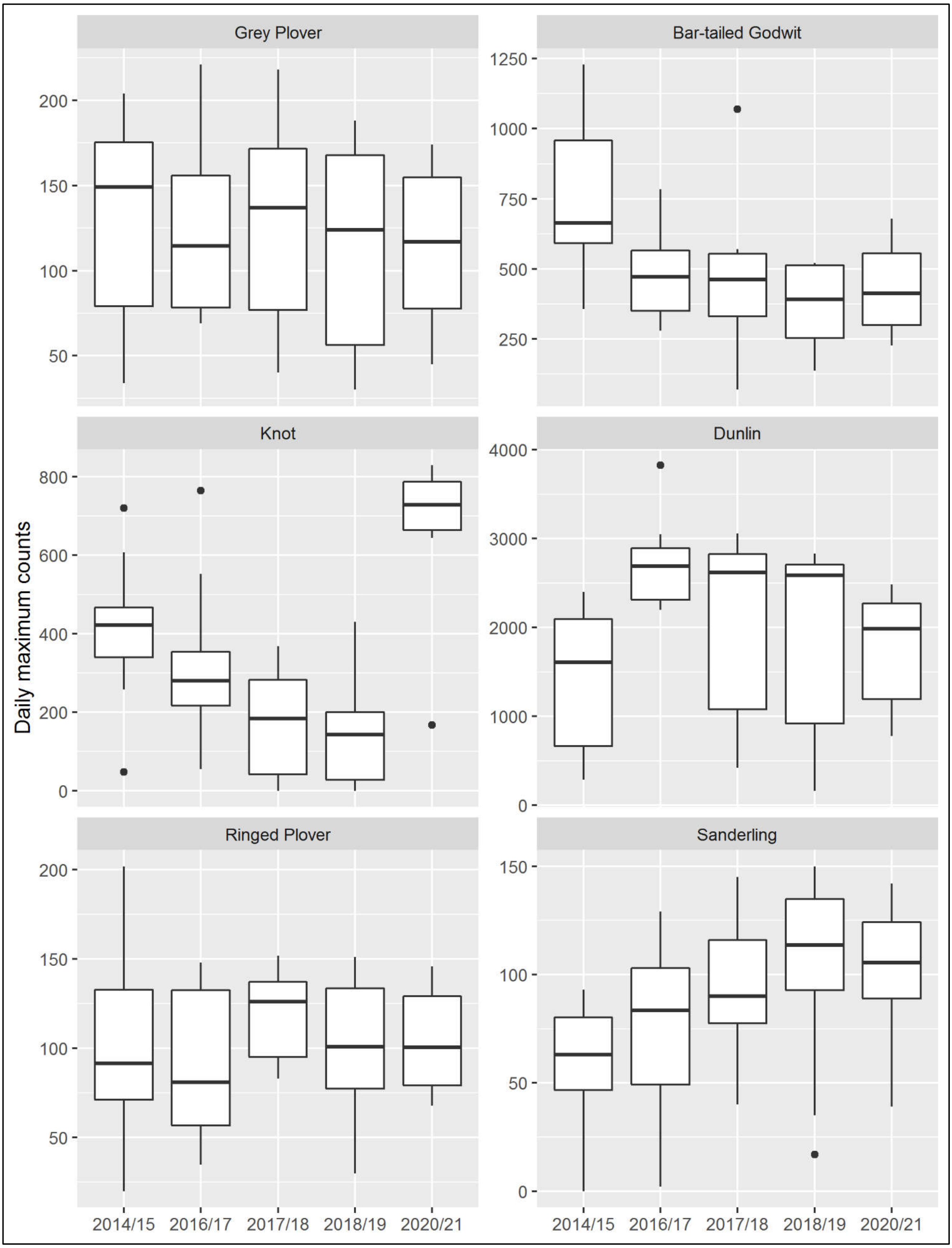


Figure 3.1 Boxplots of daily maximum counts of the IBM target species, 2014/15-2020/21.

[Note: horizontal line – median value; box – Q1 (25th %ile) – Q3 (75th %ile) values; vertical line – range from minimum to maximum; dot – outlier].

