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2021-2022

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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 2021/22.

The objectives of the monitoring were: -

- Repeat the low tide counts carried out in 2009/10.
- Collect data on Bar-tailed Godwit feeding ecology to contribute towards the development of an Individual-based Model.
- Collect data on waterbird disturbance responses to contribute towards the development of an Individual-based Model.
- Collect data on lugworm distribution and density to contribute towards the development of an Individual-based Model.

The results of the low tide counts were used to carry out updated analyses of population trends.

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 wader species that are Qualifying Interests of the Dungarvan Harbour SPA: Grey Plover, Bar-tailed Godwit, Knot and Dunlin. The research also showed that two other non-Qualifying Interest species with significant populations at Dungarvan Harbour are likely to negatively affected: Ringed Plover and Sanderling.

Monitoring across six winters has confirmed that five of the above species either completely avoid areas occupied by oyster trestles (Grey Plover, Ringed Plover, Knot, Sanderling) or show significantly reduced densities within the trestle blocks (Bar-tailed Godwit) (Gittings and O'Donoghue, 2015, 2018a, 2018b, 2019, 2021b; KRC, 2020). The evidence for the sixth species (Dunlin) is more mixed, although large Dunlin flocks never occur within the trestle blocks.

The 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 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 is being developed.

The objectives of the waterbird monitoring in 2021/22 were to repeat the low tide counts that had been carried out for the NPWS Waterbird Survey Programme in 2009/10 and collect additional data that could contribute to the development of the Individual-based Model continue the tidal cycle monitoring that had been carried out in previous winters, and to provide additional data relevant for the validation of the Individual-based Model.

In this report we refer to two groupings of wader species. The target species are the six wader species that are potentially displaced from trestle blocks: Grey Plover, Ringed Plover, Bar-tailed Godwit, Knot, Sanderling and Dunlin. The IBM species are the wader species that are included in the Individual-based Model: Oystercatcher, Grey Plover, Ringed Plover, Curlew, Black-tailed Godwit, Bar-tailed Godwit, Knot, Sanderling, Dunlin and Redshank.

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 low tide counts were carried out by David Daly, Tom Gittings, Lesley Lewis and Mark Shorten. The Bar-tailed Godwit feeding study and the disturbance trials were carried out by Tom Gittings.

2. Methods

2.1. Low tide counts

2.1.1. 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 monitoring work that has been carried out since 2014, 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 400 m 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 for the low tide counts 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. The tidal channel between the Ballyrandle Sandflats and Whitehouse Bank is part of the NPWS Waterbird Survey Programme subsite 0M425, which covers this channel and the Ballyrandle Sandflats. As this tidal channel was not included in the trestle study sectors, it was defined as a separate count sector for the low tide counts (0M425-TC).

In the Inner Harbour and the Outer Bay, the counts used the NPWS Waterbird Survey Programme subsites.

On some counts, where time allowed, Clonea Strand was also counted. This is a separate site, that is not part of Dungarvan Harbour, so the results of these counts are presented separately.

The oyster trestles occur within the lower part of Whitehouse Bank (sectors OY1-OY4; Figure 2.1).

2.1.2. Count organisation

Four counters carried out the counts. The organisation of these counters is shown in Table 2.1 and mapped in Figure 2.2. The counts of Whitehouse Bank and sectors 0M419 and 427 were carried out by one counter walking the length of Whitehouse Bank through sectors OY1-OY4, and another counter walking around the Cunnigar. The other sectors were counted from shoreline / road vantage points

Table 2.1. Counter organisation for the low tide counts.

Zone	Counter	Sectors
Inner Harbour Upper	David Daly	0M411-0M416, 0M428
	Lesley Lewis	0M423, 0M424, 0M426
Inner Harbour Main	David Daly	0M417, OM418
	Mark Shorten	0M419, 0M427
Ballyrandle Sandflats	Tom Gittings	0M425-TC
	Lesley Lewis	CN1-CN6
Whitehouse Bank	Tom Gittings	CS1, CS4, OY1-OY4
	Mark Shorten	CS2, CS3
Outer Bay	David Daly	0M422
Clonea Strand	Lesley Lewis	0M906

2.1.3. Count dates and timings

The low tide counts were carried out on six dates between October 2021 and February 2022 (Table 2.3). Clonea Strand was counted on four of these dates.

The aim was to complete the counts within a four hour period centred around high tide (rounded to the nearest five minute interval). The counts were started two hours before low tide and were completed by 01:55 - 02:50 hours after low tide (rounded to the nearest five minute interval; Table 2.2).

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

Date	Low tide		Count timings	
	time	height (m)	Dungarvan Harbour	Clonea Strand
21/10/2021	13:08	0.5	11:00-15:50	14:30-14:45
22/11/2021	13:07	0.9	11:05-15:18	-
21/12/2021	12:54	0.8	10:55-14:50	13:45-14:15
19/01/2022	12:42	0.7	10:40-14:34	-
02/02/2022	12:43	0.3	10:40-14:38	13:33-14:00
17/02/2022	12:23	0.5	10:25-14:36	12:45-13:00

Low tide data source: Admiralty tidal predictions for Dungarvan (www.ukho.gov.uk/easytide).

2.1.4. Count methods

The count methods followed those used for the NPWS Waterbird Survey Programme counts (Lewis and Tierney, 2014). These included classification of behaviour, recording of bird positions in relation to tidal zones, flock mapping and disturbance recording, following the Waterbird Survey Programme protocols.

The methods were extended for the counts on Whitehouse Bank so that these were compatible with the tidal cycle monitoring counts. Additional / modified parameters were recorded (Table 2.3), the tideline alignment was mapped, the percentage of the tideline within the trestle blocks in each sector was estimated, and tractor counts were carried out.

The tractor counts were carried out at 30 minute intervals centred on low tide throughout their period of occurrence. These counts extended outside the low tide count period when required. The tractors were counted separately in each sector and classified as working (parked or active within the trestles), travelling (moving between trestle blocks), arriving (arriving on the beach), or leaving (leaving the beach).

Table 2.3. Additional / modified parameters used for the low tide counts on Whitehouse Bank.

Parameter	Type	Details
Tidal zone	Modification to Waterbird Survey Programme parameter	Waterbird Survey Programme intertidal zone split into: TL = birds on / close to the tideline INT = birds on the intertidal above the tideline
Behaviour	Modification to Waterbird Survey Programme parameter	Additional behavioural category added to record birds flushed while counting the trestles: Y = flying birds
Location	Additional parameter	O = outside trestle blocks W = within trestle blocks T = on trestles

2.2. Bar-tailed Godwit feeding study

We carried out focal observations of feeding Bar-tailed Godwit collect data to inform the development of the Individual-based Model.

The focal observations were carried out on five days at Ballyrandle Sandflats and two days at Whitehouse Bank (Table 2.4). The surveys generally covered the full low tide period and the sections of the ebb and / or flood tide periods when there was significant exposure of intertidal habitat (subject to the timing of the low tide relative to dusk).

On each survey day, the Bar-tailed Godwit flocks were followed as they moved around the survey area and sample focal observations were carried out. The focal observations were distributed so that they were broadly representative of the distribution patterns of the Bar-tailed Godwit flocks, with more focal observations carried out in larger flocks. Due to the movement patterns of the birds, it was not possible to ensure that all the focal observations on each date were of different birds. However, the number of focal observations per day (8-11), compared to the numbers of Bar-tailed Godwit present (around 200-400) means that most of the focal observations at Ballyrandle Sandflats on each day are likely to have been independent.

Each focal observation was timed for a duration of five minutes, unless the bird stopped feeding or flew away, in which case the focal observation was truncated. The parameters recorded in the focal observations are listed in Table 2.5. In most cases prey was ingested without removing it from the sediment or the water. However, when the prey could be seen, the prey type was recorded and, if it was intact, its size estimated.

On the feeding study days at Whitehouse Bank, tractor counts were carried out using the same methods as in the low tide counts (see above).

Table 2.4. Bar-tailed Godwit focal observation survey dates.

Date	Location	Survey period	Low tide time	Low tide height	Focal observations
23/12/2021	Ballyrandle Sandflats	10:50-16:30	14:11	0.9 m	8
21/01/2022	Ballyrandle Sandflats	11:05-17:00	13:54	0.8 m	9
22/01/2022	Whitehouse Bank	11:30-17:20	14:33	0.8 m	5
24/01/2022	Ballyrandle Sandflats	12:00-16:16	16:00	0.9 m	8
21/02/2022	Ballyrandle Sandflats	11:45-18:05	14:46	0.7 m	11
22/02/2022	Ballyrandle Sandflats	12:56-18:05	15:27	0.8 m	10
04/03/2022	Whitehouse Bank	09:30-16:45	13:04	0.3 m	5

Table 2.5. Parameters recorded in Bar-tailed Godwit focal observations.

Parameter	Details
Time	Start time of focal observation
Duration	Duration of focal observation
Location	Location relative to the tideline: subtidal, tideline, or intertidal way from the tideline
Position	Marked on map
Sex	Sex assigned based on bill length
Age	First-year birds identified by retained juvenile feathering
Searching method	Predominant searching method during focal observation: Surface pecks, ploughing, half-probes, deep probes
Prey captures	Total number of successful prey captures
Capture method	Predominant method(s) used for captures, or attempted captures: surface pecks, half-probes, deep probes
Handling times	Duration of handling time for each prey capture: 1-2 secs; 3-10 secs; 11-20 secs; of > 20 secs
Kleptoparasitic interactions (intraspecific)	Number of kleptoparasitic interactions with other Bar-tailed Godwits.
Kleptoparasitic interactions (interspecific)	Number of kleptoparasitic interactions with other species.

2.3. Disturbance trials

We carried out disturbance trials opportunistically during the low tide counts and the Bar-tailed Godwit feeding study. During the low tide counts, the disturbance trials were carried out by the counter on Whitehouse Bank, while he was walking back to the car park after completing the count. During the Bar-tailed Godwit feeding study, disturbance trials were carried out in the gaps between the focal observations, such as during periods when Bar-tailed Godwits were absent, or while walking across the sandflats towards distant Bar-tailed Godwit flocks. In addition, Bar-tailed Godwit disturbance trials were carried out after a series of focal observations had been collected from a Bar-tailed Godwit flock.

The target species for the disturbance trials were the Individual-based Model species.

The disturbance trial methods were the same as those used for the disturbance trials in March 2021 (Gittings and O'Donoghue, 2021a). They were carried out by selecting a group of target species and walking towards them from a starting distance of usually at least 200 m. We tried to avoid carrying out sequential disturbance trials involving the same individuals. The parameters used for recording the disturbance responses are listed in Table 2.6. A laser rangefinder (Leupold RX-1300i TBR) was used to measure distances.

The data from the March 2021 disturbance trials are included in the analyses presented in this report.

Table 2.6. Parameters used for recording disturbance responses.

Parameter	Details
Species	Focal species
Time	Time of observation
Number	Number of birds involved
Zone	On tideline or on intertidal above tideline
Position	Marked on map
Behaviour	Behaviour of birds before disturbance response
Starting distance	The distance from the birds at the start of the trial
Approach direction	For birds on tideline, direction relative to tideline (parallel, oblique or perpendicular)
Response distance	The distance at which the birds showed a response
Response	Type of response: stopped feeding, alert, walked/ran away, flushed Where individual birds showed multiple sequential responses (e.g., alert behaviour followed by a flush response), the response distance was recorded separately for each response
Flight duration	Duration of flight for birds that showed the flush response
Time to resume feeding	For birds that were feeding before the disturbance, the duration until they resumed feeding after completing their flight

2.4. Lugworm sampling

Lugworm sampling was carried out to collect data to inform the development of the Individual-based Model. The sampling was carried out on Whitehouse Bank on each low tide count (except the October count) and at Ballyrandle Sandflats and Whitehouse Bank on each Bar-tailed Godwit feeding study day.

The sample locations were selected semi-randomly as follows. On the low tide counts, samples were taken at fixed time intervals during the counts (every 15 or 30 minutes). At these times, the counter stopped and took a sample from immediately behind his position. During the Bar-tailed Godwit feeding study, samples were taken at each location where the observer stopped to carry out focal observations or disturbance trials. As the observer may have trampled the ground in the immediate vicinity while carrying out these observations or trials, he walked 20 paces in a random direction to take the sample.

Samples were only taken from locations were the intertidal had been exposed for at least one hour. During the low tide counts, the route taken was well above the tideline, so all potential sample locations met this criterion. In the Bar-tailed Godwit feeding study, some focal observations or disturbance trials were close to the tideline, so before the middle of the low tide period, some potential sample locations did not satisfy this criterion and were omitted.

