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Marine Institute Bird Studies

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

2016-2017

Lead Agency: Marine Institute

Authors: ATKINS:

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An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

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Dungarvan Harbour SPA: Monitoring of waterbird distribution across the tidal cycle, 2016/17

January 2018

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1. Introduction

Brief

1.1 Atkins (Ecology) was commissioned by the Marine Institute to carry out tidal cycle monitoring of waterbird numbers and distribution at Dungarvan Harbour, Co. Waterford.

1.2 The brief for this work was as follows: -

> *1. This programme will focus on systematic monitoring of bird distribution on Whitehouse Bank (Dungarvan Harbour), specifically in response to a management action to create a single 400m buffer zone among oyster trestle culture sites which was created as a consequence of mitigation recommendations following appropriate assessment of aquaculture in Dungarvan Harbour, Co. Waterford. The programme requires contractors to conduct a series of tidal cycle monitoring focusing specifically on Grey Plover and Dunlin use of the tidal break/corridor. Incidental use of the 'break/corridor' by other bird species should also be documented. The monitoring regime should target two monitoring days per month, during neap and spring low tide. Each monitoring event should cover the full duration of exposure of Whitehouse Bank.*
>
> *2. Monitoring to include the period September 2016 to March 2017, inclusive.*
>
> *3. Prepare a report identifying site-use by the aforementioned species providing a commentary on the effectiveness of the management measure specifically as it relates to species distribution at the site.*

1.3 Due to the seasonal and diurnal pattern of the tidal cycle, and weather constraints, there were limitations to the range of tidal variation that could be covered in this survey, while survey work was not started until October 2017 due to issues with the designation of the Bird Corridor.

Context

1.4 This study builds on the monitoring work carried out as part of the oyster trestle study (Gittings and O'Donoghue, 2012) in 2011, the assessment, based on that work, carried out for the Dungarvan Harbour SPA Appropriate Assessment (Gittings and O'Donoghue, 2014) and subsequent monitoring of the distribution of selected waterbird species across the tidal cycle in the winter of 2014/15 (Gittings and O'Donoghue, 2015).

1.5 The Appropriate Assessment found that intertidal oyster cultivation is potentially having significant negative displacement impacts on four of the Special Conservation Interests (SCIs) of the Dungarvan Harbour SPA: namely, Grey Plover (*Pluvialis squatarola*)[1], Knot (*Calidris canutus)*, Dunlin (*Calidris alpina*) and Bar-tailed Godwit (*Limosa lapponica*). These species are referred to, hereafter as the target species. In the case of Grey Plover, Knot and Dunlin, the main displacement impact appeared to be exclusion of most, or all, birds from Whitehouse Bank during the low tide period when the tideline is within the zone occupied by the oyster trestles; the evidence for this was the occurrence of large flocks of these species in the upper shore zone of Whitehouse Bank on the rising/falling tide, before/after the tideline reached the trestles. In the case of Bar-tailed Godwit, the density of birds on Whitehouse Bank is much lower than the density on the Ballyrandle Sandflats,

[1] Referred to by the common name Black-bellied Plover in North American literature.

despite the two areas being broadly similar intertidal biotopes (however, there is some evidence that there may be differences in food resources between the two areas).

1.6 The monitoring study carried out in 2014/15 (Gittings and O'Donoghue, 2015) found evidence that indicated that the timing of movements of the target species was related to the exposure of mudflats in the Inner Harbour, rather than the tideline reaching the trestles on Whitehouse Bank. However, the study also found evidence of a marked decrease in the utilisation of Whitehouse Bank by Grey Plover at low tide over recent winters and this may have been linked to changes in the configuration of the trestles that eliminated the trestle-free corridors that had been present on Whitehouse Bank. Arising from the results of this study, a reorganisation of aquaculture licences was carried out, as part of the process of approving licence renewals and new applications. This reorganisation was designed to create a trestle-free corridor (the *Bird Corridor*) approximately 400m wide in a section of Whitehouse Bank where Grey Plover had been recorded at low tide in the 2011 trestle study.

1.7 The primary objective of the monitoring carried out in 2016/17 was to collect data on the usage of the Bird Corridor by the target species. In addition, the monitoring provided further data on the movement patterns of the target species onto/off Whitehouse Bank in the ebb and flood tides, and on their association with oyster trestles. The monitoring included ten tidal cycle counts between October 2016 and February 2017, which used the same methodology as the 2014/15 monitoring. The low tide counts, included in the tidal cycle counts, provided information on usage of the Bird Corridor. In addition, the Bird Corridor was continuously monitored throughout the low tide period on four days in March 2017 to provide more detailed data on bird usage of the Bird Corridor, and disturbance impacts from husbandry activities, throughout the low tide period.

1.8 Data was also collected on an additional four species: Light-bellied Brent Goose (*Branta bernicla hrota*), Ringed Plover (*Charadrius hiaticula*), Golden Plover (*Pluvialis apricaria*) and Sanderling (*Calidris alba*). These species are referred to as the additional monitored species. Light-bellied Brent Goose is a SCI of the Dungarvan Harbour SPA, and while it appears to have a neutral/positive association with oyster trestles at Dungarvan Harbour, it can show an apparent negative association with oyster trestles at other sites (Gittings and O'Donoghue, 2012). Golden Plover is a SCI of the Dungarvan Harbour SPA, and there is some indication of potential displacement impacts from oyster trestles on its population in Dungarvan Harbour. Ringed Plover and Sanderling are not SCIs of the Dungarvan Harbour SPA, but occur in numbers close to national importance levels, and are species that appear to show a strong negative response to oyster trestles. Data was collected on these two species to inform potential future requirements for Environmental Impact Assessment (EIA) of any new applications for intertidal oyster licensing in Dungarvan Harbour (as EIA requirements are not restricted to SCI species). In addition, this data can be used to inform future appropriate assessments of other coastal SPAs where these species are SCIs.

1.9 The data collected on the additional monitored species is included in Appendix A of this report, but is not analysed or discussed here.

Limitations

1.10 The decisions of waders to utilise areas for feeding, and the timings of movements between areas, will usually be based on the availability of suitable food resources and the density of potential competitors. Therefore, detailed information on benthic invertebrates would be required to fully analyse wader distribution patterns, and the potential displacement impacts of intertidal oyster cultivation, in Dungarvan Harbour.

1.11 The configuration of the oyster trestle blocks on Whitehouse Bank is subject to ongoing change. The accuracy of mapping available to the contract also impacts on the accuracy of the recording of the tideline position at low tide on Whitehouse Bank.

Personnel

1.12 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 and Pat Smiddy. Data entry was carried out by Owen Twomey.

2. Methods

Study area and count sectors

2.1 Dungarvan Harbour was divided into three broad zones by Gittings and O'Donoghue (2014a) 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).

2.2 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 2.2).

2.3 The study area for the present monitoring work was: Whitehouse Bank and the eastern section of the Inner Harbour (main) for the ebb and flood tide counts; and the Outer Sandflats and the Inner Harbour for the low tide counts.

2.4 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.

2.5 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 the summer of 2014, which was provided by the Department of Agriculture, Fisheries and the Marine. However, the trestles in, and around, the Bird Corridor were mapped by the Department of Agriculture, Fisheries and the Marine in October 2016, and subsequent changes to the trestle configuration were mapped by eye by Tom Gittings while carrying out low tide counts.

Survey design

Tidal cycle counts

2.6 The survey included three components: -

- Ebb tide counts: a series of four counts at 30 minute intervals across the ebb tide period, focussing on Whitehouse Bank and the adjacent area of the Inner Harbour (main).
- Low tide count: a single low tide count covering the Inner Harbour, Ballyrandle Sandflats and Whitehouse Bank.
- Flood tide counts: a series of four counts at 30 minute intervals across the flood tide period, focussing on Whitehouse Bank and the adjacent area of the Inner Harbour (main).