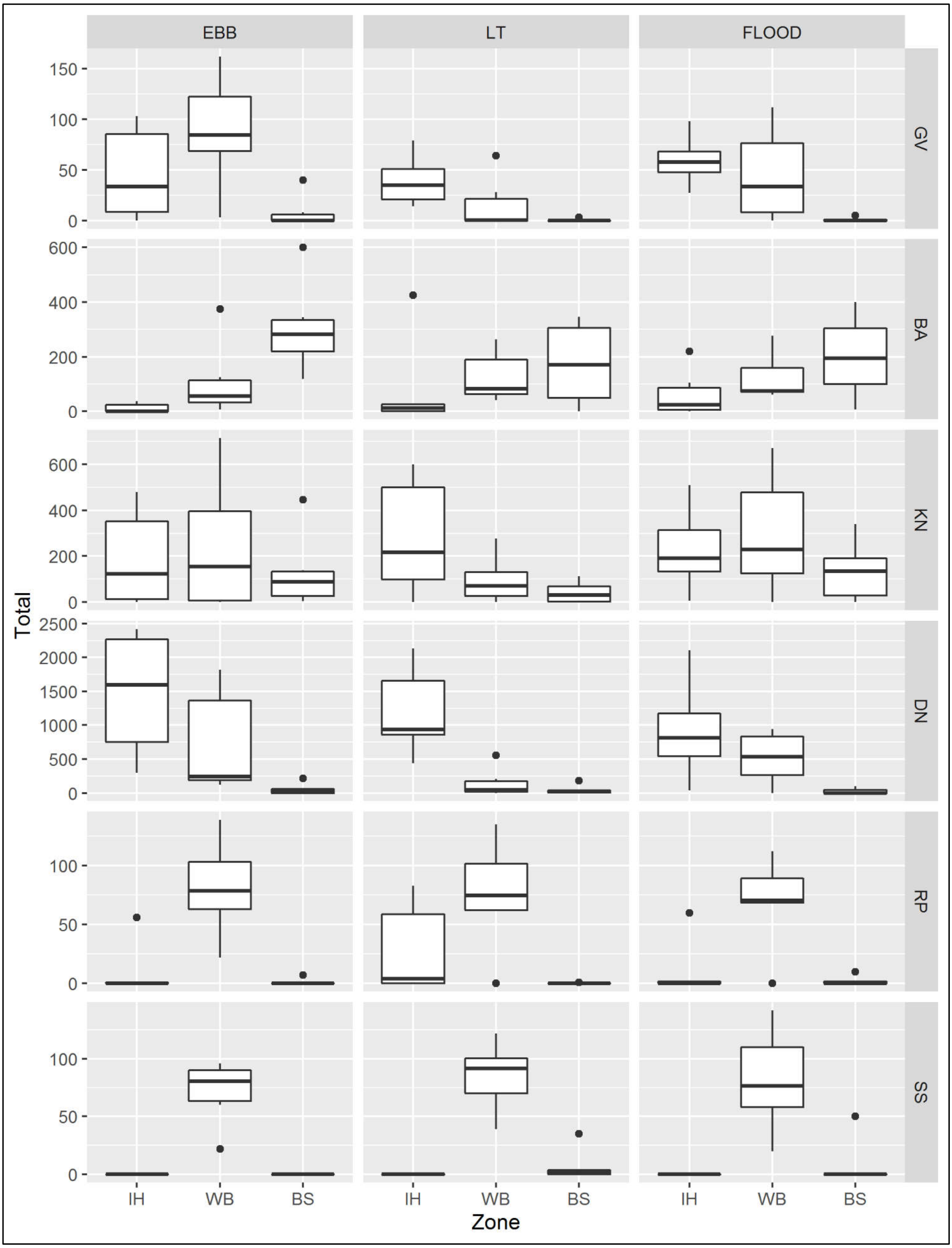


Figure 3.2 Boxplot of maximum daily ebb, low tide and flood tide in each zone.

[Note [1]: IH – Inner Harbour; WB – Whitehouse Bank & BS - Ballyrandle Sandflats; Note [2] horizontal line – median value; box – Q1 (25th %ile) – Q3 (75th %ile) values; vertical line – range from minimum to maximum; dot – outlier].