The samples were 1 x 1 m quadrats. The number of lugworm casts in each quadrat was counted. Where quadrats contained no lugworm casts, the presence (if any) of casts adjacent to the quadrats was counted. The GPS position of each sample was recorded.

The lugworm data was analysed in the Individual-based Model report (Stillman *et al.*, 2022), so analysis of the data is not included in the present report.

2.5. 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.

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.

2.6. Data analysis

Most of the data analyses presented in this report are simple tabular or graphical summaries of the survey results from 2021/22, with more detailed analyses in some cases (described below). Where relevant, we also compare the results from 2020/21 with the results from the tidal cycle counts in 2014/15-2020/21 and / or the NPWS Waterbird Survey counts in 2009/10. However, we have not included the results from 2019/20 in these comparisons due to apparent issues with survey coverage that became evident when we tried to analyse the data.

We analysed the patterns of husbandry activity on Whitehouse Bank by calculating tractor minutes, where each tractor on each tractor count represents 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 analysed population trends at Dungarvan Harbour from 1994/95 - 2021/22. We used the I-WeBS dataset for 1994/95 - 2019/20 and added the low tide count data from 2021/22. Note that the I-WeBS dataset includes the Waterbird Survey Programme counts from 2009/10. We restricted the analyses to the mid-winter months (November – February), due to the very limited I-WeBS coverage outside these months. As there were two low tide counts in February 2022 we selected the count that was closest to the middle of the month. We used the standard methods for analysing waterbird population trends, which are the methods used for the analyses by Kennedy *et al.* (2022).

2.7. 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, 2020/21 and 2021/22. Metadata for these datasets are included in Appendix A.

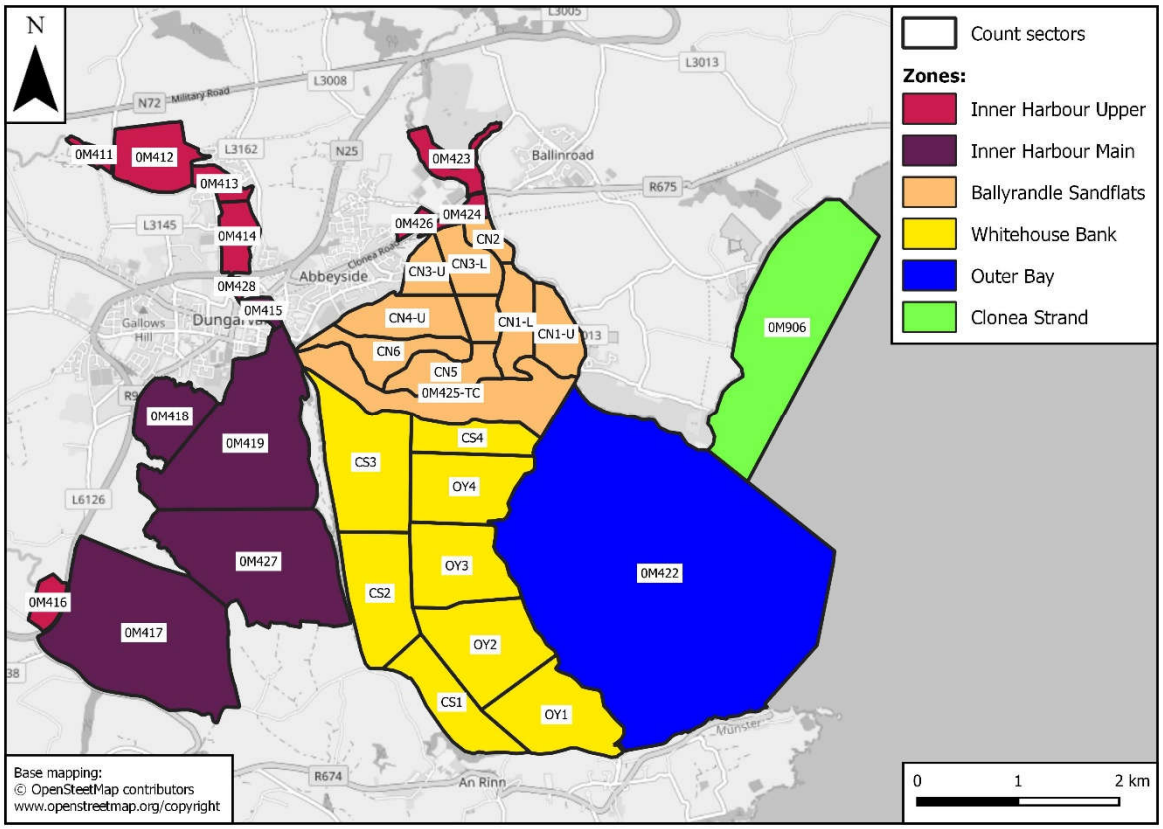

Figure 2.1. Zones and count sectors.

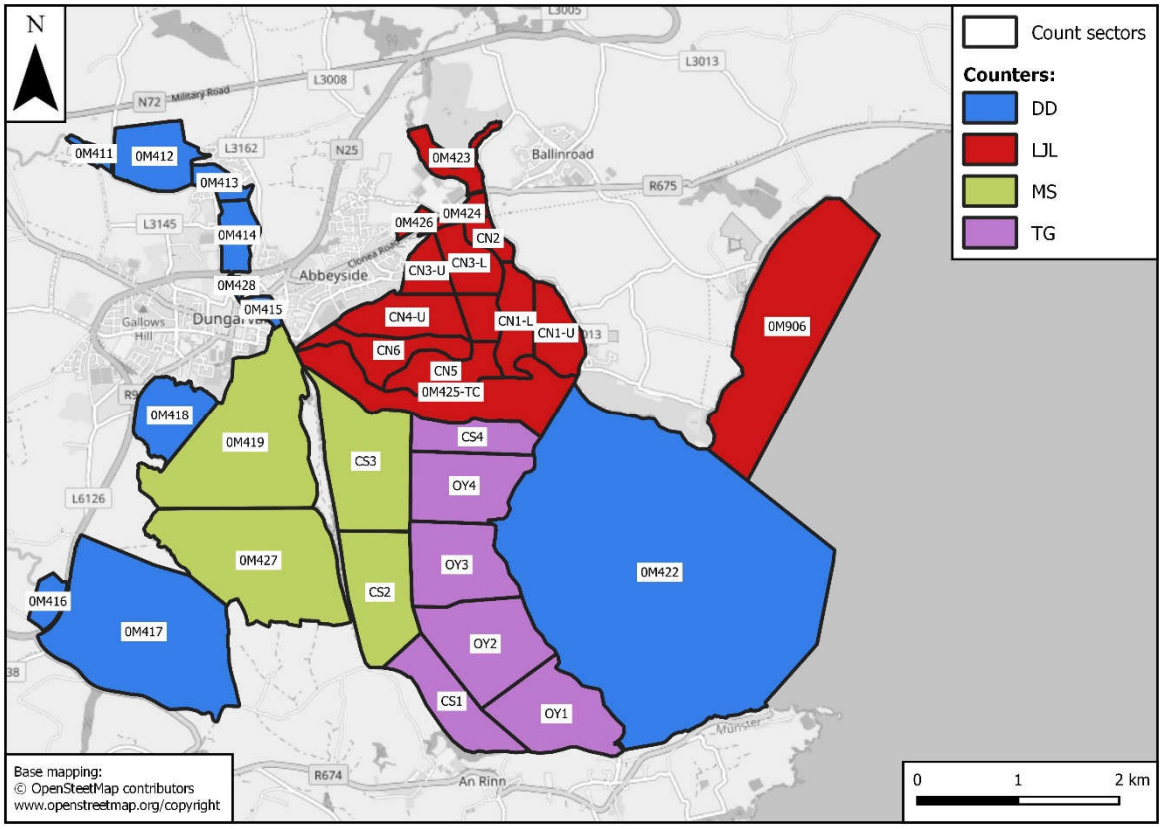

Figure 2.2. Sector allocations.

3. Results

3.1. Oyster cultivation activity

The daily mean of 1,637 tractor minutes in 2021/22 was the third lowest recorded in the monitored winters. However, as in 2020/21, there was an exceptionally low value in the Christmas period (495 tractor minutes on 21/12/2022). Excluding these values, the tractor activity levels have been very similar across the last three monitored winters (Table 3.1).

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	1,797	1,215-2,355
2021/22	1,828	1,125-2,355

The 2020/21 and 2021/22 data excludes exceptionally low values during the Christmas period. The 2021/22 data excludes the counts from 22/01/2022 as these did not cover the full period of tractor activity.

3.2. Low tide counts

3.2.1. Overall numbers

A total of 41 waterbird species were recorded during the low tide counts in Dungarvan Harbour. These included the six target species (Table 3.2), another eleven species that are Qualifying Interests of the Dungarvan Harbour SPA (Table 3.3), and a further 26 non-Qualifying Interest species (Table 3.4). A total of 15 waterbird species were recorded in low numbers during the low tide counts in Clonea Strand (Table 3.5).

Grey Plover numbers were low with a peak count of only 63 (Table 3.2), compared to regular daily maxima of around 100-200 during tidal cycle counts in 2014/15-2020/21 (Figure 3.1). However, the latter were mainly recorded on ebb or flood tide counts, and we have highlighted the phenomenom of disappearing Grey Plover at low tide in the reports on the tidal cycle counts.

Bar-tailed Godwit numbers were also rather low with totals of less than 150 on four of the six counts (Table 3.2), compared to regualr daily maxima of around 250-500 during tidal cycle counts in 2016/17-2020/21 (Figure 3.1). This was more surprising, as the daily maxima during the tidal cycle counts were usually recorded at low tide.

The other target species were recorded in broadly comparable numbers to the range of daily maxima in the tidal cycle counts (Figure 3.1).

Table 3.2. Low tide count totals of target species in Dungarvan Harbour.

Species	21-10-2021	22-11-2022	21-12-2021	19-01-2022	02-02-2022	17-02-2022
Grey Plover	10	51	35	1	60	63
Ringed Plover	28	90	1	24	118	89
Bar-tailed Godwit	102	53	317	137	417	99
Knot	23	56	483	280	329	154
Sanderling	115	1	88	10	74	61
Dunlin	446	2318	772	3155	1969	1436

Table 3.3. Low tide count totals of other Qualifying Interest species in Dungarvan Harbour.

Species	21-10-2021	22-11-2022	21-12-2021	19-01-2022	02-02-2022	17-02-2022
Light-bellied Brent Goose	250	817	784	555	763	652
Shelduck	70	172	533	342	317	326
Red-breasted Merganser	4	16	8	25	30	28
Great Crested Grebe	14	28	23	21	26	3
Oystercatcher	636	469	571	0	516	358
Golden Plover	37	8	3935	4000	4000	2530
Lapwing	146	768	584	741	938	130
Curlew	567	477	253	449	516	511
Black-tailed Godwit	688	483”	543	631	748	443
Turnstone	84	33	28	28	31	18
Redshank	556	683	417	358	551	533

Table 3.4. Low tide count totals of other non-Qualifying Interest species in Dungarvan Harbour.

Species	21-10-2021	22-11-2022	21-12-2021	19-01-2022	02-02-2022	17-02-2022
Whooper Swan	12	0	0	0	0	0
Wigeon	77	406	153	172	217	126
Teal	279	512	501	166	365	307
Mallard	44	5	39	28	4	0
Goldeneye	0	1	0	0	0	4
Red-throated Diver	0	9	0	0	1	1
Great Northern Diver	1	1	1	0	0	3
Cormorant	133	76	75	75	109	70
Shag	3	5	28	0	0	17
Little Egret	45	23	9	8	17	18
Grey Heron	21	14	7	7	13	6
Little Grebe	9	12	13	6	26	2
Slavonian Grebe	0	0	0	9	1	0
Whimbrel	0	1	2	0	0	0
Spotted Redshank	0	0	0	0	0	1
Greenshank	19	14	11	13	14	10
Jack Snipe	0	0	1	0	0	0
Snipe	0	0	31	0	10	0
Black-headed Gull	1800	847	580	1002	461	601
Common Gull	103	36	332	331	267	232
Lesser Black-backed Gull	27	45	21	22	64	74
Herring Gull	339	122	257	121	197	342
Great Black-backed Gull	50	102	10	18	21	28
Kingfisher	1	0	0	0	0	0
Unidentified gull	0	0	0	0	18	0

Table 3.5. Low tide count totals (Clonea Strand).