2.7 On the ebb and flood tide counts, the objective was to achieve complete coverage of Whitehouse Bank. The counts of the adjacent area of the Inner Harbour (main) covered (approximately) the sections of 0M419 and 427 to the east of the main tidal channel. However, the objective of these latter counts was to record positions that birds moving to/from Whitehouse Bank came from, or

moved to, and the counts were not intended to provide accurate data on the bird numbers in the Inner Harbour (main).

2.8 The count periods are shown in Table 2.1. The ebb and flood tide counts covered the periods when the tideline 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 gaps between the end of the ebb counts and start of the low tide count, and between the end of the low tide count and the start of the flood tide counts, allowed time for the counters covering the Inner Harbour and Ballyrandle Sandflats to travel between these areas and Whitehouse Bank.

2.9 Note that the numbering of the ebb tide counts has been changed for this report, compared to the previous report (Gittings and O'Donoghue, 2015). The counts numbered EBB0-EBB3 in Gittings and O'Donoghue (2015) are now numbered EBB1-EBB4. The count numbered EBB4 in Gittings and O'Donoghue (2015) corresponds to the 30 minute interval between the count numbered EBB4 in this report and the start of the low tide period.

Table 2.1 - Count periods used for the tidal cycle counts.

Period	Count	Start time	Finish time
Ebb tide	EBB1	-04:00	-03:30
	EBB2	-03:30	-03:00
	EBB3	-03:00	-02:30
	EBB4	-02:30	-02:00
Low tide	LT	-01:30	+01:30
Flood tide	FLOOD1	+02:00	+02:30
	FLOOD2	+02:30	+03:00
	FLOOD3	+03:00	+03:30
	FLOOD4	+03:30	+04:00

All times are relative to low tide.

Bird corridor monitoring

2.10 The main objective of the bird corridor monitoring was to continuously monitor the Bird Corridor throughout its period of tidal exposure. In addition, monitoring of the adjacent areas of the upper shore was carried out on the ebb and flood tides to help understand movement patterns of birds onto/off the Bird Corridor.

2.11 Counts were carried out at 30 minute intervals from four hours before low tide to four hours after low tide (Table 2.2).

2.12 During the period when the Bird Corridor was exposed (EBB5-FLOOD0 counts), all waterbirds within the Bird Corridor were counted. The EBB1-EBB4 and FLOOD1-FLOOD4 counts only covered the target species within sectors CS1 and CS2 (and OY1-OY3 for Light-bellied Brent Goose).

Table 2.2 - Count periods used for the bird corridor monitoring.

Period	Count	Start time	Finish time
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

All times are relative to low tide.

Count dates and timings

Tidal cycle counts

2.13 The tidal cycle counts were carried out on ten dates between October 2016 and February 2017 (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 0.3-0.7m (Table 2.3), representing spring-mean low tides (mean low water spring = 0.4 m; mean low tide = 0.75 m).

Table 2.3 - Count dates and timings for the tidal cycle counts.

Date	Low tide		Count timings		
	time	height	Ebb	LT	Flood
04/10/2016	14:19	0.7m	10:20-12:20	12:50-15:50	16:20-18:20
18/10/2016	13:59	0.2m	10:00-12:00	12:30-15:30	16:00-18:00
02/11/2016	12:51	0.7m	8:50-10:50	11:20-14:20	14:50-16:50
16/11/2016	12:46	0.3m	8:45-10:45	11:15-14:15	14:45-16:45
30/11/2016	12:01	0.7m	8:00-10:00	10:30-13:30	14:00-16:00
15/12/2016	12:35	0.3m	8:30-10:30	11:00-14:00	14:30-16:30
13/01/2017	12:24	0.3m	8:25-10:25	10:55-13:55	14:25-16:25
31/01/2017	13:57	0.6m	9:55-11:55	12:25-15:25	15:55-17:55
13/02/2017	13:30	0.4m	9:30-11:30	12:00-15:00	15:30-17:30
28/02/2017	12:57	0.4m	8:55-10:55	11:25-14:25	14:55-16:55

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

2.14 The bird corridor monitoring counts were carried out on four dates in March 2017 during moderate spring low tide conditions (Table 2.4).

Table 2.4 - Count dates and timings for the Bird Corridor counts.

Date	Low tide		Count timings		
	time	height	Ebb	LT	Flood
02/03/2017	14:18	0.4m	10:20-12:50	12:50-15:50	15:50-18:20
04/03/2017	15:50	0.5m	11:50-14:20	14:20-17:20	17:20-19:50
13/03/2017	12:30	0.3m	8:38-11:00	11:00-14:00	14:00-16:30
16/03/2017	14:09	0.4m	10:15-12:40	12:40-15:40	15:40-18:10

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

Counter organisation

2.15 All the tidal cycle counts were carried out with three counters. The areas covered by each counter on each count are shown in Table 2.5. All the bird corridor monitoring counts were carried out by a single counter (Tom Gittings).

Table 2.5 – Coverage of the tidal cycle counts.

Period	Counter	Coverage
Ebb and flood tide	Lesley Lewis	Whitehouse Bank (CS1)
	Tom Gittings	Whitehouse Bank (CS3) and eastern side of Inner Harbour (main)
	Pat Smiddy	Whitehouse Bank (CS2) and eastern side of Inner Harbour (main)
Low tide	Lesley Lewis	Ballyrandle Sandflats and sectors 0M423-424 in Inner Harbour (upper)
	Tom Gittings	Whitehouse Bank
	Pat Smiddy	Inner Harbour (main) and sectors 0M412-414 in Inner Harbour (upper)

John Meade counted the sections normally covered by Lesley Lewis on 13/02/2017.

Count methodology

2.16 The tidal cycle counts were mainly carried out from shoreline vantage points, apart from the low tide count on Whitehouse Bank. In the latter case, the trestle blocks obscured the detection of birds from shoreline vantage points. Instead, these counts were carried out by walking a transect roughly parallel to, and a few 100m above, the tideline, and carefully scanning along each row of trestles. As most birds occur on, or close to the tideline, and the birds are habituated to the presence of humans through husbandry activity, it was possible to carry out counts in this way without causing significant disturbance.

2.17 The Bird Corridor counts were carried out from shoreline vantage points. The counts of the Bird Corridor during its period of exposure (EBB5-FLOOD0 counts) were carried out from the Whitehouse Bank car park (Figure 2.2), which provides a view line approximately down the middle of the Bird Corridor. On the EBB1-EBB4 and FLOOD1-FLOOD4 counts, the counts were carried out from the shoreline to the east of the car park at a position that provided views of the upper shore on both sides of the Bird Corridor (Figure 2.2).

2.18 On each tidal cycle count, all the target species, and additional monitored species, present were counted. Birds were counted separately in each count sector and in the two sub-divisions of sector OY2. In addition, on the low tide count, all waterbird species in the Bird Corridor were counted.

2.19 During the bird corridor monitoring counts, all waterbird species in the Bird Corridor were counted on counts when the Bird Corridor was exposed (EBB5-FLOOD0 counts). The counts took place at the start of each count period and normally took 5-10 minutes to complete. For the remainder of each count period, the Bird Corridor was monitored and any arrivals or departures of the target species (excluding Light-bellied Brent Goose) were recorded. The EBB1-EBB4 and FLOOD1-FLOOD4 counts covered the target species within sectors CS1 and CS2 (and OY1-OY3 for Light-bellied Brent Goose), and some of the counts for CS2 were of low accuracy due to the distances involved.

2.20 Counters also recorded the behaviour of the birds (feeding, 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.

2.21 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 counts, the percentage of the tideline within the trestle blocks in each count sector was estimated (by recording the distances of trestle blocks and/or trestle-free areas along the transect route).