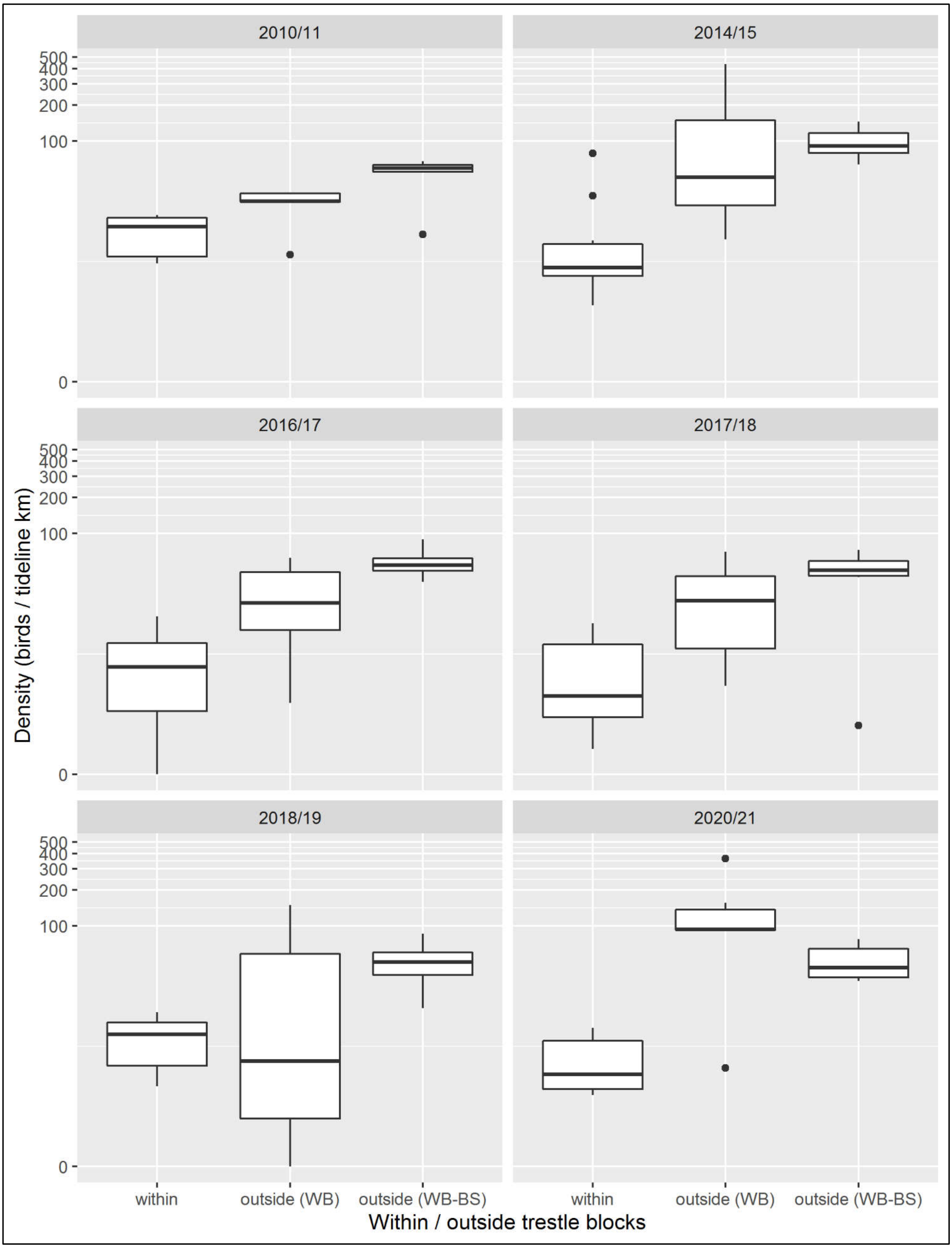