Species	21-10-2021	21-12-2021	02-02-2022	17-02-2022
Light-bellied Brent Goose	0	8	40	85
Great Northern Diver	0	0	1	0
Cormorant	3	0	0	0
Little Egret	0	0	1	0
Grey Heron	2	1	0	0
Oystercatcher	1	10	10	11
Ringed Plover	0	0	0	2
Curlew	0	1	0	0
Sanderling	0	0	15	2
Dunlin	0	0	0	40
Black-headed Gull	1	0	4	61
Common Gull	0	0	0	5
Lesser Black-backed Gull	0	0	0	2
Herring Gull	5	8	6	6
Great Black-backed Gull	0	6	0	0

3.2.2. Distribution patterns

3.2.2.1. Zone distribution

The zone distributions of the target species, the other Qualifying Interest species, and other common species in the 2009/10 and 2021/22 low tide counts are compared in Figure 3.2-Figure 3.5.

The distribution patterns of the target species in 2021/22 were generally as expected from the tidal cycle low tide counts in 2014/15-2020/21 (Figure 3.2). However, Grey Plover numbers in the Inner Harbour Main were low, reflecting the low overall counts of this species in 2021/22.

The distribution patterns of the main wildfowl species were broadly similar in 2009/10 and 2021/22 (Figure 3.3). However, Light-bellied Brent Goose occurred in much higher numbers in the Inner Harbour Upper in 2009/10, while Cormorant numbers in the Outer Bay were surprisingly low in that winter.

The non-target wader species showed some apparent shifts in distribution towards Whitehouse Bank in 2021/22 compared to 2009/10 (Figure 3.4). However, these involved three species that occur in high numbers within the trestle blocks (Oystercatcher, Redshank and Turnstone). The 2009/10 counts of Whitehouse Bank were carried out from the shoreline of the Cunnigar, so birds within the trestle blocks will have been significantly under-recorded. The absence of Turnstone from the other zones in 2021/22, where they occurred in 2009/10, may reflect an overall decline in numbers (see above), rather than a shift towards Whitehouse Bank. The distribution patterns of the other wader species were generally similar in 2009/10 and 2021/22.

The distribution patterns of the gull species were broadly similar in 2009/10 and 2021/22 (Figure 3.5).

3.2.2.2. Oyster trestles

The only target species that were recorded within the trestle blocks were Bar-tailed Godwit and Dunlin. Other species that regularly occurred within the trestle blocks in significant numbers included Light-bellied Brent Goose,

Curlew, Turnstone, Redshank, Black-headed Gull, Common Gull and Herring Gull. The percentages of the total low tide counts of these species that occurred within the trestle blocks are shown in Table 3.6.

The 2009/10 Waterbird Survey Programme counts did not include adequate coverage of waterbirds within the trestle blocks as the counts of Whitehouse Bank were carried out from the shoreline of the Cunnigar. Therefore, apart from the target species, there is no previous data available for comparison. However, for most of the species, the mean percentage within the trestle blocks is broadly in line with expectations based on general knowledge of their occurrence patterns within Dungarvan Harbour.

Light-bellied Brent Goose and Dunlin showed a high variability in their occurrence within the trestle blocks. The highest numbers of Light-bellied Brent Goose within the trestle blocks usually occur on ebb and flood tides when the trestles are partly covered, while numbers at low tide are more variable. Around 400 Dunlin were recorded in the trestle blocks on the first two low tide counts, but they were absent from the trestle blocks, or occurred in very low numbers, on the subsequent counts. This variability reflects the patterns shown in the tidal cycle monitoring.

Nearly all of the Turnstone recorded in the low tide counts occurred within the trestle blocks. While the trestle blocks are attractive to Turnstone, it is possible that Turnstone were missed elsewhere (e.g., on rocky shores in the Outer Bay). Only 1% of the Turnstones were recorded on the trestles, which seems surprisingly low. However, a lot of the Turnstone in the trestle blocks were flushed before their position (on or off the trestles) could be recorded.

Oystercatcher, Redshank and Herring Gull also occurred in significant numbers. Around 40% of the Oystercatchers within the trestle blocks occurred on the trestles, which amounted to around 7% of the total Dungarvan Harbour count. This figure is very similar to the estimate included in the Individual-based Model. Herring Gulls also regularly occurred on trestles, but the birds on the trestles were not counted separately.

Table 3.6. Percentage of the total low tide count within trestle blocks.

Species	Mean	Min	Max
Light-bellied Brent Goose	18%	1%	54%
Oystercatcher	17%	12%	22%
Curlew	5%	1%	7%
Bar-tailed Godwit	10%	2%	34%
Turnstone	94%	79%	100%
Dunlin	18%	0%	92%
Redshank	31%	19%	46%
Black-headed Gull	6%	2%	12%
Common Gull	3%	0%	7%
Herring Gull	20%	6%	31%

3.2.2.3. Bird corridor

The Bird Corridor counts are shown in Table 3.7.

The only target species recorded in the Bird Corridor were Bar-tailed Godwit and Dunlin. Small numbers of Bar-tailed Godwit occurred on most counts, while a single Dunlin occurred on one count.

Table 3.7. Bird corridor counts.

Species	21/10/2021	22/11/2021	21/12/2021	19/01/2022	02/02/2022	17/02/2022
Light-bellied Brent Goose	11	76	53	5	29	2
Oystercatcher	56	4	2	8	3	1
Curlew	1	3	0	0	13	1
Bar-tailed Godwit	5	2	0	1	7	1
Dunlin	0	1	0	0	0	0
Redshank	0	0	0	0	49	0
Black-headed Gull	32	189	0	11	4	9
Common Gull	8	2	52	0	38	23
Herring Gull	0	0	8	0	6	5

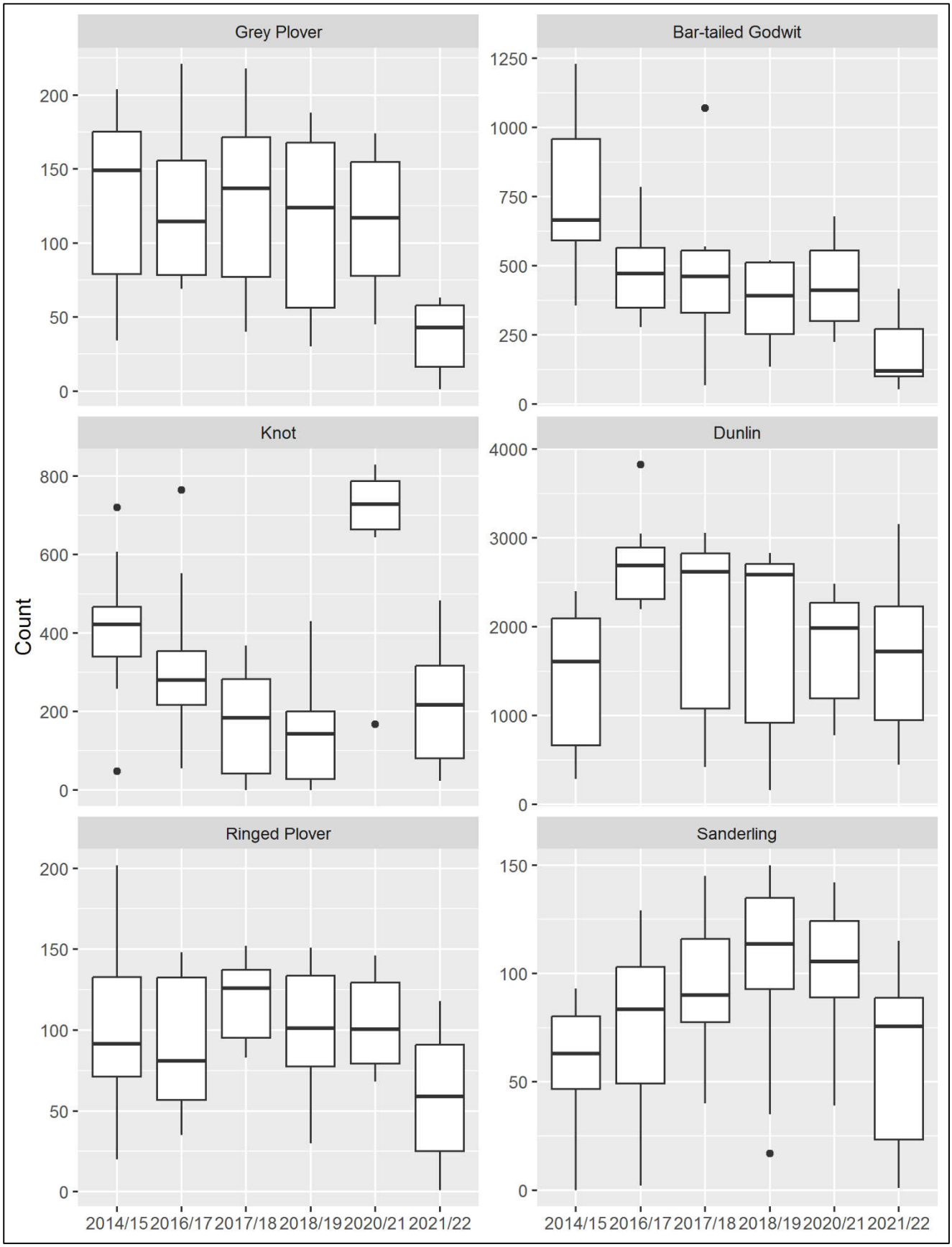

Figure 3.1. Boxplots of counts of the target species, 2014/15-2021/22, including the daily maxima from the tidal cycle counts in 2014/15-2020/21 and the total counts from the low tide counts in 2021/22.

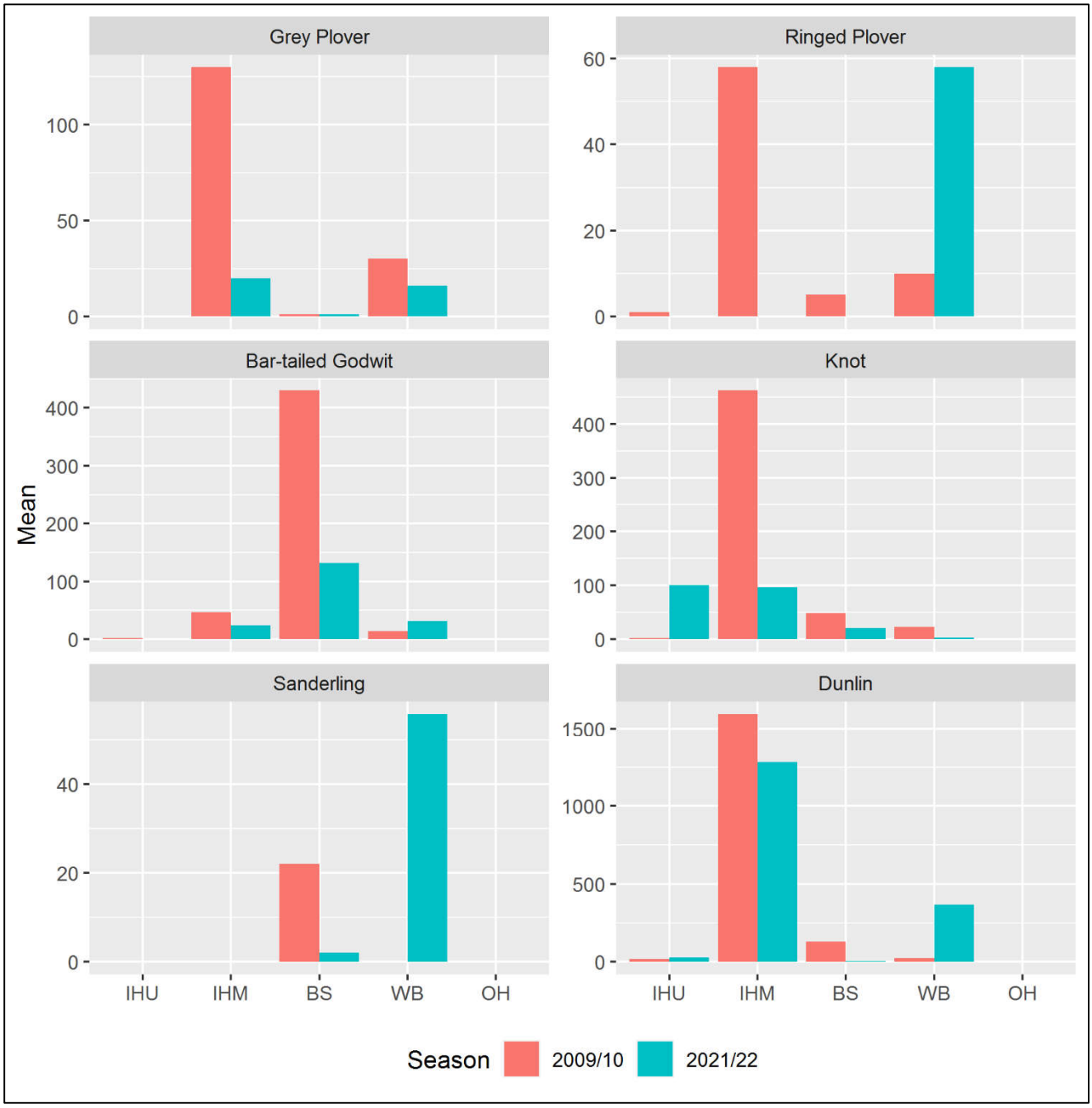

Figure 3.2. Zone distribution of the target species in the 2021/22 low tide counts, compared to the 2009/10 low tide counts.