2.22 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). During the bird corridor monitoring counts, the tractor counts only covered part of sector OY2 and did not cover sector OY1, due to the position of the vantage point used during the low tide period. Also, during these counts, the number of tractors within 250m of either side of the Bird Corridor was also counted. These latter counts did not include tractors that had been parked within these zones but had no associated husbandry activity.

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

2.24 Detailed recording instructions were provided to the counters and the count data was recorded on standard recording forms and maps.

Data processing

2.25 All count data was entered into Excel spreadsheets and the Whitehouse Bank 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.

2.26 The notes on bird movements, and the timings of counts, were reviewed to identify potential double-counts. Where double-counts were identified, these were excluded from calculations of count totals.

Data analysis

2.27 The patterns of husbandry activity on Whitehouse Bank were assessed 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).

2.28 The patterns of bird numbers on Whitehouse Bank, and bird movements onto/off Whitehouse Bank, during the ebb and flood tide periods was compared to the movement of the tideline on Whitehouse Bank, and in the adjacent section of the Inner Harbour, to identify whether birds occurrence on Whitehouse Bank was related to either the tideline reaching the trestle zone, or the exposure of intertidal habitat in the Inner Harbour.

2.29 The distribution of birds at low tide in relation to the presence of oyster trestles was analysed by comparing the observed numbers within oyster trestle blocks with the numbers that would be predicted if the birds were distributed evenly throughout suitable habitat, and were not affected by the presence of oyster trestles. These analyses were restricted to Bar-tailed Godwit, as Dunlin distribution patterns in 2016/17 violated the assumptions required for this analysis, and Grey Plover and Knot never occurred within the trestle blocks during the tidal cycle counts.

2.30 These analyses were based on the methodology used in the trestle study (Gittings and O'Donoghue, 2012). However, because up to date mapping of the trestle configuration on Whitehouse Bank was not available, the methodology was modified to use data on the proportion of tideline within oyster trestles only. In the Outer Sandflats zone, Bar-tailed Godwit mainly occurred on, or close to the tideline: on nine of the ten counts, 77-100% (mean 94%) of the Bar-tailed Godwits were on the tideline. On the other count 60% were on the tideline due to the atypical presence of a flock in sector CS3, but this sector is excluded from the analyses (see below). Therefore, we considered that the tideline length provided a reasonable representation of the availability of suitable habitat, and calculated the expected number of birds in areas of oyster trestles using the following formula:

Expected number = total number * proportion of tideline within oyster trestles

2.31 We only included counts with totals of ten or more birds in these analyses. We carried out two analyses: one using all the relevant sectors within the Outer Sandflats zone (all sectors analysis) and the other using only the relevant sectors on Whitehouse Bank (close sectors analysis). The relevant sectors were CN1-CN5 in Ballyrandle Sandflats, and OY1-OY4 on Whitehouse Bank. CN6 in Ballyrandle Sandflats was excluded as this sector is largely occupied by mixed sediment habitat (and was not included in the trestle study). CS1-CS4 on Whitehouse Bank were excluded because these sectors are usually not used by Bar-tailed Godwit at low tide: CS1-CS3 are upper shore areas which are largely empty of birds at low tide, while CS4 is an area of sandflat adjacent to the main tidal channel which is little used by waterbirds.

2.32 The tideline lengths within, and outside, the trestle blocks in the relevant areas on Whitehouse Bank were calculated from the tidelines mapped during the low tide counts and the estimated proportions of the tidelines that were within the trestle blocks. In calculations of tideline length we also excluded the narrow sandbanks that are exposed below the main tideline in sector OY1: these sandbanks have steeply shelving shorelines, and, therefore, do not provide much tideline habitat.

2.33 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.

2.34 We then compared the observed number with the expected number. We used scatter graphs to assess the relationship between observed and expected numbers.

2.35 We also used an adapted version of Jacobs Index (Jacobs, 1974) to compare the predicted and observed occurrence of birds within trestle blocks on each count. The index is defined as:

$$D = r - p / (r + p - 2rp)$$

2.36 D can vary from -1 (indicating complete avoidance) to +1 (strong preference). We defined r as the proportion of the total count recorded within the trestle blocks and p as the predicted number within the trestle blocks divided by the total count. We calculated index values for each count with predicted numbers of ten or more. To examine the overall pattern of association we calculated the mean index value across all counts (with expected numbers < 10) in each dataset (all sectors and close controls in the extensive study and the intensive study). We examined the correlations between index values and total numbers in case the pattern of association was affected by the numbers present

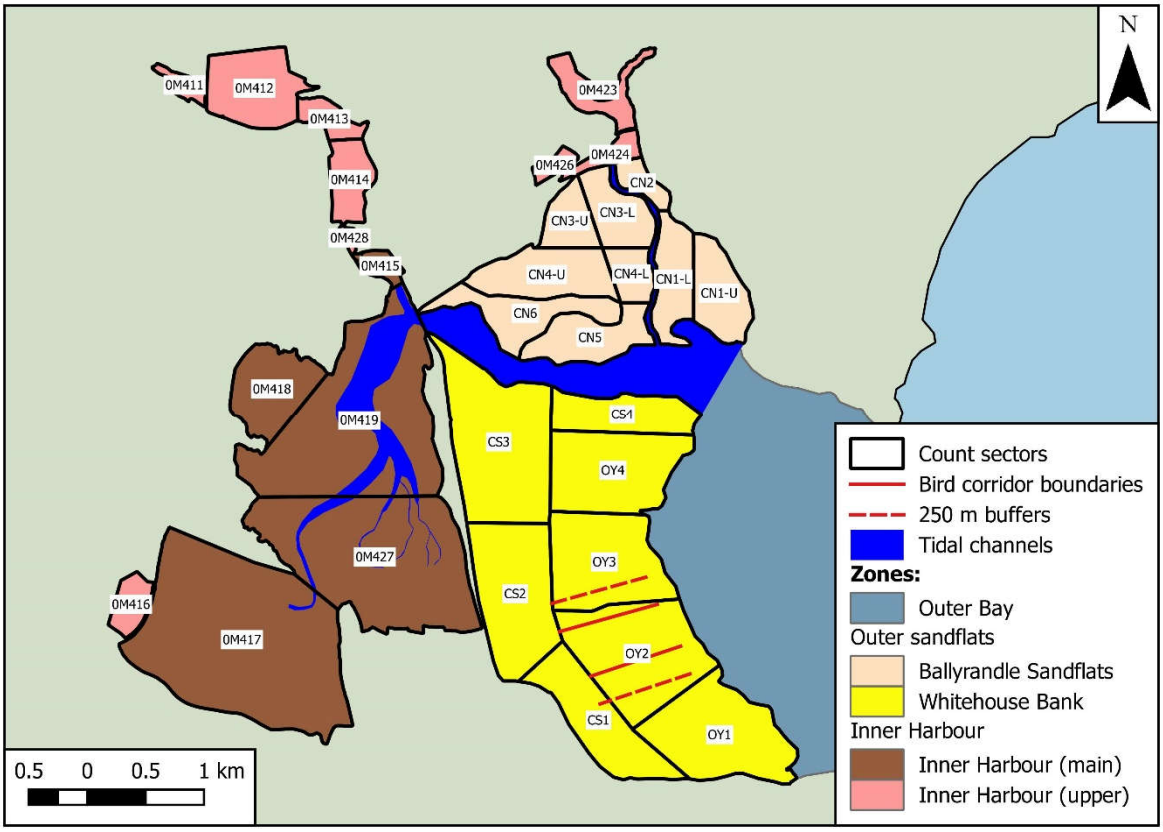


Figure 2.1 – Zones and count sectors.