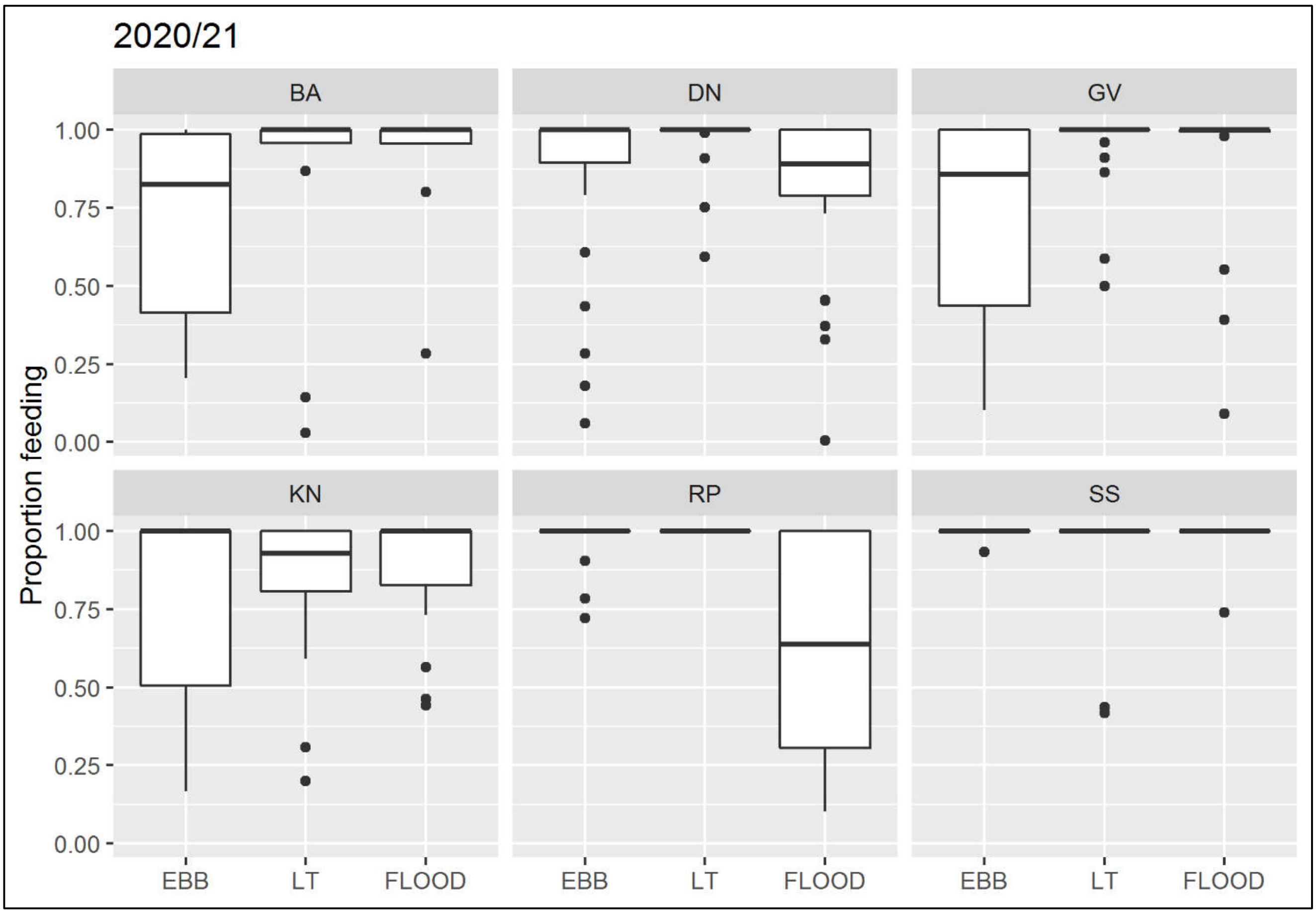