Key:

IHU - Inner Harbour Upper

IHM – Inner Harbour Main

BS – Ballyrandle Sandflats

WB – Whitehouse Bank

OB – Outer Bay

CS – Clonea Strand

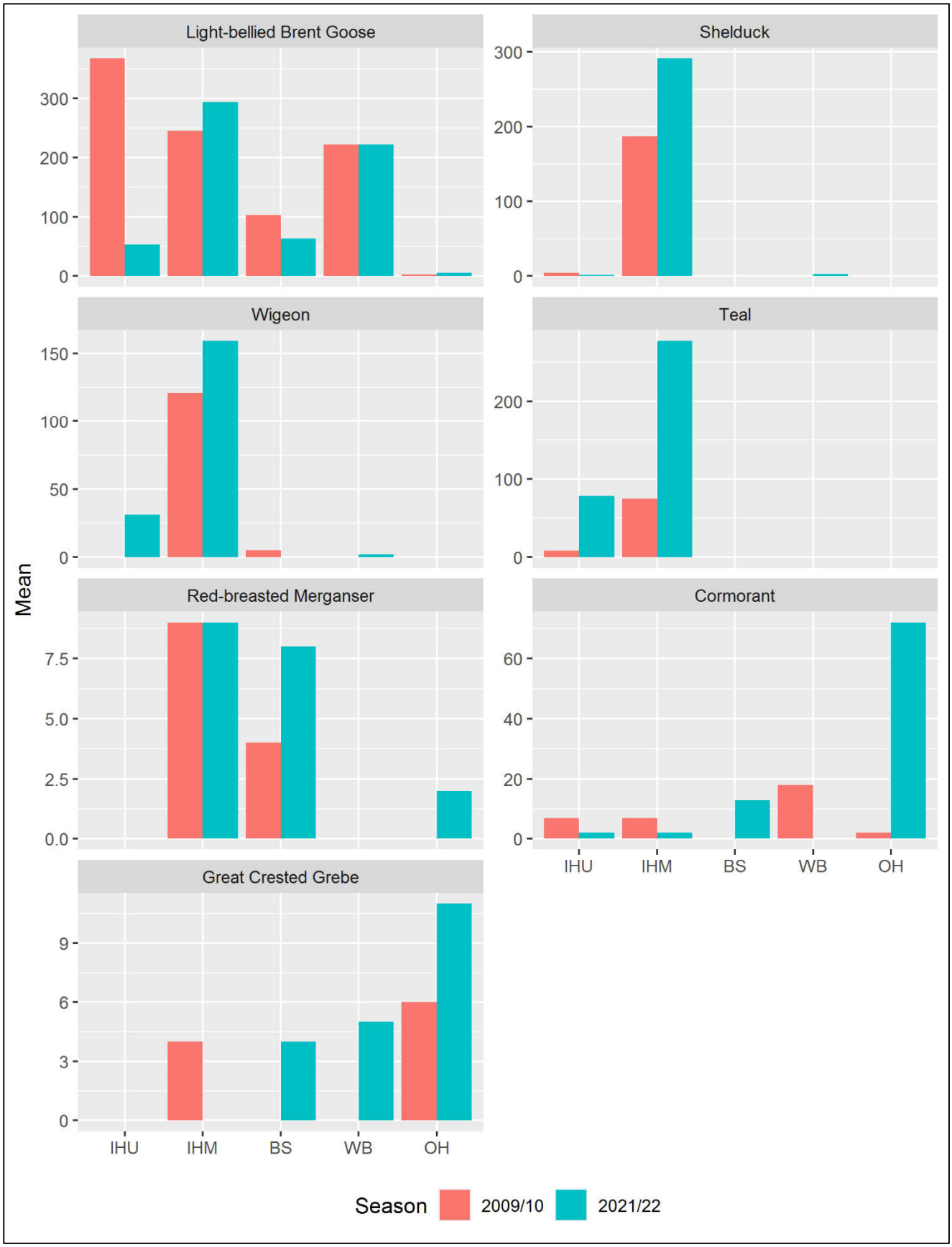

Figure 3.3. Zone distribution of the wildfowl species in the 2021/22 low tide counts, compared to the 2009/10 low tide counts.

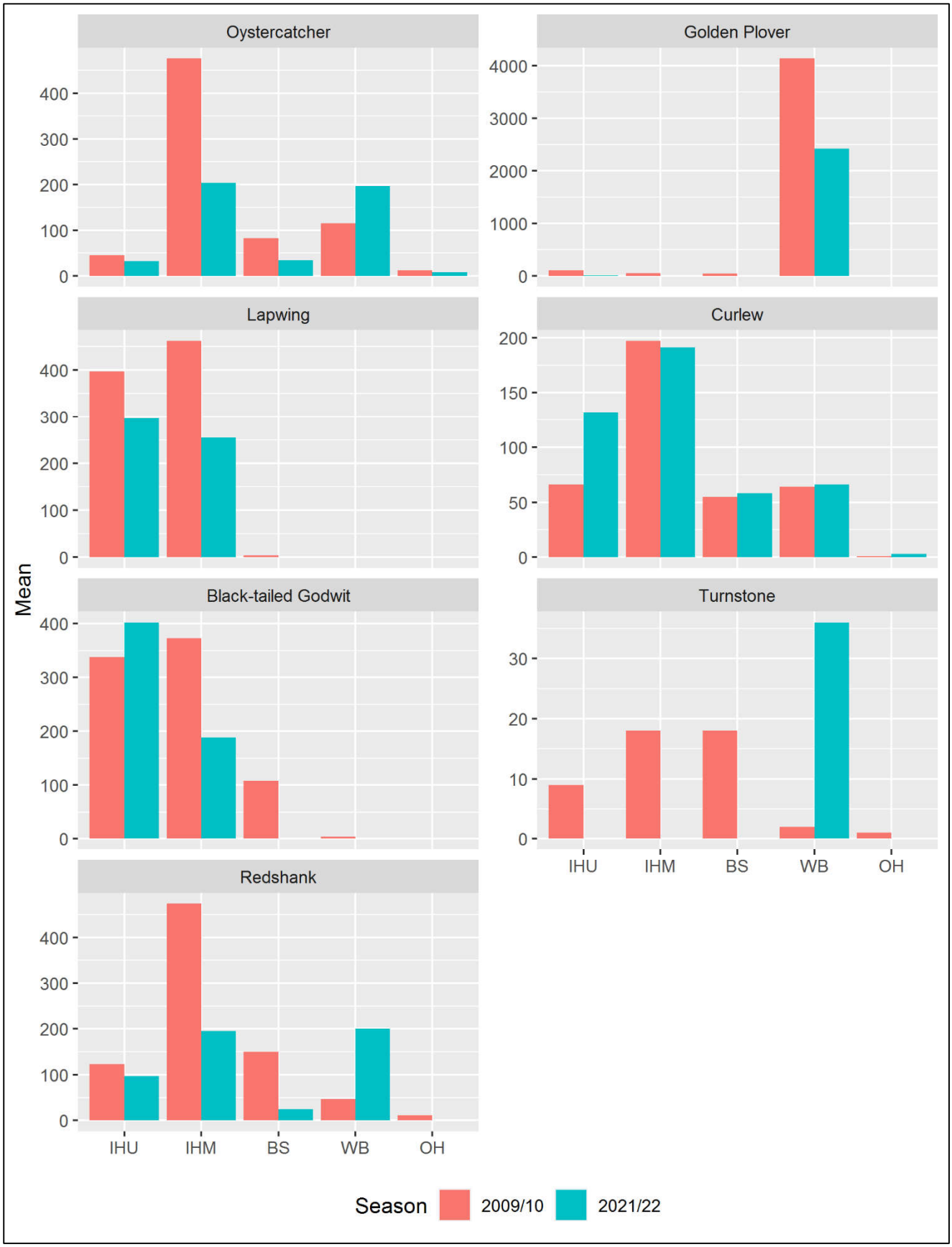

Figure 3.4. Zone distribution of the non-target wader species in the 2021/22 low tide counts, compared to the 2009/10 low tide counts.

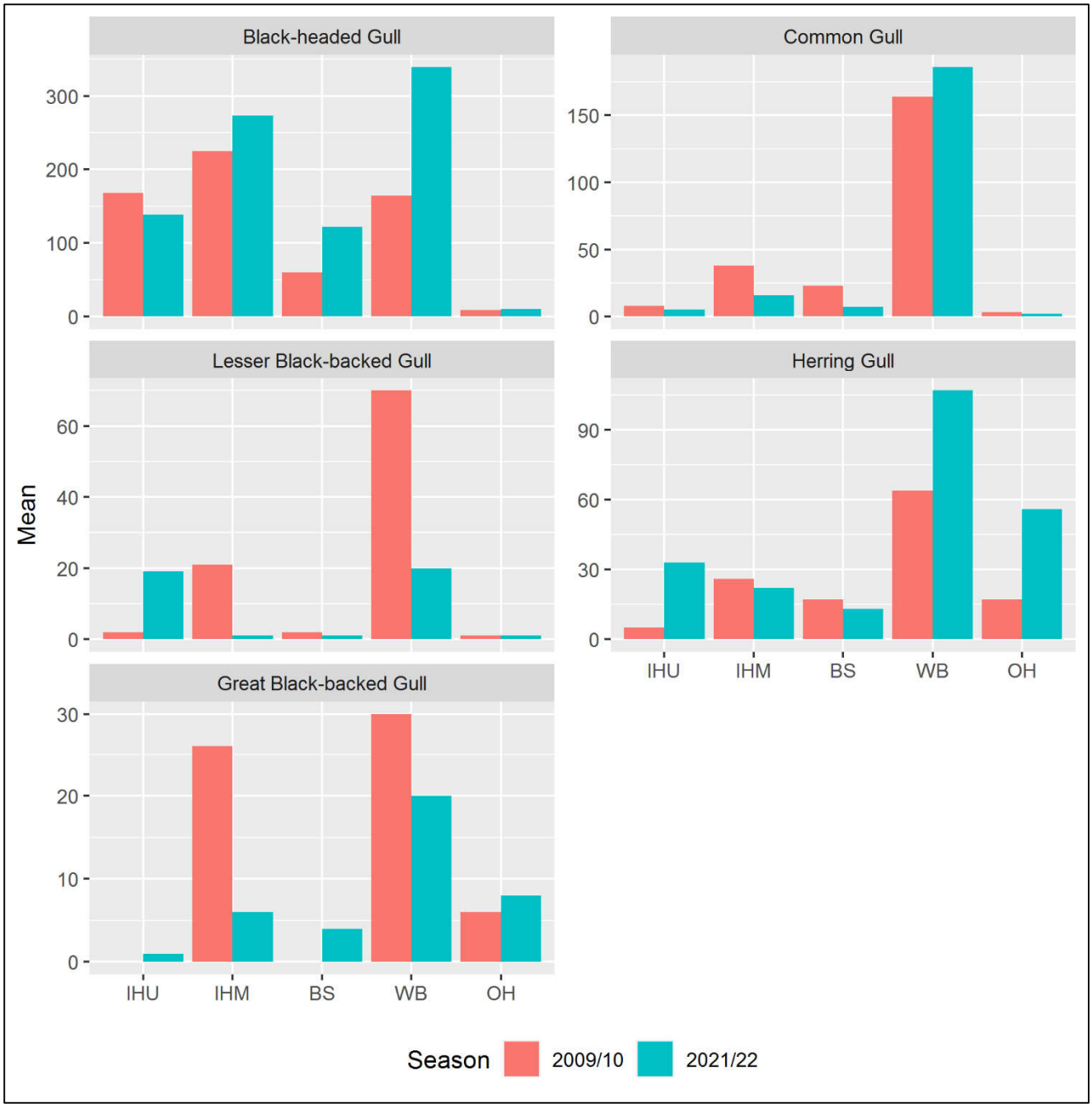

Figure 3.5. Zone distribution of the gull species in the 2021/22 low tide counts, compared to the 2009/10 low tide counts.