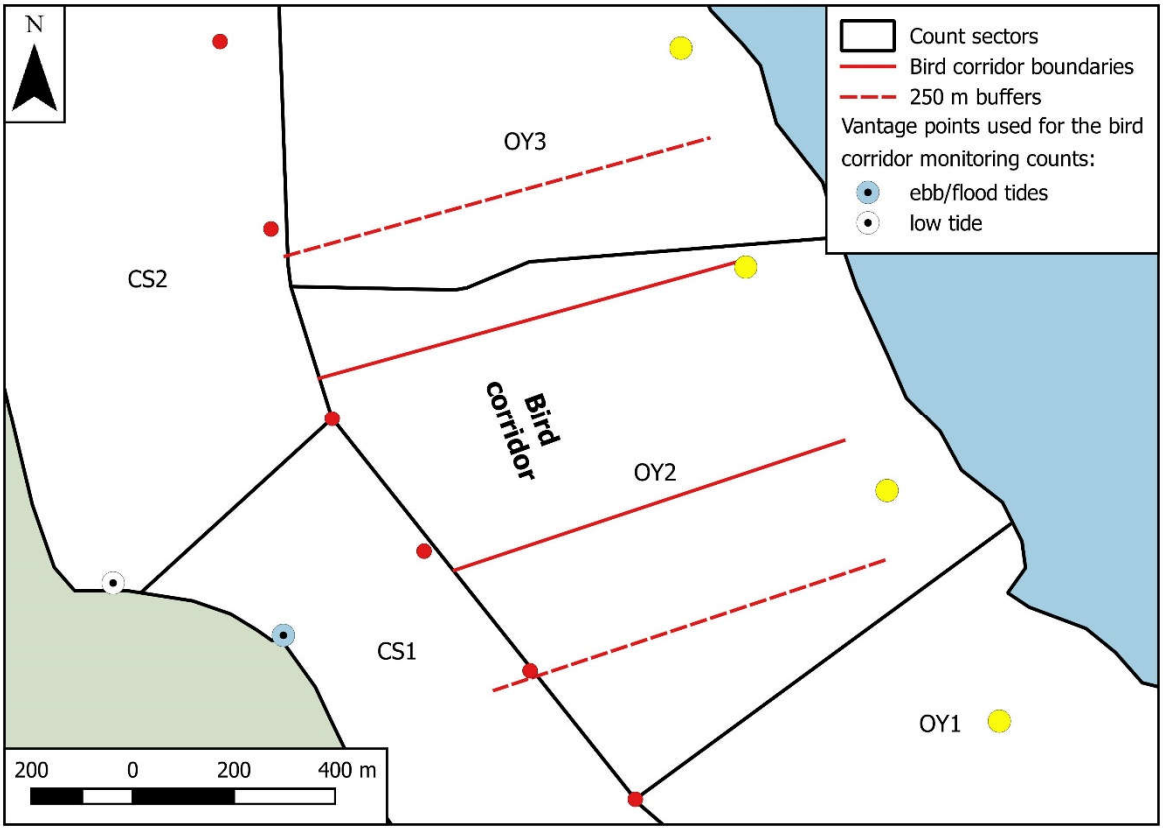


Figure 2.2 – Bird corridor.

3. Results: Tidal cycle counts

Introduction

3.1 This chapter presents the results of the 2016/17 tidal cycle counts for the target species, excluding the data on their occurrence in the Bird Corridor which is included in Chapter 4. Where relevant, comparisons are made with similar data from previous winters.

3.2 The results of the tidal cycle counts for the additional monitored species are included in Appendix A.

Oyster cultivation activity

3.3 Up to date trestle mapping was not available for the winter of 2016/17, apart from the area around the Bird Corridor (see Chapter 4). The most recent trestle mapping available for the rest of Whitehouse Bank was from the summer of 2014 (Figure 3.1). Apart from the changes around the Bird Corridor, other differences between the trestle configuration in the winter of 2016/17 and the configuration shown by this mapping included expansion of trestles in the lower section in sector OY1 and filling in of gaps northern section of sector OY3.

3.4 There was a mean of 2,060 (range 1,455-2,625) tractor minutes per count day in the winter of 2016/17, compared to 1,584 (range 900-2,400) in the winter of 2014/15. Tractor minutes per count day were negatively correlated with the low tide height (Spearman's r = -0.524, one-sided p = 0.009, n = 20. Therefore, as the mean low tide height per count day was lower in 2016/17 compared to 2014/15 (0.46m in 2016/17, compared to 0.59 in 2014/15), a higher mean level of tractor activity would have been expected in 2016/17, compared to 2014/15. However, trend lines fitted to the 2014/15 and 2016/17 datasets had similar slopes but the y intercept was lower in 2014/15 compared to 2016/17 (Text Figure 3.1). Therefore, while the data is limited, it indicates a similar pattern, but a higher overall level, of husbandry activity in 2014/15 compared to 2016/17.

3.5 Tractor activity usually occurred from 150-120 minutes before low tide to 90-120 minutes after low tide, with the highest levels of activity between around 75 minutes before low tide and 45 minutes after low tide, and with similar activity patterns in 2016/17 compared to 2014/15 (Table 3.1). Overall, across the two winters there was more tractor activity before low tide (mean percentage of total activity = 50%, range = 39-72%) compared to after low tide (mean percentage of total activity = 33%, range = 10-45%), and there were only two count days on which more tractor activity occurred after low tide.

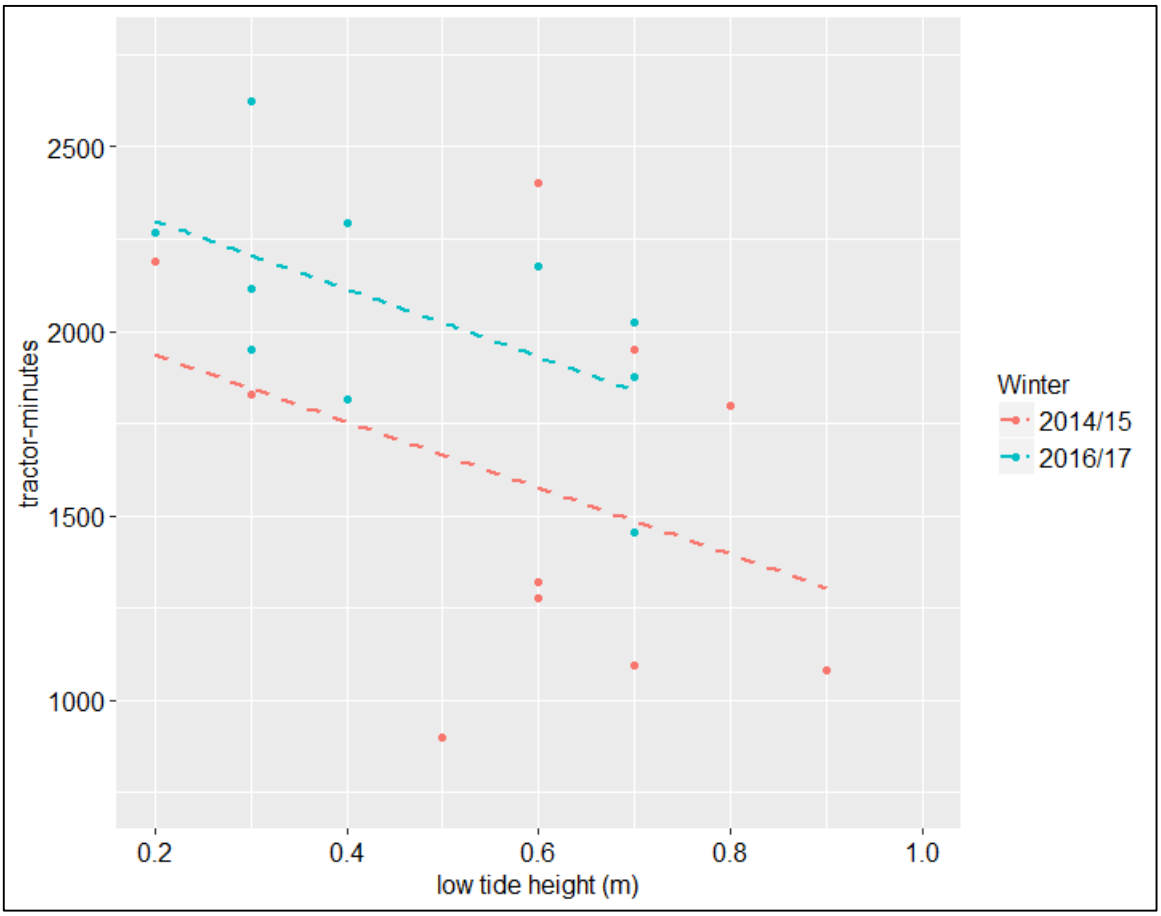
Table 3.1 – Distribution of tractor activity across the tidal cycle, shown as the mean percentage of tractor minutes per count day at 30 minute intervals.