Figure 3.3 **Boxplot of Bar-tailed Godwit densities within trestle blocks, outside trestle blocks on Whitehouse Bank (WB), and outside trestle blocks across Whitehouse Bank and Ballyrandle Sandflats (WB- BS).**



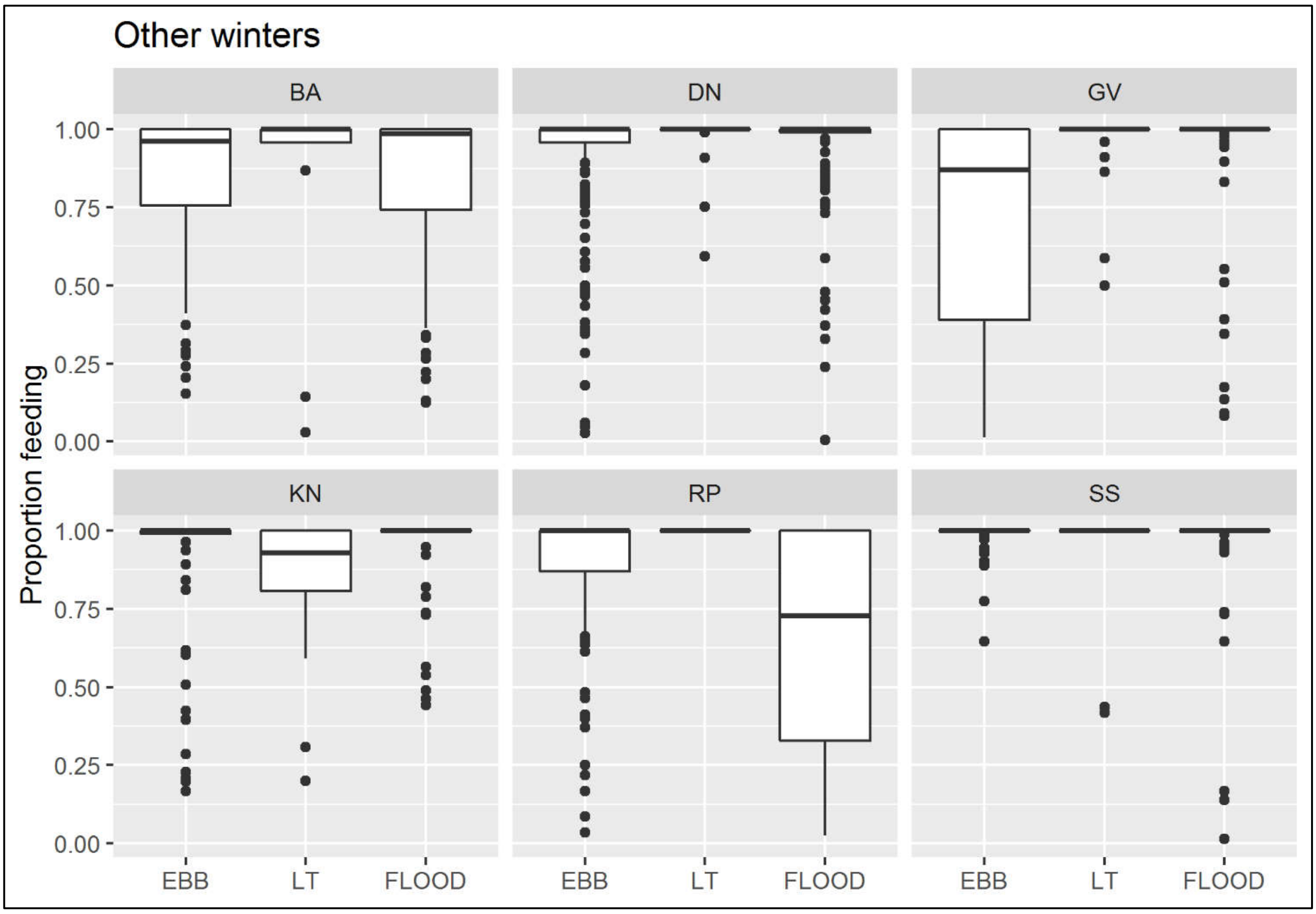


Figure 3.4 Boxplot of the proportions of feeding birds on ebb, low tide and flood tide counts.

4. Discussion and conclusions

4.1. Discussion

The winter of 2020/21, was the sixth winter of tidal cycle waterbird monitoring at Dungarvan Harbour (2014/15 and 2016/17-2020/21), while comparable data for the low tide period is also available for a seventh winter (2010/11).

We adapted the survey protocol this winter to include ebb/flood tide counts at Ballyrandle Sandflats, and 30 minute counts across the low tide period in the main areas used by the IBM target species at low tide. The inclusion of the ebb/flood tide counts at Ballyrandle Sandflats may affect comparisons of Bar-tailed Godwit numbers with other winters, as Ballyrandle Sandflats is favoured by Bar-tailed Godwit across the tidal cycle. The 30 minute counts across the low tide period mean that care is required in the analyses of the low tide count data: to obtain total low tide counts it is necessary to take the maximum of the 30 minute low tide counts, and add it to the total from the single low tide count, while also being aware of the possibility of double counts.

The broad patterns of the spatial distribution and movements of the IBM target species across the tidal cycle have been generally similar across these winters. Apparent differences between the winters in some of the finer details of the above patterns should be interpreted with caution, as the number of counts each winter only represents a small fraction of the total number of days in the seasonal occurrence period of each species.