3.3. Population trends

The updated population trends for the target species, and the other main wildfowl and wader species at Dungarvan Harbour are shown in Figure 3.6 - Figure 3.8. These are based on the I-WeBS dataset but includes the 2021/22 low tide counts. The inclusion of the latter means there are differences between the index values presented here, and those presented by Kennedy *et al.* (2022), due to changes in the GLM coefficients that are used to calculate the imputed counts. There may also be differences in the I-WeBS datasets: Kennedy *et al.* (2022) includes index values for the 2000/01 and 2003/04 winters, but there are no count data for these winters in the I-WeBS dataset that we received.

The Grey Plover and Bar-tailed Godwit index values show sharp decreases in 2021/22 after relatively stable values over the preceding winters (Figure 3.6). However, these decreases may be due to coverage issues (see Discussion).

Kennedy *et al.* (2022) did not include trend analyses for wildfowl species, so the analyses presented here are the first for these species at Dungarvan Harbour. Some of the more notable trends are the increase in Light-bellied Brent Goose up to the late 2000s, followed by a gradual decrease; the decline in Shelduck numbers: and the large increase in Teal numbers. The Light-bellied Brent Goose trend is broadly similar to the national trends, while Shelduck have also showed a large decline over the same period at other south coast sites.

The trends for the non-target wader species are shown in Figure 3.8. Most of these trends are broadly similar to the national trends reported by Kennedy *et al.* (2022). Of particular, note is the massive decline in the Dungarvan Harbour Lapwing population over the entire period, and the consistent declines in the Dungarvan Harbour Oystercatcher and Turnstone populations since the late 2000s. However, apart from an increase at the very start of the period, the Dungarvan Harbour Black-tailed Godwit population has not shown an increasing trend, unlike the national trend.

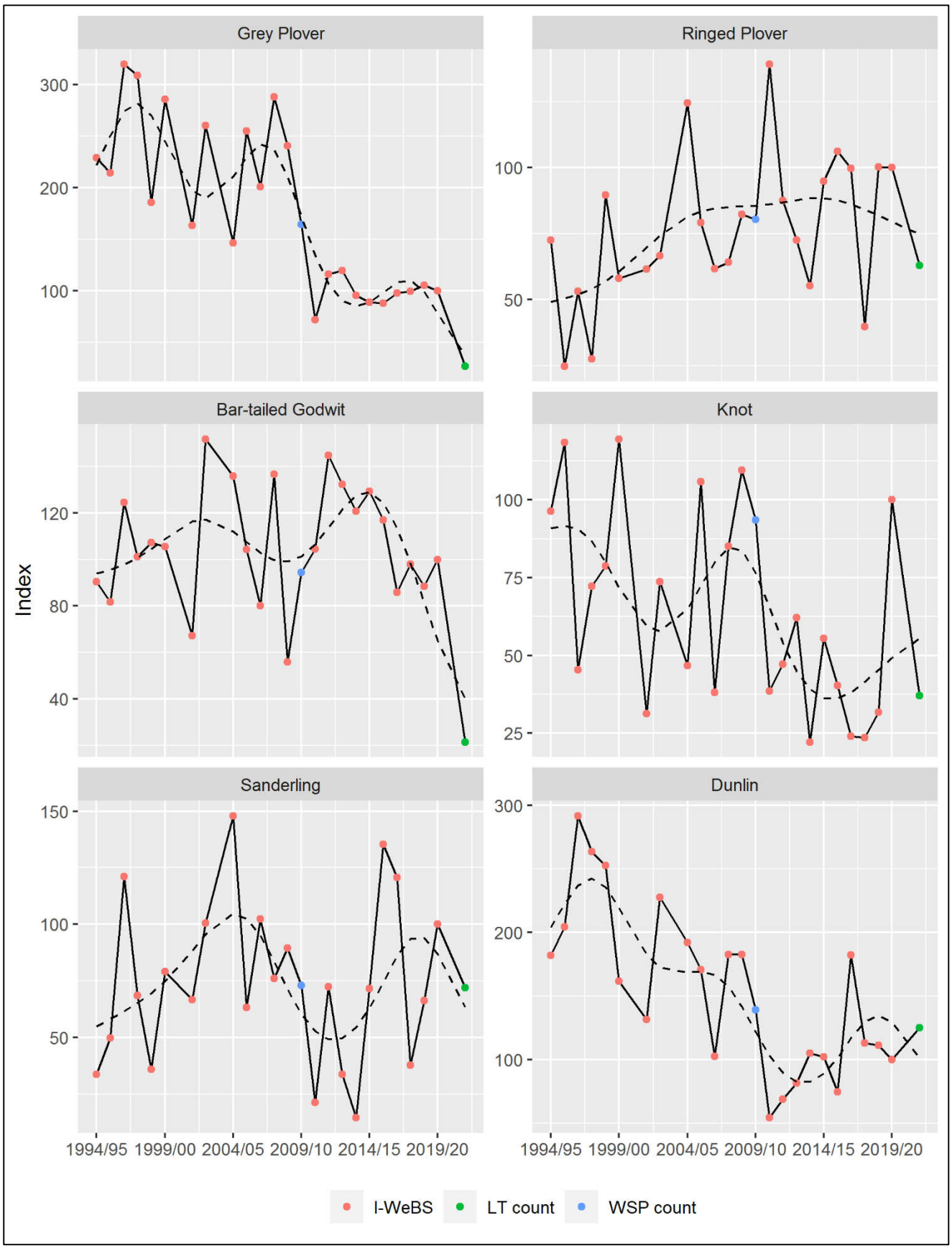

Figure 3.6. Population trends of target species at Dungarvan Harbour, 1994/95 - 2021/22.

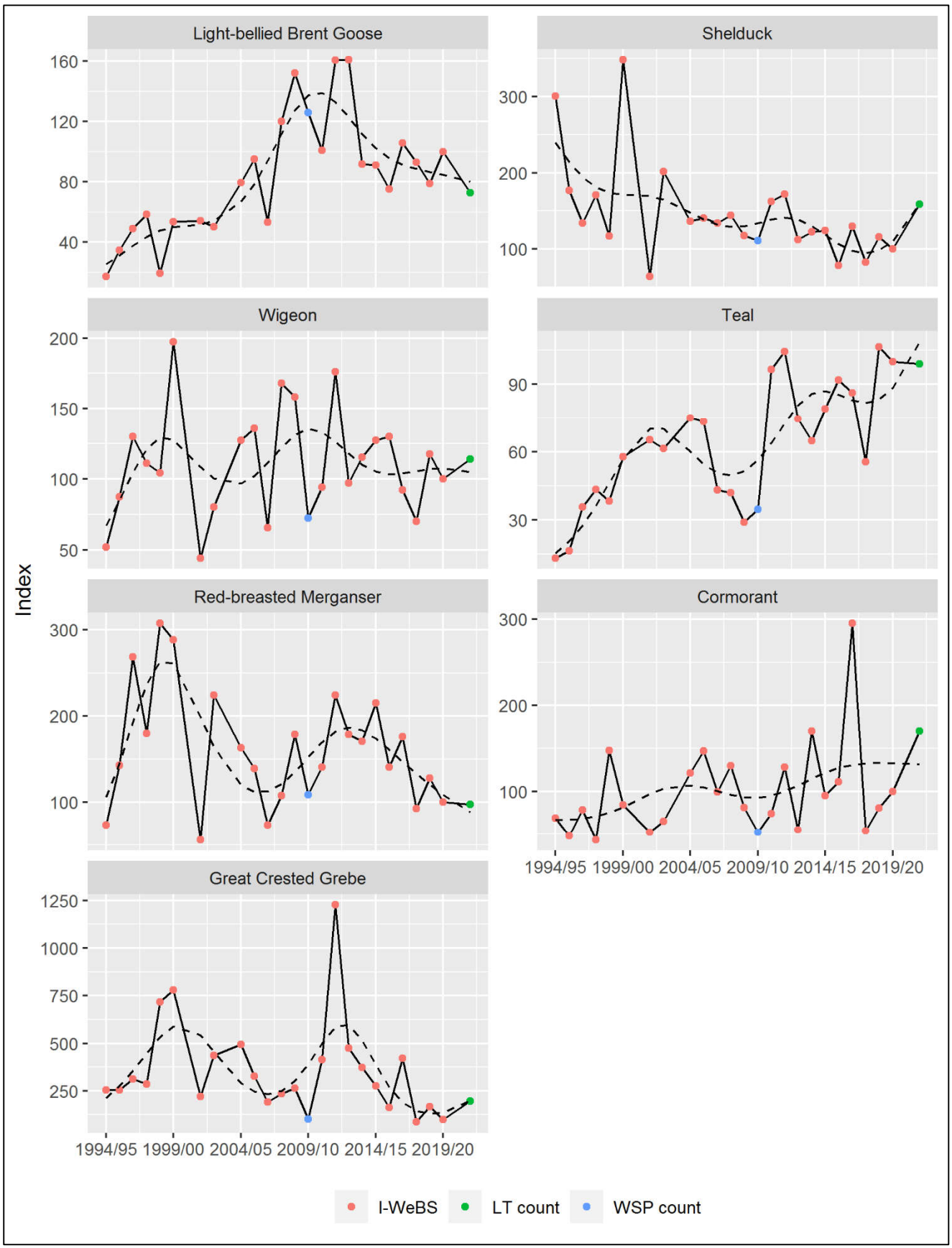

Figure 3.7. Population trends of wildfowl species at Dungarvan Harbour, 1994/95 - 2021/22.

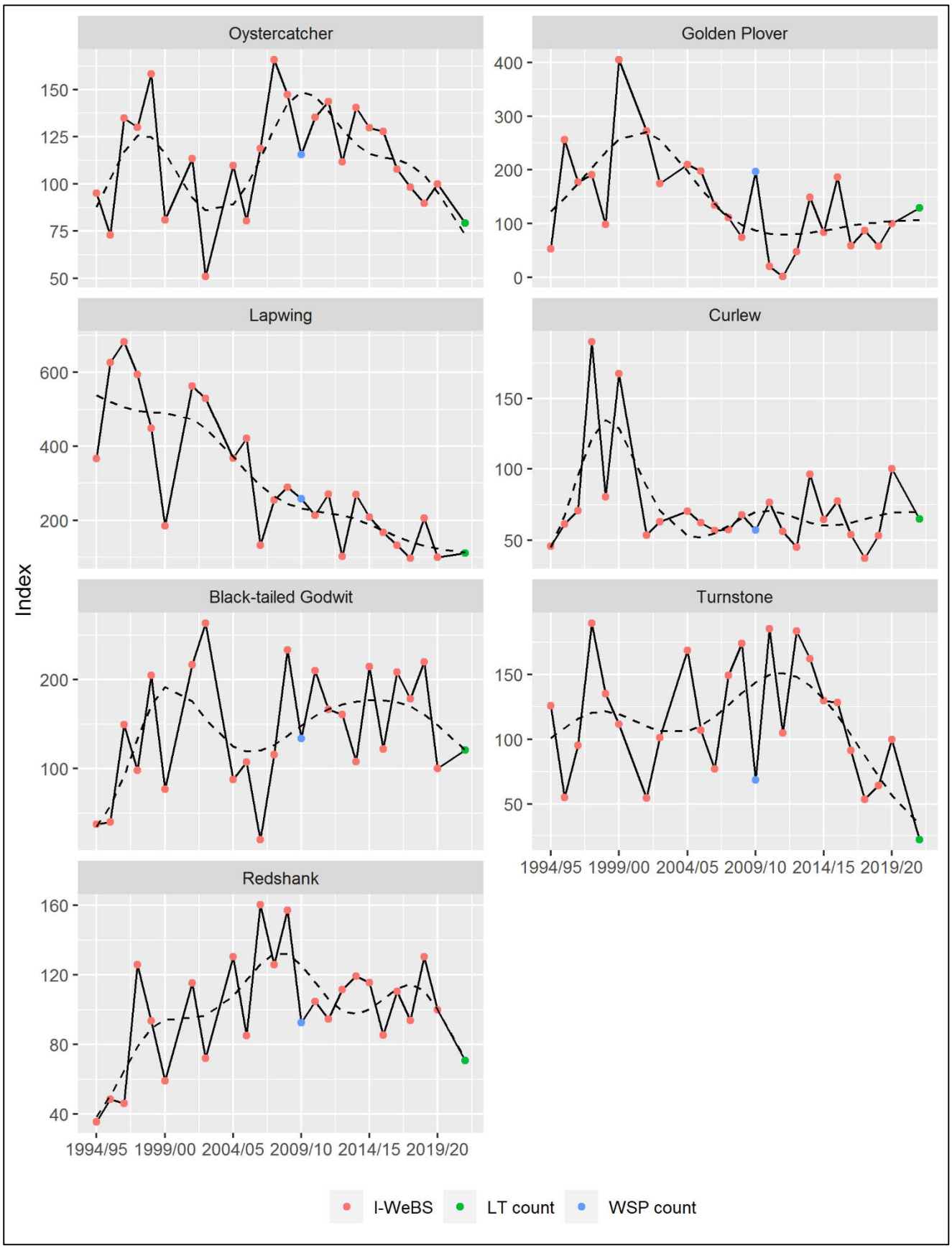

Figure 3.8. Population trends of the non-target wader species at Dungarvan Harbour, 1994/95 - 2021/22.