Winter	Minutes before/after low tide								
	≤ -120	-90	-60	-30	0	+30	+60	+90	≥ +120
2014/15	6%	10%	17%	19%	19%	14%	9%	5%	1%
2016/17	6%	11%	16%	17%	16%	14%	11%	6%	4%
Overall	6%	10%	16%	18%	17%	14%	10%	6%	3%

Each data column in this table, apart from the end columns, represent a 30 minute period centred on the time given; e.g., -90 minutes before low tide represents the period from -115 to -75 minutes before low tide.

Waterbird numbers

3.6 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 low tide counts covered a larger area than the ebb and flood tide counts and would, therefore, be expected to record the highest numbers. However, this was not always the case.



Text Figure 3.1 – Relationship between tractor activity and low tide height.

Tidal cycle distribution

3.7 The counts of the target species across the tidal cycle on Whitehouse Bank are shown in Table 3.3. On the ebb tide, Grey Plover mainly occurred on the EBB1 and EBB2 counts. On some days, the Grey Plover remained on the EBB3 count, but significant numbers only stayed until the EBB4 period on one of the ten counts. Bar-tailed Godwit and Dunlin also tended to occur in larger numbers during the EBB0 and EBB1 periods, but the pattern was less marked and significant numbers remained on Whitehouse Bank throughout the ebb tide period and into the low tide period on several dates. On the days when significant numbers of Knot occurred on Whitehouse Bank, counts, they remained until the EBB3 or EBB4 counts. The occurrence of all the target species on Whitehouse Bank during the flood tide period was more erratic, but significant numbers could be present early in the flood tide period.

3.8 On most of the counts, the Grey Plover, Knot, Bar-tailed Godwit and Dunlin flocks on Whitehouse Bank mainly consisted of feeding birds (Table 3.4).

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		
		Ebb	LT	Flood
Grey Plover	04/10/2016	71	8	46
	18/10/2016	64	40	96
	02/11/2016	74	13	73
	16/11/2016	108	137	105
	30/11/2016	69	28	54
	15/12/2016	91	47	55
	13/01/2017	125	162	130
	31/01/2017	133	94	70
	13/02/2017	191	11	213
	28/02/2017	221	125	171
Bar-tailed Godwit	04/10/2016	243	269	518
	18/10/2016	120	316	19
	02/11/2016	162	301	62
	16/11/2016	38	474	118
	30/11/2016	39	279	236
	15/12/2016	212	580	297
	13/01/2017	45	469	46
	31/01/2017	701	436	501
	13/02/2017	784	601	531
	28/02/2017	226	448	409
Knot	04/10/2016	126	215	196
	18/10/2016	0	224	1
	02/11/2016	20	79	16
	16/11/2016	0	55	51
	30/11/2016	0	343	1
	15/12/2016	313	242	333
	13/01/2017	48	227	125
	31/01/2017	765	413	375
	13/02/2017	527	275	552
	28/02/2017	358	159	266
Dunlin	04/10/2016	2594	2337	2181
	18/10/2016	2786	2268	1408
	02/11/2016	1662	2260	1683
	16/11/2016	2150	2862	1040
	30/11/2016	2200	1856	1322
	15/12/2016	2410	2372	2450
	13/01/2017	3822	3652	2500
	31/01/2017	2901	2170	2141
	13/02/2017	3045	2426	2000
	28/02/2017	1782	2265	1327

Data are the maxima across four ebb tide counts, one low tide count, and four flood tide counts. The areas covered varied between counts (see text for details).

Table 3.3 - Counts of the target species across the tidal cycle on Whitehouse Bank.

Species	Date	Ebb tide				Low tide	Flood tide			
		1	2	3	4		1	2	3	4
Grey Plover	04/10/2016	0	31	53	13	5	0	0	0	0
	18/10/2016	64	41	12	0	0	16	15	57	54
	02/11/2016	74	14	0	0	0	12	0	0	1
	16/11/2016	108	91	0	0	0	0	0	0	74
	30/11/2016	49	18	0	1	2	1	1	0	0
	15/12/2016	31	91	67	1	0	0	0	9	7
	13/01/2017	46	37	0	0	0	0	0	0	22
	31/01/2017	96	79	23	1	0	0	1	0	0
	13/02/2017	143	184	159	101	10	60	77	61	20
	28/02/2017	194	211	20	2	0	46	81	133	96
Bar-tailed Godwit	04/10/2016	240	227	208	234	23	34	89	27	24
	18/10/2016	42	13	8	117	15	6	11	12	2
	02/11/2016	160	25	24	6	22	4	5	40	51
	16/11/2016	38	8	31	30	105	85	87	98	76
	30/11/2016	0	6	8	11	39	8	16	67	183
	15/12/2016	5	119	174	184	83	99	88	270	227
	13/01/2017	0	0	0	1	44	0	0	0	0
	31/01/2017	586	383	358	39	49	31	0	16	54
	13/02/2017	325	463	368	374	282	39	105	65	1
	28/02/2017	160	162	42	49	30	8	4	5	5
Knot	04/10/2016	0	30	7	8	5	2	2	1	0
	18/10/2016	0	0	0	0	0	0	0	1	0
	02/11/2016	20	0	0	0	0	0	0	0	0
	16/11/2016	0	0	0	0	0	0	0	0	0
	30/11/2016	0	0	0	0	0	1	0	1	0
	15/12/2016	0	72	88	53	0	0	0	13	0
	13/01/2017	0	0	0	0	0	0	0	0	0
	31/01/2017	544	765	606	0	0	0	0	0	0
	13/02/2017	355	361	284	142	0	12	0	2	0
	28/02/2017	254	358	273	96	0	0	18	13	30
Dunlin	04/10/2016	323	295	134	144	389	99	34	14	16
	18/10/2016	580	336	623	469	192	28	54	109	91
	02/11/2016	972	699	692	276	186	22	1	3	3
	16/11/2016	1495	978	600	416	481	55	84	17	407
	30/11/2016	502	46	49	6	46	2	1	0	1
	15/12/2016	2300	2044	560	1	104	0	0	200	200
	13/01/2017	10	22	0	0	25	0	0	1	272
	31/01/2017	2131	341	43	16	39	53	41	34	30
	13/02/2017	846	786	459	195	85	100	27	11	0
	28/02/2017	410	398	322	195	269	117	178	322	330

Ebb tide counts were carried out from around four hours before low tide (EBB1 count) to two hours before low tide (EBB4 count), low tide counts were carried out over a three hour period centred around low tide, and flood tide counts were carried out from around two hours after low tide (FLOOD1 count) to four hours after low tide (FLOOD4 count).