The above point is also relevant to the assessment of the usage of the Bird Corridor. The pattern of occasional use of the Bird Corridor by large flocks of the IBM target species that we have observed will mean that there is likely to be a large degree of chance variation in the incidence of Bird Corridor use recorded each winter. Therefore, the fact that significant numbers of IBM target species were recorded in the Bird Corridor on two of the six counts in 2020/21 does not necessarily mean that there was a higher incidence of use of the Bird Corridor compared to previous winters.

The trends in the population sizes of the IBM target species indicated by the analyses of the tidal cycle counts in this report are generally to the trends in the I-WeBS count data over a similar period (assuming that the direction of the trend indicated by the I-WeBS counts up to 2019/20 continued into the 2020/21 winter). In particular, the high Bar-tailed Godwit numbers in the winter of 2014/15 reflect a period of high I-WeBS counts from 2011/12-2015/16, while the increasing trend in Sanderling numbers and the stability of the Grey Plover and Ringed Plover numbers are also reflected in the I-WeBS data. The I-WeBS counts also show much larger numbers of Knot in 2019/20, compared to the other winters in this period, which may reflect the high Knot counts in the 2020/21 winter in our dataset. However, the low Dunlin numbers in the 2014/15 tidal cycle counts are not reflected in the I-WeBS data.

The tidal cycle waterbird monitoring has also provided further evidence to support most of our original conclusions about the negative associations of the IBM target species with oyster trestle cultivation in Gittings and O'Donoghue (2012, 2016). Across all winters, there have only been a handful of records of Grey Plover and Knot records, and no Ringed Plover and Sanderling records, within trestle blocks. Most of the Grey Plover and Knot records within the trestle blocks involved birds that had been feeding outside trestle blocks on the flood tide and then moved to roost on trestles as the tide came in. While Bar-tailed Godwit regularly occur within trestle blocks in small numbers, large flocks only occur in the OY sectors on spring low tides when the tideline is below the trestles. The Bar-tailed Godwit densities have consistently been around five times higher outside trestle blocks, compared to within trestle blocks, and the difference in densities is similar when comparing Bar-tailed Godwit densities within trestle blocks with the densities outside the trestle blocks on Whitehouse Bank, or with the densities outside the trestle blocks on Whitehouse Bank and Ballyrandle Sandflats combined.

The picture with Dunlin is a bit more complex. Our original study indicated that Dunlin showed a similar pattern of reduced densities within trestle blocks to Bar-tailed Godwit. However, the tidal cycle waterbird monitoring has shown that sizeable numbers of Dunlin can occur within trestle blocks in some winters, with peak counts of 221 in 2016/17 and 157 in 2018/19. However, in other winters (including 2020/21), Dunlin were much scarcer within the trestle blocks. As discussed above, this may not be due to real differences between the winters but may just be due to chance variation in the activity patterns of Dunlin on the days when the counts were carried out. The analyses that we carried out in the trestle study of Dunlin association with trestles (Gittings and O'Donoghue 2021, 2016) cannot be easily repeated, as these analyses required accurate mapping of the trestle configurations. However, the tidal cycle count data indicates that Dunlin at low tide on Whitehouse Bank often do not show a negative association with trestle blocks. Unlike Bar-tailed Godwit, large flocks of Dunlin do not regularly occur below the trestle blocks on spring low tides. However, the occasional occurrence of much larger flocks of Dunlin in the Bird Corridor, than have ever been recorded in the trestle blocks, indicates that there may be scale-dependent avoidance effect. It is notable that, even when relatively large numbers of Dunlin occur within the trestle blocks they occur in small groups, and we have never recorded single Dunlin flocks of over 100 birds within the trestle blocks.

4.2. Conclusions

The broad patterns of the spatial distribution and movements of the IBM target species across the tidal cycle indicated by the 2020/21 tidal cycle waterbird monitoring were generally similar to previous winters. The overall numbers of most of the species were generally similar to recent winters, and the trends over the monitoring period are generally similar to those shown by I-WeBS data. However, Knot numbers were exceptionally high, while Sanderling numbers have shown an increasing trend, and the Bar-tailed Godwit population seems to have declined since a period of high numbers in the 2011/12-2015/16. The tidal cycle waterbird monitoring has added to the evidence base supporting our original conclusions about the high sensitivity of Grey Plover, Bar-tailed Godwit, Knot, Ringed Plover and Sanderling to oyster trestle cultivation. However, the response of Dunlin to oyster trestle cultivation may be more complex than indicated by our original study.