3.4. Bar-tailed Godwit feeding study

3.4.1. General observations

Around 200-400 Bar-tailed Godwit were recorded on each observation day at Ballyrandle Sandflats. They were most consistently present around the middle of the low tide period, when they usually fed in one or two large flocks in the outer parts of sectors CN1-L, CN1-U and CN4-L. At low tide, this area is a shallow delta, where the tidal channel of the Glendine River splits into separate channels enclosing small islands of exposed intertidal, and with large areas of very shallow subtidal habitat (Figure 3.9). The godwits mainly fed in the shallow subtidal and were often 50-100m out from the nearest area of exposed intertidal.

On the ebb and flood tides, the godwits usually followed the tidal channel of the Glendine River. However, on some dates, the godwits were absent for large parts of the ebb or flood tide. On 21st January 2022, the entire godwit flock flew to the Inner Harbour around 1.5 hours after low tide, and did not return until the Ballyrandle Sandflats were largely flooded, when they assembled in a pre-roost gathering along the upper part of the tidal channel. On 21st February 2022, the godwits were largely absent from Ballyrandle Sandflats for the ebb tide period, and the first half of the low tide period, with the main flock only arriving at around the full low tide. However, they then remained on Ballyrandle Sandflats for the remainder of the low tide period and followed the tideline up the tidal channel during the flood tide period until the sandflats were completely flooded.

On the two survey days on Whitehouse Bank, very few Bar-tailed Godwits were present.

3.4.2. Focal observations

A total of 56 focal observations were completed with a total duration of 239 minutes. These included 46 observation with a total duration of 191 minutes at Ballyrandle Sandflats and 10 observations with a total duration of 48 minutes on Whitehouse Bank. The location of the focal observation positions on Ballyrandle Sandflats are shown in Figure 3.9.

Overall, around 70% of the focal observations were of birds in shallow subtidal habitat below the tideline. However, females were more frequent in this habitat than males (84% vs 47% of observations; Table 3.8). None of the three observations of birds aged as first-years were from the shallow subtidal habitat.

A total of 388 prey captures were recorded during the focal observations. The median capture rate was 1.4 prey captures per minute (range 0-5.4). The capture rate did not differ between sexes, location (intertidal, tideline or subtidal) or zone (Ballyrandle Sandflats or Whitehouse Bank).

A total of 31 interactions were recorded, with all but one occurring at Ballyrandle Sandflats. These represented a rate of 0.2 kleptoparasitic interactions per minute at Ballyrandle Sandflats and 0.02 kleptoparasitic interactions per minute at Whitehouse Bank. At Ballyrandle Sandflats, the rate was higher in focal observations in subtidal habitat compared to on the tideline (0.26 vs 0.10 kleptoparasitic interactions per minute)

In most cases, the birds were feeding in shallow water and ingested the prey without removing it from the water so it was not possible to identify the prey item. However, there were 60 observations of prey captures where the prey type, or probably prey type, was identified (Table 3.9).

The most frequently recorded prey type was suspected clams. However, 15 of the 20 records of this prey type came from a single focal observation. Thin worms were the next most frequently recorded prey type. These were worms that were around 0.5 – 1.5 times the length of a godwit's bill and were not either lugworms or ragworms. There were nine observations of lugworm, or suspected lugworm, captures. The two confirmed captures involved whole lugworms that had been removed from the water by the godwit and were clearly visible. The suspected captures involved godwits removing suspected lugworm fragments from the water before ingesting them. The frequency of crabs and shrimps as prey items may be exaggerated in the data in Table 3.9 as, due to the nature of the capture and handling methods, the captures of these prey items are more likely to have been identified.

An alternative approach to assessing the frequency of lugworms in the godwit's diet is to examine the distribution of handling times, as lugworms will often require long handling times. These can be compared to the distribution of handling times recorded by Duijns *et al.* (2014) for godwits feeding on lugworms in the Dutch Wadden Sea. Around 36% of the handling times recorded at Dungarvan Harbour were very short (1-2 seconds), while only

12% of the handling times were longer than 10 seconds (Table 3.10). By contrast, Duijns *et al.* (2014) only recorded a single handling time of 1-2 seconds, while around 70% of the handling times were longer than 10 seconds.

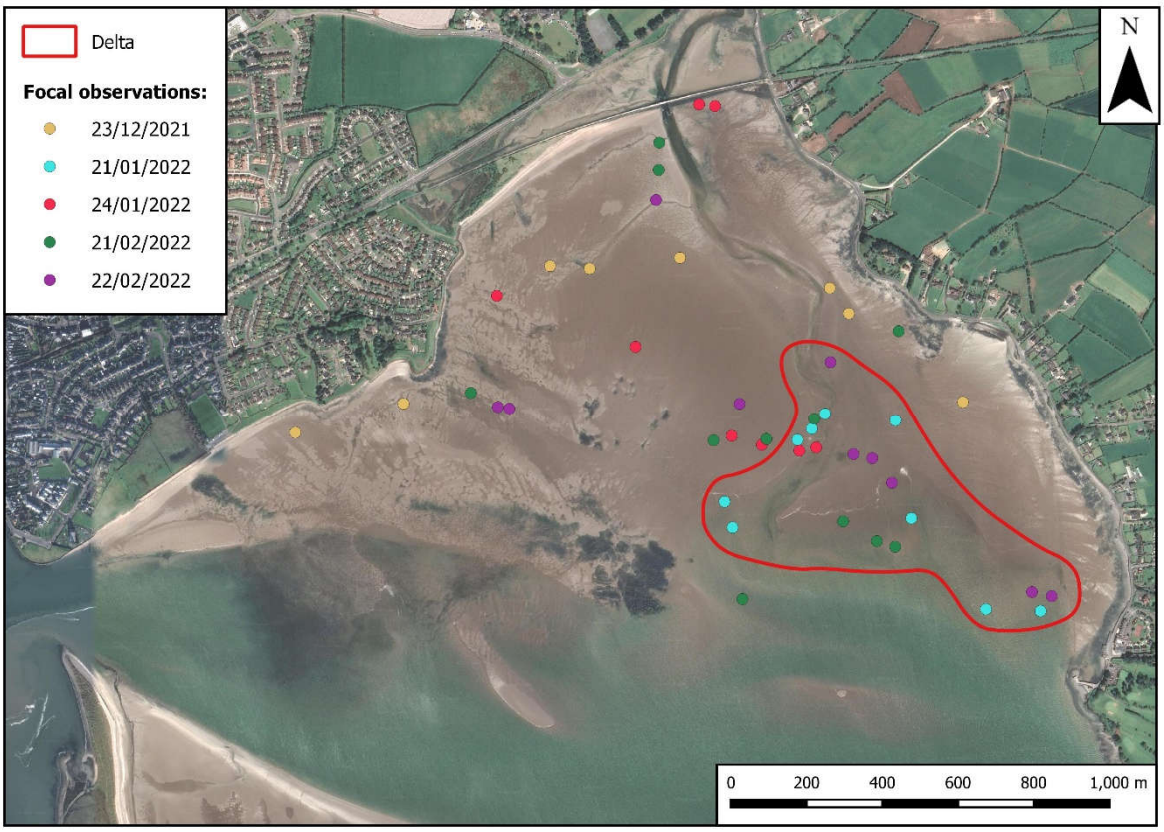

Figure 3.9. Approximate extent of the low tide delta, and the distribution of focal observation positions on Ballyrandle Sandflats.

Table 3.8. Location of the focal observations.

Location	Number of observations	
	females	males
Intertidal away from the tideline	2	3
Intertidal on the tideline	3.5	7
Subtidal below the tideline	31.5	9

One female observation was of a bird that moved between the intertidal and the subtidal, so is represented as half an observation in each of these categories.

Table 3.9. Prey items recorded in the focal observations.

Prey type	Number of observations	
	confirmed prey type	suspected prey type
clam	0	20
crab	3	0
lugworm	2	7
ragworm	0	1
thin worm	19	0
shrimp	7	0

Table 3.10. Distribution of successful handling times in the Bar-tailed Godwit focal observations at Dungarvan Harbour, compared to the distribution recorded by Duijns *et al.* (2014).

Handling time	Number of observations	
	Dungarvan Harbour	Duijns *et al.* (2014)
1-2 secs	118	1
3-10 secs	168	21
11-20 secs	31	23
> 20 secs	9	10

3.4.3. Bar-tailed Godwit faecal samples

Attempts were made to collect Bar-tailed Godwit faecal samples from Ballyrandle Sandflats on 21st and 22nd February. This involved searching areas that had been recently occupied by Bar-tailed Godwit flocks. However, due to their habit of feeding in shallow water, it was very hard to find any faeces. Even when birds were feeding on the intertidal, the surface of the sediment was very wet and the faeces rapidly dissolved on contact with the sediment.

On 21st February, no Bar-tailed Godwit faeces were found. On 22nd February, five samples were collected from an area where a group of Bar-tailed Godwit had been feeding on relatively firm sediment and had been observed defecating. One of these samples comprised more or less intact faeces with cockle shell fragments, and may have been Curlew faeces (Oystercatchers do not ingest the cockle shell). The others were samples of sediment with white urine splashes, which may have been dissolving Bar-tailed Godwit faeces. However, no identifiable prey remains were found in these samples.

3.5. Disturbance trials

A total of 270 disturbance trials were completed in the winters of 2020/21 and 2021/22. Over two-thirds of these involved Oystercatcher Curlew and Bar-tailed Godwit, reflecting the widespread distribution of the first two species on the Outer Sandflats, and the focus on Bar-tailed Godwit in the 2021/22 surveys (Table 3.11).

In most cases, birds only showed a brief alert response before they flew, and there was no appreciable difference between the alert distance and the flight initiation distance. There were a few cases when birds started running away before flying. In these cases, the observer continued walking towards the birds and the flight initiation distance was generally very similar to the distance at which they started running. In some cases, the flight initiation distance was higher, reflecting the fact that the birds were running faster than the walking pace of the observer.

In the following analyses, data is only presented for species with a sample size of at least ten observations with the relevant parameter recorded.

The median flight initiation distances ranged from under 50 m for Ringed Plover, Dunlin and Sanderling to over 175 m for Curlew. The species are arranged in order of body size in Figure 3.10, showing that the flight initiation distances generally increased with body size. The flight initiation distances of Grey Plover and Knot were an exception to this pattern. This partly reflected some very large flight initiation distances recorded in March 2021 on Whitehouse Bank, which may be unrepresentative due to the small number of individuals present (i.e., they are more likely to involve multiple observations of the same individuals). However, even when these observations are excluded, the medians are only reduced very slightly, although most of the high value outliers disappear. Oystercatcher, Curlew and Bar-tailed Godwit did not show significant differences in flight initiation distances between Ballyrandle Sandflats and Whitehouse Bank; the other species had too few observations for this comparison. Flight initiation distances were not analysed for Dunlin due to small sample sizes.