Table 3.4 - Percentages of feeding birds of the target species across the tidal cycle on Whitehouse Bank.

Species	Date	Ebb tide				Low tide	Flood tide			
		1	2	3	4		1	2	3	4
Grey Plover	04/10/2016		29%	15%	0%					
	18/10/2016	0%	0%	0%			100%	100%	100%	13%
	02/11/2016	9%	57%				100%			
	16/11/2016	35%	18%							0%
	30/11/2016	88%	100%							
	15/12/2016	0%	13%	1%						
	13/01/2017	41%	59%							0%
	31/01/2017	5%	54%	22%						
	13/02/2017	10%	48%	96%	82%	40%	100%	92%	31%	0%
	28/02/2017	40%	74%	5%			4%	100%	100%	90%
Bar-tailed Godwit	04/10/2016	100%	100%	100%	100%	91%	100%	100%	100%	0%
	18/10/2016	100%	100%		97%	100%		100%	100%	
	02/11/2016	50%	100%	100%		82%			100%	96%
	16/11/2016	100%		100%	70%	99%	100%	100%	100%	16%
	30/11/2016				100%	100%		100%	100%	100%
	15/12/2016		100%	82%	85%	89%	96%	100%	100%	41%
	13/01/2017					100%				
	31/01/2017	28%	68%	100%	41%	82%	74%		100%	100%
	13/02/2017	62%	82%	100%	100%	95%	100%	100%	100%	
	28/02/2017	44%	100%	100%	100%	97%				
Knot	04/10/2016		100%							
	18/10/2016									
	02/11/2016	0%								
	16/11/2016									
	30/11/2016									
	15/12/2016		100%	100%	6%				100%	
	13/01/2017									
	31/01/2017	40%	99%	100%						
	13/02/2017	100%	100%	100%	100%		100%			
	28/02/2017	80%	100%	100%	100%			100%	100%	100%
Dunlin	04/10/2016	85%	100%	99%	100%	96%	98%	100%	100%	63%
	18/10/2016	100%	100%	99%	98%	71%	100%	33%	100%	100%
	02/11/2016	100%	100%	100%	100%	85%	100%			
	16/11/2016	52%	95%	100%	100%	91%	100%	81%	88%	42%
	30/11/2016	89%	96%	100%		72%				
	15/12/2016	96%	100%	100%		98%			100%	100%
	13/01/2017	100%	91%			92%				96%
	31/01/2017	12%	100%	100%	75%	79%	81%	59%	56%	50%
	13/02/2017	36%	100%	100%	100%	87%	100%	100%	100%	
	28/02/2017	79%	96%	100%	100%	99%	100%	100%	100%	100%

Percentages are only included for counts where > 9 birds were recorded. See notes to Table 3.6 for details of count timings.

3.9 The movement patterns of Grey Plover and Bar-tailed Godwit onto/off Whitehouse Bank during the ebb tide period were similar in 2016/17, compared to 2014/15 (Table 3.5 and Text Figure 3.2). Grey Plover numbers generally remained high across the EBB1 and EBB2 count periods, decreasing in the EBB3 count period and with most birds gone by the EBB4 count period. Bar-tailed Godwit numbers showed a general pattern of decrease (Table 3.5), but with a lot of variability, across the ebb tide period (Text Figure 3.2), The higher mean percentage at low tide in 2014/15 compared to 2016/17 was due to three count days in 2014/15 when large flocks of Bar-tailed Godwit were recorded moving back on to Whitehouse Bank during the second half of the low tide period. Knot and Dunlin remained longer on Whitehouse Bank on the ebb tide in 2016/17, compared to 2014/15. (Table 3.5). In 2014/15, most birds had departed by the EBB3 period, while in 2016/17 numbers remained high on some count days into the EBB3 and (Dunlin) EBB4 periods (Text Figure 3.2).

Table 3.5 – Mean percentage of the maximum ebb tide count recorded in each count period across the ebb and low tides on Whitehouse Bank.

Species	Season	EBB1	EBB2	EBB3	EBB4	LT	n
Grey Plover	2014/15	99%	84%	23%	5%	0%	11
	2016/17	80%	73%	31%	8%	2%	10
Bar-tailed Godwit	2014/15	93%	78%	42%	26%	72%	10
	2016/17	73%	64%	53%	60%	24%	7
Knot	2014/15	99%	73%	10%	0%	11%	6
	2016/17	60%	95%	84%	32%	0%	4
Dunlin	2014/15	99%	59%	4%	0%	1%	7
	2016/17	99%	65%	47%	28%	33%	9

Data is only included for count days where the maximum Whitehouse Bank ebb tide count was > 25 (Grey Plover), > 50 (Bar-tailed Godwit and Knot) or > 100 (Dunlin). Note that EBB1 counts were only carried out on five of the eleven count days in 2014/15 and no low tide count was carried out on one of the count days in 2014/15.

3.10 As in 2014/15, most observations of Grey Plover, Knot and Dunlin movements were of birds moving between Whitehouse Bank and the Inner Harbour, while Bar-tailed Godwits on Whitehouse Bank moved to/from both the Inner Harbour and the Ballyrandle Sandflats.

Low tide distribution

Distribution across Dungarvan Harbour

3.11 During the low tide counts, Grey Plover and Knot occurred very rarely on Whitehouse Bank, and Bar-tailed Godwit and Dunlin occurred in relatively low numbers (Table 3.6). Grey Plover mainly occurred in the Inner Harbour, with some birds on the Ballyrandle Sandflats on three of the count dates. However, on many of the counts the total numbers recorded at low tide were significantly lower than the maximum ebb tide count indicating that not all the Grey Plover were located at low tide. Knot and Dunlin also generally occurred in larger numbers in the Inner Harbour, with some Knot also present at the Ballyrandle Sandflats on several count dates. Bar-tailed Godwits usually mainly occurred on the Ballyrandle Sandflats.

Text Figure 3.2 – Occurrence pattern of the target species on Whitehouse Bank across the ebb and low tide periods. The dot plots show the percentages of the maximum ebb tide count recorded on each ebb tide count and on the low tide count on each count day in 2014/15 and 2016/17. The following low tide counts that were > 100% of the maximum ebb tide count are shown as 100% in these dot plots: 2 no. counts of Bar-tailed Godwit in 2014/15 (106% and 304%); and 1 no. count of Dunlin in 2016/17 (120%). See footnote to Table 3.5 for other details.

3.12 The overall low tide distribution patterns across Dungarvan Harbour in 2016/17 were generally similar to those recorded in 2014/15 (Table 3.7). However, Knot tended to occur in lower numbers on the Ballyrandle Sandflats, while Dunlin were completely absent from the Ballyrandle Sandflats. The low tide distribution patterns of Grey Plover, Bar-tailed Godwit and Knot within the Outer Sandflats zone in 2016/17 were also generally similar to those recorded in 2014/15 (Table 3.8). However, due to the absence of Dunlin from the Ballyrandle Sandflats in 2016/17, there was a marked change in the low tide distribution pattern of this species in the Outer Sandflats zone (Table 3.8).

Table 3.6 - Distribution of the target species at low tide.