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Appendix A. Metadata for Dungarvan waterbird monitoring datasets

A.1. Dungarvan_waterbird_monitoring_ 2014_2021_ counts.csv

This dataset contains the full waterbird count data for the winters of 2014/15, 2016/17, 2017/18, 2018/19 and 2020/21.

Field	Data type	Details
Season	Text	Winter: 2014/15, 2016/17, 2017/18, 2018/19, 2020/21
Month	Integer	Month number: 1 = Jan to 12 = Dec
Date	Date	Count date
Type	Text	BCM = Bird Corridor Monitoring; IH = Inner Harbour Monitoring
Time_start	Time	Start time of count
Time_finish	Time	End time of count
Tide	Text	EBB = ebb tide; LT = low tide; FLOOD = flood tide
Count	Text	EBB1-EBB5 = 30 minute ebb tide counts from 4 hours before low tide to 1.5 hours before low tide LT1-LT6 = 30 minute low tide counts from 1.5 hours before low tide to 1.5 hours after low tide FLOOD0-FLOOD4 = 30 minute flood tide counts 1.5 hours after low tide to 4 hours after low tide LT = single low tide count
Zone	Text	BS = Ballyrandle Sandflats; IHM = Inner Harbour Main; IHU = Inner Harbour Upper; WB = Whitehouse Bank
Sector	Text	Count sector; see Figure 2.1
Bird_corridor	Text	BC = within Bird Corridor; NB = outside Bird Corridor
Group	Text	Target = Grey Plover, Bar-tailed Godwit, Knot and Dunlin; Additional = Light-bellied Brent Goose, Golden Plover, Ringed Plover and Sanderling; Other = all other species
Species	Text	BTO species code
Tzone	Text	INT = intertidal, SUB = subtidal; TL = tideline
Location	Text	W = within trestle blocks; O = outside trestle blocks; NR = not recorded
Trestles	Text	OT = on trestles; N = not on trestles; NR = not recorded
Behaviour	Text	F = feeding; Y = flying; R = roosting/other
Number	Text	Number of birds recorded
Quality	Text	OK or LOW
Double_count	Text	YES or NO
Counter	Text	DF = Darío Fernández-Bellon; JD = John Deasy; JM = John Meade; LJL = Lesley Lewis; MS = Mark Shorten; PS = Pat Smiddy; TG = Tom Gittings; TN = Tony Nagle
Notes	Text	Free form field for notes

A.2. Dungarvan_waterbird_monitoring_ 2014_2021_ tractor_counts.csv

This dataset contains the full tractor count data for the winters of 2014/15, 2016/17, 2017/18, 2018/19 and 2020/21.

Field	Data type	Details
Season	Text	Winter: 2014/15, 2016/17, 2017/18, 2018/19, 2020/21
Month	Integer	Month number: 1 = Jan to 12 = Dec
Date	Date	Count date
Type	Text	BCM = Bird Corridor Monitoring; DS = disturbance studies; TC = tidal cycle counts
Time	Time	Time of count
Sector	Text	Count sector; see Figure 2.1
Number	Integer	Number of tractors
Activity	Text	arriving, departing, travelling or working
Notes	Text	Free form field for notes

A.3. Dungarvan_waterbird_monitoring_ 2014_2021_ tidelines.csv

This dataset contains the full tideline data for Ballyrandle Sandflats and Whitehouse Bank for the winters of 2014/15, 2016/17, 2017/18, 2018/19 and 2020/21, as used in the analyses of Bar-tailed Godwit densities.

Field	Data type	Details
Season	Text	Winter: 2014/15, 2016/17, 2017/18, 2018/19, 2020/21
Month	Integer	Month number: 1 = Jan to 12 = Dec
Date	Date	Count date
Zone	Text	BS = Ballyrandle Sandflats; WB = Whitehouse Bank (excluding sector CS4)
Length	Integer	Tideline length in metres
TL_percent	Decimal	Proportion of tideline inside trestle blocks

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