The flight times also showed a general pattern of increasing with body size, with median flight times ranging from 12 seconds for Sanderling to 42 seconds for Curlew. The data includes flight times for a number of flights that were not completed: i.e., the birds flew out of view. For each species, the median flight times were higher for the uncompleted flights. Therefore, the data will underestimate the overall distribution of flight times. Flight times were not analysed for Dunlin or Redshank due to small sample sizes (flight times were not recorded for all observations).

For birds that had been feeding before being disturbed, the time to resume feeding after completing the flight was usually very small. The median differences between the flight times and the resume times ranged from 0 seconds for Bar-tailed Godwit and Sanderling to 5 secs for Curlew. These do not include the small number of observations when birds that had been feeding before being disturbed started roosting after they completed their flights.

The mean flight initiation distances recorded at Dungarvan Harbour were generally similar to those recorded by Collop *et al.* (2016) in the Wash, with the exception of Curlew which had a much larger flight initiation distance at the Wash (Table 3.12). The mean flight times were around 1.5 – 2 times greater in Dungarvan Harbour compared to the Wash (Table 3.12).

Table 3.11. Number of disturbance trials completed in the 2020/21 and 2021/22 winters.

Species	Number of observations		
	Ballyrandle Sandflats	Whitehouse Bank	Total
Oystercatcher	37	72	109
Grey Plover	4	13	17
Ringed Plover	0	12	12
Curlew	24	15	39
Bar-tailed Godwit	32	18	50
Knot	7	7	14
Sanderling	3	9	12
Dunlin	2	5	7
Redshank	6	4	10

Table 3.12. Comparison of mean flight initiation distance and flight times recorded at Dungarvan Harbour with those recorded in the Wash by Collop *et al.* (2016).

Species	Flight initiation distances (m)		Flight times (secs)	
	Dungarvan Harbour	Collop *et al.*	Dungarvan Harbour	Collop *et al.*
Curlew	182	340	50	34
Oystercatcher	101	97	30	21
Bar-tailed Godwit	74	84	39	20
Grey Plover	112	132	49	23
Redshank	71	80	-	17
Knot	89	72	50	20
Ringed Plover	45	41	16	12
Sanderling	40	25	18	10

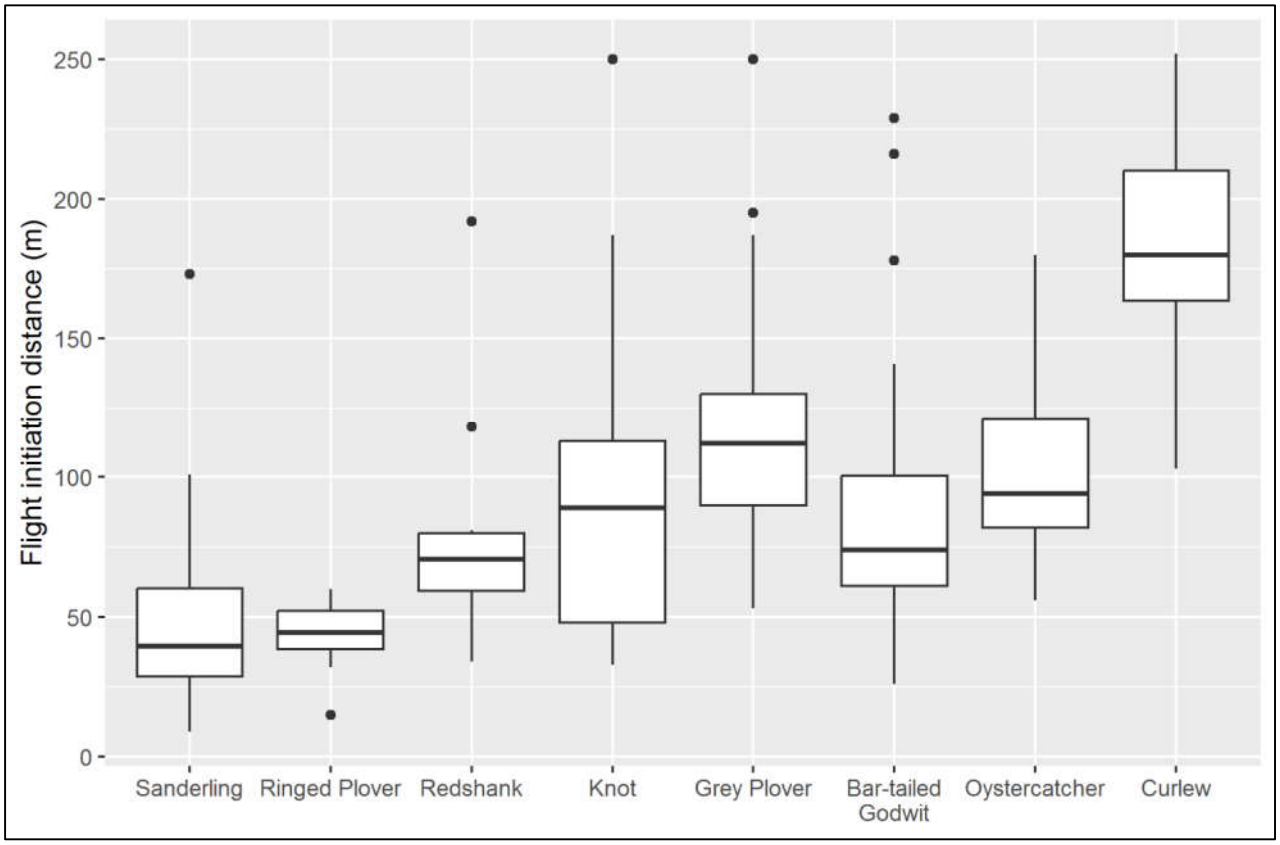

Figure 3.10. Boxplot of flight initiation distances recorded at Dungarvan Harbour in the winters of 2020/21 and 2021/22.

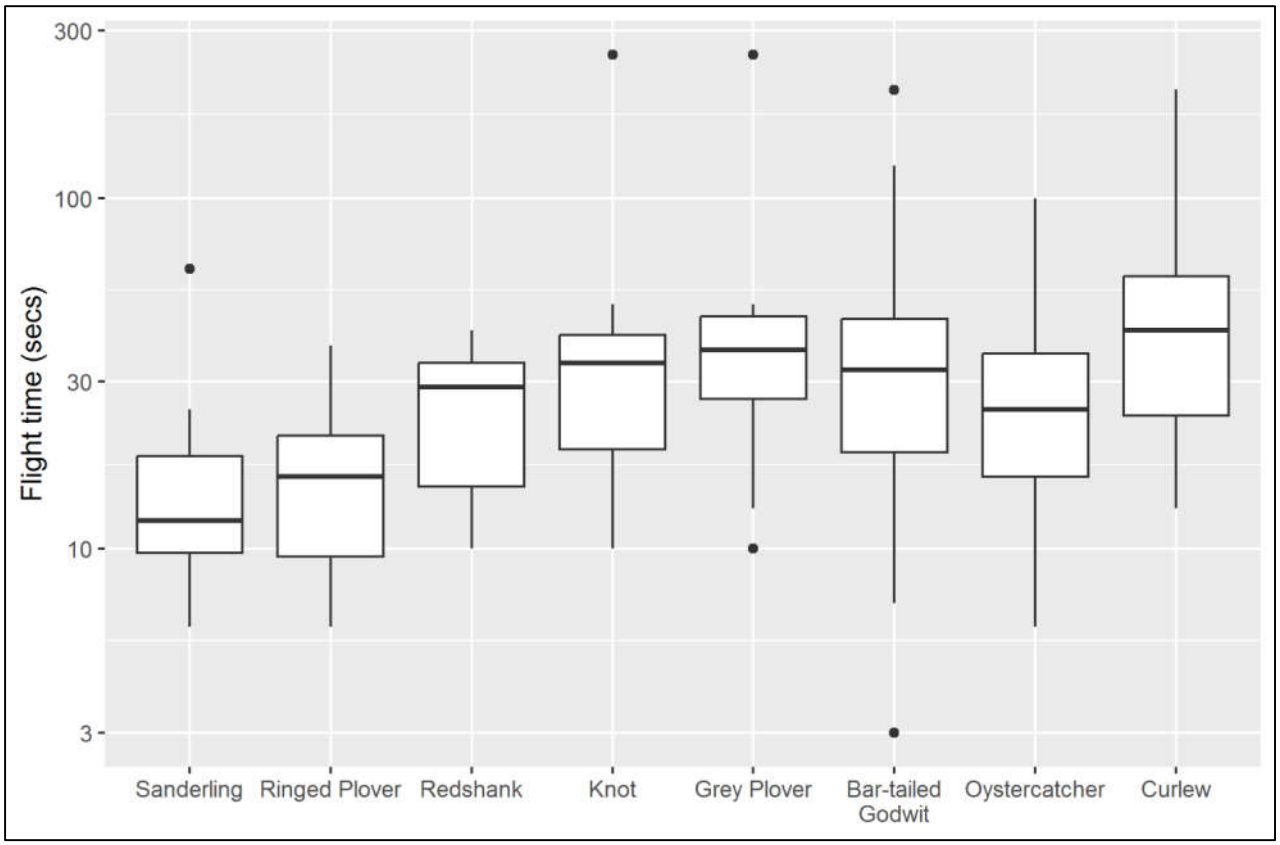

Figure 3.11. Boxplot of flight times recorded at Dungarvan Harbour in the winters of 2020/21 and 2021/22.

4. Discussion

4.1. Low tide counts

The overall numbers and distribution patterns of most species were broadly in line with expectations based on previous monitoring data and general knowledge of distribution patterns in Dungarvan Harbour. However, two of the target species (Grey Plover and Bar-tailed Godwit) occurred in very low numbers.

The low numbers of Grey Plover that we recorded reflects the phenomenon of Grey Plover disappearing at low tide that was apparent from the tidal cycle monitoring, and which we have discussed in previous reports. This may be due to birds roosting at low tide in creeks in the Inner Harbour Main, where they are not visible from shoreline vantage points. However, it is surprising that we did not record good numbers of Grey Plover on at least one count.

The low numbers of Bar-tailed Godwit were more unexpected as the daily maxima during the tidal cycle counts were usually recorded at low tide. During the Bar-tailed Godwit feeding study, around 200-400 Bar-tailed Godwit were recorded on Ballyrandle Sandflats on each of the five survey days, but on some days they were absent for a significant part of the low tide period. Therefore, it seems likely that the low numbers recorded on the low tide counts were caused by birds being missed due to their movement patterns, rather than a real decline in numbers.

The above issues with the Grey Plover and Bar-tailed Godwit counts reflect general issues with low tide counts as a method of monitoring population sizes. At low tide birds move around more than at high tide, so birds can be missed, or double-counted, depending on their movement patterns, relative to the sequences in which the sectors are counted. There is also a much larger area to cover at low tide, with more opportunities for birds to be hard to detect due to distance and / or topography.

These low tide counts also provide the first quantitative data that can be used to assess the distribution patterns relative to the trestle blocks of the non-target species at the Dungarvan Harbour scale. This data will help to inform any further development of the Individual-based Model. It also illustrates the degree to which the 2009/10 low tide counts are likely to have underestimated the overall numbers, and the occurrence patterns on Whitehouse Bank, of certain species such as Turnstone and Redshank.

4.2. Population trends

The population trends presented in this report include the data from the 2021/22 low tide counts (and also include data from the 2009/10 Waterbird Survey Programme low tide counts, which are part of the I-WeBS dataset). Therefore, some caution should be applied to the interpretation of these trends, due to the issues with using low tide counts to monitor population sizes. In particular, the large declines in the Grey Plover and Bar-tailed Godwit indices in 2021/22 may be spurious for the reasons discussed above.

The I-WeBS data for the early part of the I-WeBS period is also quite limited, with only one or two counts in many of those winters. This means that the index values for those winters are based on high components of imputed counts.

Despite the above issues, the overall trends for many species are broadly similar to the national trends, or regional trends. In particular, the trends for the six target species do not appear to be obviously different from the national trends, which may indicate a lack of impact from oyster trestle cultivation. The more notable differences from the national trend include the large increase in the Teal population and the lack of a consistent increase in the Black-tailed Godwit population.

4.3. Bar-tailed Godwit feeding ecology

A major focus of the survey work this winter was aimed at developing our understanding of the feeding ecology of Bar-tailed Godwit at Dungarvan Harbour. This was prompted by the development of the Individual-based Model, which indicated that Bar-tailed Godwit may at risk from the impacts of oyster trestle cultivation in Dungarvan Harbour.