Species	Date	Inner Harbour		Outer Sandflats	
		upper	main	Ballyrandle	Whitehouse
Grey Plover	04/10/2016	0	3	0	5
	18/10/2016	0	29	11	0
	02/11/2016	0	13	0	0
	16/11/2016	1	136	0	0
	30/11/2016	2	24	0	2
	15/12/2016	0	47	0	0
	13/01/2017	0	117	45	0
	31/01/2017	0	94	0	0
	13/02/2017	0	1	0	10
	28/02/2017	0	57	68	0
Bar-tailed Godwit	04/10/2016	0	13	233	23
	18/10/2016	0	17	284	15
	02/11/2016	1	2	276	22
	16/11/2016	0	2	367	105
	30/11/2016	1	37	202	39
	15/12/2016	0	153	344	83
	13/01/2017	0	69	356	44
	31/01/2017	2	148	237	49
	13/02/2017	0	17	302	282
	28/02/2017	1	46	371	30
Knot	04/10/2016	84	114	12	5
	18/10/2016	136	72	16	0
	02/11/2016	79	0	0	0
	16/11/2016	1	28	26	0
	30/11/2016	0	332	11	0
	15/12/2016	0	156	86	0
	13/01/2017	0	227	0	0
	31/01/2017	0	360	53	0
	13/02/2017	0	275	0	0
	28/02/2017	0	129	30	0
Dunlin	04/10/2016	31	1887	30	389
	18/10/2016	51	2025	0	192
	02/11/2016	0	2074	0	186
	16/11/2016	0	2381	0	481
	30/11/2016	0	1810	0	46
	15/12/2016	0	2268	0	104
	13/01/2017	0	3618	9	25
	31/01/2017	0	2125	6	39
	13/02/2017	0	2341	0	85
	28/02/2017	0	1996	0	269

Grey cells indicate no counts were carried out.

Table 3.7 - Mean percentage occurrence of the target species in the main zones of Dungarvan Harbour in 2009/10 and 2014/15.

Species	Season	Mean percentage of total count			n
		Inner Harbour	Ballyrandle Sandflats	Whitehouse Bank	
Grey Plover	2009/10	83%	1%	16%	4
	2014/15	74%	26%	0%	8
	2016/17	79%	21%	0%	4
Bar-tailed Godwit	2009/10	11%	87%	2%	4
	2014/15	7%	70%	23%	10
	2016/17	11%	74%	15%	10
Knot	2009/10	80%	15%	5%	4
	2014/15	62%	34%	4%	8
	2016/17	89%	10%	0%	8
Dunlin	2009/10	92%	6%	2%	4
	2014/15	83%	12%	5%	9
	2016/17	92%	0%	7%	10

Counts with low total numbers present are excluded from the analyses.

Table 3.8 - Mean percentage occurrence of the target species in the subdivisions of the Outer Sandflats zone of Dungarvan Harbour in 2009/10, 2011 and 2014/15.

Species	Season	Mean percentage of Outer Sandflats count		n
		Ballyrandle Sandflats	Whitehouse Bank	
Grey Plover	2009/10	6%	94%	2
	2011	2%	98%	5
	2014/15	99%	1%	5
	2016/17	100%	0%	2
Bar-tailed Godwit	2009/10	98%	2%	4
	2011	72%	28%	5
	2014/15	75%	25%	10
	2016/17	84%	16%	10
Knot	2009/10	83%	17%	3
	2011	87%	13%	3
	2014/15	87%	13%	8
	2016/17	95%	5%	7
Dunlin	2009/10	76%	24%	4
	2011	43%	57%	4
	2014/15	67%	33%	8
	2016/17	1%	99%	6

Counts with low total numbers present in the Outer Sandflats zone are excluded from the analyses.

Distribution within Whitehouse Bank

3.13 Only two of the target species (Bar-tailed Godwit and Dunlin) regularly occurred on Whitehouse Bank at low tide.

3.14 Bar-tailed Godwit occurred almost exclusively along the tideline on the lower sandflats in sectors OY2-OY4. However, on 13/02/2017, a flock of 212 was present at low tide on the upper shore in sector CS3. Their percentage occurrence within the trestle blocks (Table 3.9) varied from 0-90% (mean 38%), compared to 9-63% (mean 33%) in 2014/15

3.15 Dunlin occurred in small numbers, either on the upper sandflats (usually in sector CS3) or within the oyster trestle blocks (mainly sectors OY3 and OY4) (Table 3.10). Therefore, the Dunlin distribution appears to have been concentrated in the northern section of Whitehouse Bank. This distribution pattern differs from the more erratic distribution patterns recorded in previous winters, which did not show a clear pattern of concentration in one section of Whitehouse Bank (Table 3.10). Their percentage occurrence within the trestle blocks in 2016/17 (Table 3.9) reflected their relative distribution between sector CS3 and OY3-OY4, and varied from 3-100% (mean 57%), compared to 0-100% (mean 47%) in 2014/15.

Table 3.9 - Distribution of Dunlin and Bar-tailed Godwit on Whitehouse Bank at low tide in relation to the presence of oyster trestles.

Species	Date	Count		% within trestle blocks
		Within trestle blocks	Outside trestle blocks	
Bar-tailed Godwit	04/10/2016	6	17	26%
	18/10/2016	0	15	0%
	02/11/2016	6	16	27%
	16/11/2016	14	91	13%
	30/11/2016	24	15	62%
	15/12/2016	49	34	59%
	13/01/2017	14	30	32%
	31/01/2017	22	27	45%
	13/02/2017	59	223	21%
	28/02/2017	27	3	90%
Dunlin	04/10/2016	34	355	9%
	18/10/2016	192	0	100%
	02/11/2016	179	7	96%
	16/11/2016	221	260	46%
	30/11/2016	42	4	91%
	15/12/2016	100	4	96%
	13/01/2017	25	0	100%
	31/01/2017	7	32	18%
	13/02/2017	12	73	14%
	28/02/2017	9	260	3%

Table 3.10 – Distribution of Dunlin between count sectors during low tide counts of Whitehouse Bank.

Season	Date	Count sector						
		CS1	CS2	CS3	OY1	OY2	OY3	OY4
2016/17	04/10/2016	0	31	318	6	1	10	23
	18/10/2016	0	0	0	0	0	81	111
	02/11/2016	0	0	7	0	0	78	101
	16/11/2016	0	0	260	0	35	52	134
	30/11/2016	0	0	4	0	6	21	15
	15/12/2016	0	1	0	0	3	1	99
	13/01/2017	0	0	0	0	1	1	23
	31/01/2017	0	0	32	0	0	3	4
	13/02/2017	0	0	71	0	2	11	1
	28/02/2017	0	0	260	0	0	2	7
2014/15	23/10/2014	0	0	0	0	0	1	60
	27/10/2014	0	0	0	1	0	0	0
	10/11/2014	0	0	14	0	0	0	0
	12/11/2014	0	0	1	0	0	0	0
	24/11/2014	0	0	2	0	0	0	17
	10/12/2014	0	0	0	0	6	0	2
	22/12/2014	0	31	10	0	0	0	0
	08/01/2015	0	0	2	0	0	0	4
2010/11	06/01/2011	48	32	142	0	65	23	37
	22/01/2011	0	1	0	0	9	6	1
	03/02/2011	0	0	0	12	1	2	0
	21/02/2011	0	135	443	0	7	9	3
	03/03/2011	0	0	7	0	282	7	2

Distribution patterns in relation to the presence of oyster trestles

3.16 Of the target species, Grey Plover and Knot were never recorded within the trestle blocks during the tidal cycle low tide counts. Both species rarely occurred on Whitehouse Bank during the low tide counts, but did occur regularly on the Ballyrandle Sandflats.

3.17 Bar-tailed Godwit and Dunlin did occur within the trestle blocks.

3.18 For Bar-tailed Godwit, the observed numbers within the trestles were generally lower than the predicted numbers for both the all sectors and close sectors analyses (Text Figure 3.3). The Jacob's Index values were negative, and similar to those calculated from the 2014/15 data, indicating avoidance of the oyster trestles (Table 3.11). The confidence intervals for the index values did not include zero (Table 3.11). Across the combined dataset, comparison of the observed and predicted numbers indicates that when the predicted numbers exceed a threshold value of around 200, the observed numbers show a much higher deviation from the predicted numbers, compared to when the predicted numbers are below this threshold (Text Figure 3.3). However, the index values did not show any obvious relationship to the total numbers present (Text Figure 3.4) or the predicted numbers (Text Figure 3.4).