4.3.1. Overall distribution patterns

While the focal observations collected a lot of detailed data, the simple process of tracking Bar-tailed Godwit movements around the Ballyrandle Sandflats across several low tide periods was very informative. This indicated that Bar-tailed Godwits have very specific habitat preferences that may not be well represented by the sector divisions used for the Individual-based Model.

We have previously noted the very strong association of Bar-tailed Godwit with the tideline. However, the observations from this study indicate that it is the occurrence of extensive areas of shallow (godwit-depth) water below the tideline that is the critical factor dictating Bar-tailed Godwit distribution. At Ballyrandle Sandflats, the configuration of the bay and the tidal channel produces a large delta of suitable habitat. This area appears to support the bulk of the Bar-tailed Godwit population across the middle of the low tide period. This delta extends across significant parts of three count sectors, while the benthic sampling for the Individual-based Model only included two samples from this area.

The importance of shallow water below the tideline for Bar-tailed Godwit is reflected in their distribution patterns elsewhere in Dungarvan Harbour and at other sites. On Whitehouse Bank, the very shallow grade of the sandflats produces large areas of very shallow water. On spring low tides, these are exposed below the trestle blocks and often support large flocks of Bar-tailed Godwit. By contrast, in the Inner Harbour, which does not usually hold significant numbers of Bar-tailed Godwit, the tideline at low tide is mainly defined by deeply cut tidal channels with very limited areas of godwit-depth shallow water. Further afield, in Cork Harbour, the restriction of Bar-tailed Godwits to Lough Mahon reflects the fact that this is the only area in the harbour where the topography produces extensive areas of very shallow water at low tide.

4.3.2. Feeding ecology

The godwits' habit of feeding in shallow water and ingesting prey without removing it from the water made it difficult to determine prey types from direct observation. We also attempted to investigate their diet by collecting faecal samples. However, this proved very difficult, due to their habit of feeding in shallow water, and due to the faeces rapidly dissolving when deposited on wet sediment. For future work, efforts to collect faecal samples from their high tide roosts may be more productive, although it may be difficult to distinguish Bar-tailed Godwit faeces in the typical mixed-species high tide roosts that occur at Dungarvan Harbour.

Despite the above difficulties, we did confirm that the Bar-tailed Godwits were feeding on lugworms, although the analysis of the handling times recorded from the focal observations suggested that the godwit diet was not numerically dominated by lugworms. However, while lugworms may not be numerically dominant in the godwit diet at Dungarvan Harbour, they may still provide the most significant energetic component, due to their size relative to most of the other prey types.

During many of the prey captures that were observed, the bill movements and the way that the prey was ingested appeared similar to the behaviour that we have previously observed of Oystercatcher feeding on clams, so these may be a significant component of their diet. It was only towards the end of the study, we started recording obvious examples of this behaviour as suspected clam captures, so the data underestimates the frequency of this type of prey capture.

We also recorded a high rate of kleptoparasitic interactions in the Bar-tailed Godwits feeding on the Ballyrandle Sandflats. The overall rate of 0.2 kleptoparasitic interactions per minute (rising to 0.26 kleptoparasitic interactions per minute in the preferred subtidal habitat) is higher than the rate of around 1.5 kleptoparasitic interactions per minute recorded for the highest density of female Bar-tailed Godwits (> 5 birds/ha) by Duijns and Piersma (2014). High rates of kleptoparasitic interactions are often considered to indicate resource limitation. This high rate of kleptoparasitic interactions may also have implications for further development of the Individual-based Model, as interference competition is one of the factors that is modelled.

4.3.3. Disturbance trials

The disturbance trials carried out over the winters of 2020/21 and 2021/22 collected large datasets on the responses to pedestrian activity in the intertidal for three of the IBM species (including one of the target species), as well as more limited data for the other five target species. The only IBM species for which data was not collected was Black-tailed Godwit, which does not occur in the Outer Sandflats.

With the exception of Curlew, the flight initiation distances and flight times recorded at Dungarvan Harbour were broadly comparable to those recorded in a similar study in the Wash by Collop *et al.* (2016). Curlew had a much larger flight initiation distance in the Wash. In fact, the starting distance for most of the disturbance trials at Dungarvan Harbour was less than the mean flight initiation distance for Curlew in the Wash. While this could suggest that the Curlew flight initiation distances were underestimated due to the starting distances, this seems unlikely to be the case given the distribution of the flight initiation distances that were recorded.

The flight initiation distances showed the pattern of increasing with body size that has been reported in other studies. Grey Plover was an exception to this pattern, with a relatively high flight initiation distance for its body size, and this was also the case in the Wash study.

The data collected from the disturbance trials could contribute to any future development of the Individual-based Model to examine impacts from recreational disturbance. It also gives an indication of potential sensitivity to disturbance from workers carrying out husbandry activity in the trestle blocks.

It seems likely that tractor activity causes higher flight initiation distances than pedestrian activity. On the other hand, the disturbance trials involved the observer walking directly towards the focal birds, while most tractor activity is along fixed routes and will be at oblique angles to the potentially disturbed birds.

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Appendix A. Metadata for Dungarvan waterbird monitoring datasets

A.1. Dungarvan_waterbird_monitoring_ 2014_2022_ counts.csv

This dataset contains the full waterbird count data for the winters of 2014/15, 2016/17, 2017/18, 2018/19, 2020/21 and 2021/22 winters.

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; TC = tidal cycle counts; WSP = counts following Waterbird Survey Programme methods.
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; CS = Clonea Strand; FIELDS = fields; IHM = Inner Harbour Main; IHU = Inner Harbour Upper; OB = Outer Bay; 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	DD = David Daly; 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_2022_ tractor_counts.csv

This dataset contains the full tractor count data for the winters of 2014/15, 2016/17, 2017/18, 2018/19, 2020/21 and 2021/22 winters.

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	BA = Bar-tailed Godwit feeding study; BCM = Bird Corridor Monitoring; DS = disturbance studies; TC = tidal cycle counts; WSP = counts following Waterbird Survey Programme methods
Time	Time	Time of count
Sector	Text	Count sector; see Figure 2.1
Number	Integer	Number of tractors
Activity	Text	arriving, departing, parked, travelling or working; NR = not recorded

A.3. Dungarvan_BA_feeding_study_details_ 2021_2022.csv

This dataset contains details of the dates, timings and weather conditions of the Bar-tailed Godwit feeding study survey days.

Field	Data type	Details
Date	Date	Survey date
Zone	Text	BS = Ballyrandle Sandflats; WB = Whitehouse Bank
Time_start	Time	Start time of survey
Time_finish	Time	Finish time of survey
Cloud	Integer	Cloud cover: 1 = 0-33%, 2 = 33-67%; 3 = 67-100%
Rain	Integer	Rainfall: 1 = none; 2 = showers; 3 = drizzle; 4 = light rain; 5 = heavy rain
Wind	Text	Compass bearing and Beaufort scale
Visibility	Integer	1 = good; 2 = moderate; 3 = poor
Notes	Text	Free-form field for notes

A.4. Dungarvan_BA_focal_observations_2021_2022.csv

This dataset contains the focal observation data recorded in the Bar-tailed Godwit feeding study in the winter of 2021/22.

Field	Data type	Details
Date	Date	Survey date
Zone	Text	BS = Ballyrandle Sandflats; WB = Whitehouse Bank
Ref	Integer	Cross-reference to prey capture data
x	Integer	Irish Grid x coordinate of bird position
y	Integer	Irish Grid y coordinate of bird position
Time	Time	Start time of focal observation
Duration	Integer	Duration in seconds of focal observation
Location	Text	Location of bird: INT = intertidal above tideline; TL = intertidal on tideline; SUB = subtidal below tideline
Sex	Text	M = male; F = female
Age	Text	AD = adult; J = juvenile / first-winter
Search_method	Text	Predominant searching method during focal observation: PECK = surface pecks; PL = ploughing; HP = half-probes; FP = full probes
Captures	Integer	Total number of successful prey captures
Capture_method	Text	Predominant method(s) used for captures, or attempted captures: PECK = surface pecks; HP = half-probes; FP = full probes
HT1	Integer	Number of handling times of 1-2 seconds duration; NR = not recorded
HT2	Integer	Number of handling times of 3-10 seconds duration; NR = not recorded
HT3	Integer	Number of handling times of 11-20 seconds duration; NR = not recorded
HT4	Integer	Number of handling times of > 20 seconds duration; NR = not recorded
Klepto_intra	Integer	Number of intraspecific kleptoparasitic interactions; NR = not recorded
Klepto_inter	Integer	Number of interspecific kleptoparasitic interactions; NR = not recorded
Notes	Text	Free form field for notes

A.5. Dungarvan_BA_prey_capture_data_ 2021_2022.csv

This dataset contains the prey capture data recorded during focal observations in the Bar-tailed Godwit feeding study in the winter of 2021/22.

Field	Data type	Details
Date	Date	Survey date
Ref	Integer	Cross-reference to GPS position and focal observation data
Type	Text	Prey type
Size	Decimal	Estimated prey size relative to bill length; NR = not recorded
Confirmed	Text	YES = prey type clearly seen; NO = prey type inferred from behaviour of bird and/or partial views
Notes	Text	Free form field for notes

A.6. Dungarvan_disturbance_observations_ 2021_2022.csv

This dataset contains the disturbance observation data recorded in March 2021 and in the winter of 2021/22.

Field	Data type	Details
Date	Date	Survey date
Zone	Text	BS = Ballyrandle Sandflats; WB = Whitehouse Bank
Ref	Integer / Decimal	Observation number; decimals indicate multiple observations of birds from the same position
x	Integer	Irish Grid x coordinate of focal bird position
y	Integer	Irish Grid y coordinate of focal bird position
Time	Time	Time of observation
Species	Text	BTO species code
Number1	Integer	Number of birds showing disturbance response
Number2	Integer	Overall flock size of birds associating with focal bird
Feeding	Integer	Number of birds feeding in flock
Location	Text	Location of bird: INT = intertidal above tideline; TL = intertidal on tideline; SUB = subtidal below tideline
Behaviour	Text	Behaviour of bird before disturbance response: F = feeding; R = roosting/other
Approach	Text	Approach direction relative to tideline: OB = oblique; PL = parallel; PP = perpendicular
Starting_distance	Integer	The distance from the focal bird at the start of the trial
Response	Text	Indicates whether the focal bird showed a disturbance response
Alert_distance	Integer	Distance at which the focal bird showed an alert response; NA = no alert response, or negligible difference between alert distance and run or flight distance
Run_distance	Integer	Distance at which the focal bird showed a run response; NA = no run response, or negligible difference between run distance and flight distance
Flight_distance	Integer	Distance at which the focal bird showed a flight response; NA = no flight response
Lateral_distance	Integer	Lateral distance at which the focal bird showed a flight response
Flight_time	Integer	Duration in seconds of flight; NA = no flight response
Flight_completed	Text	Indicates whether the flight was completed within the observation (YES), or the bird disappeared from view before completing the flight (NO)
Resume_time	Integer	For birds that were feeding before the disturbance, the duration until they resumed feeding after completing their flight; NA = no flight response; NR = not recorded; R = went to roost after completing flight
Notes	Text	Free form field for notes

A.7. Dungarvan_lugworm_data_202122.csv

This dataset contains the lugworm quadrat data recorded in the winter of 2021/22.

Field	Data type	Details
Date	Date	Survey date
Zone	Text	BS = Ballyrandle Sandflats; WB = Whitehouse Bank
Sample	Integer	Sample number
x	Integer	Irish Grid x coordinate of quadrat position
y	Integer	Irish Grid x coordinate of quadrat position
Time	Time	Time sample recorded
Casts	Integer	Number of casts in quadrat
Nearby	Text	YES = casts nearby quadrat; NO = no casts nearby quadrat; NA = casts in quadrat
TL_distance	Integer	Distance from the tideline; NR = not recorded
TL_accuracy	Integer	Accuracy of tideline distance: 0 = estimated; 1 = measured with laser rangefinder; NA = tideline distance not recorded

WS Atkins Ireland Limited
Unit 2B
2200 Cork Airport Business Park
Cork
T12 R279

Tel: +353 21 429 0300

Further details available on www.emff.marine.ie

Managing Authority EMFF 2014-2020	Specified Public Beneficiary Body
Department of Agriculture Food & the Marine Clogheen, Clonakilty, Co. Cork. P85 TX47 Tel: (+)353 (0)23 885 9500 www.agriculture.gov.ie/emff	Marine Institute Rinville, Oranmore, Co. Galway, H91 R673 Phone: (+)353 (0)91 38 7200 www.marine.ie

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