3.19 Using the combined dataset across all seasons, the mean Bar-tailed Godwit densities outside the trestle blocks were five times higher than the densities within the trestle blocks (Table 3.12).

3.20 The assumptions required for calculating expected values were clearly violated for Dunlin in 2016/17, as their distribution patterns indicated that some other factor, apart from the presence of oyster trestles, was influencing their distribution pattern within the Outer Sandflats zone (see paragraph 3.15). Furthermore, as they mainly occurred on the intertidal away from the tideline, tideline length did not provide a reasonable representation of the availability of suitable habitat. Therefore, we have not calculated expected numbers of Dunlin, or D index values for Dunlin. However, based on their percentage occurrence within trestle blocks, Dunlin distribution within the Outer Sandflats zone appears to have had a neutral or positive association with oyster trestles in 2016/17.

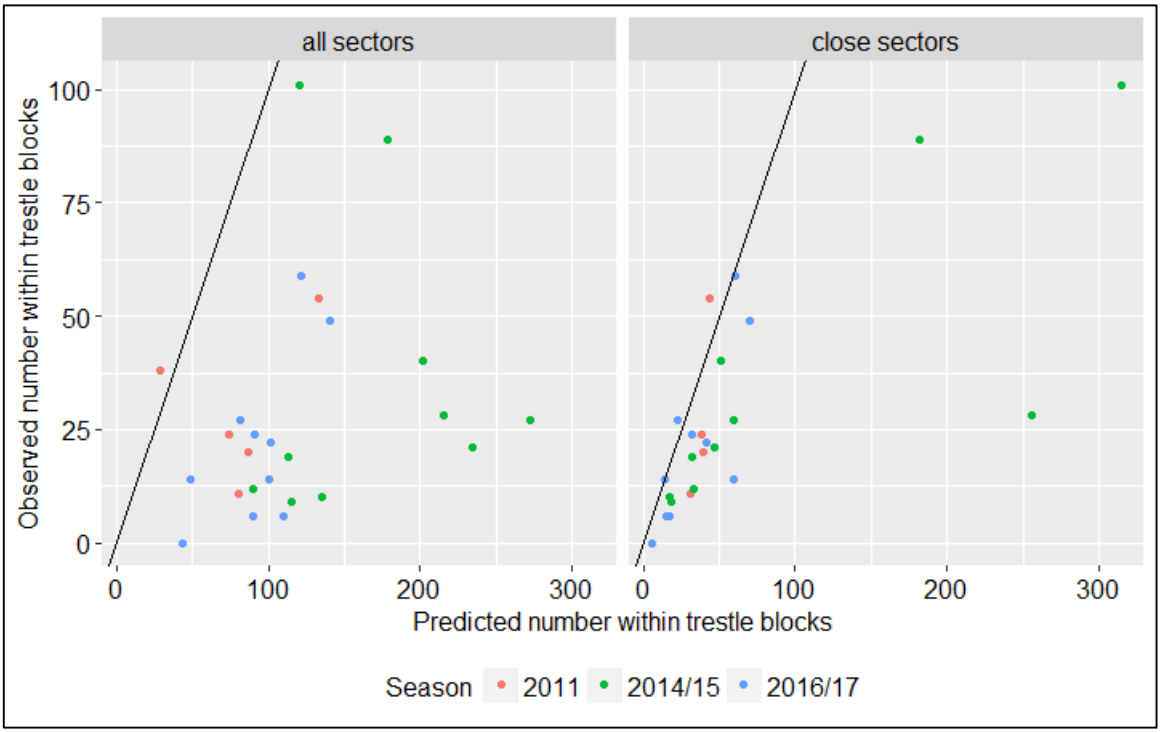
Table 3.11 - Mean Jacob's index (D) values (± 95% C.I.).

Species	Seasons	All sectors			Close sectors		
		Mean D	D > 0	n	Mean D	D > 0	n
Bar-tailed Godwit	2016/17	-0.73 (± 0.13)	0	10	-0.51 (± 0.34)	1	10
	2014/15	-0.72 (± 0.19)	0	10	-0.65 (± 0.11)	0	10
	2011	-0.47 (± 0.47)	1	5	-0.25 (± 0.72)	1	4
	all	-0.67 (± 0.11)	1	25	-0.53 (± 0.16)	2	24

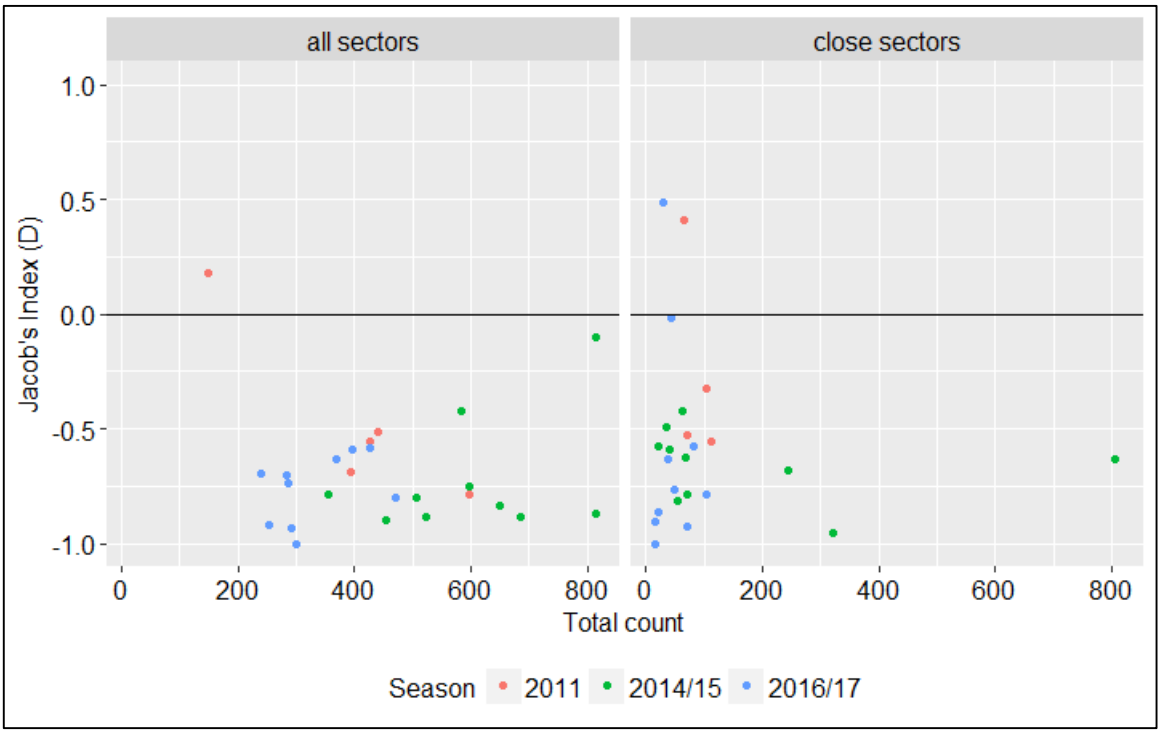
Table 3.12 - Mean densities (birds/km tideline length) within and outside trestle blocks.

Species	Analysis	Outside		Within	
		Mean	CI	Mean	CI
Bar-tailed Godwit	all sectors	65.5	14.0	14.3	6.5
	close sectors	71.7	44.8	14.3	6.5

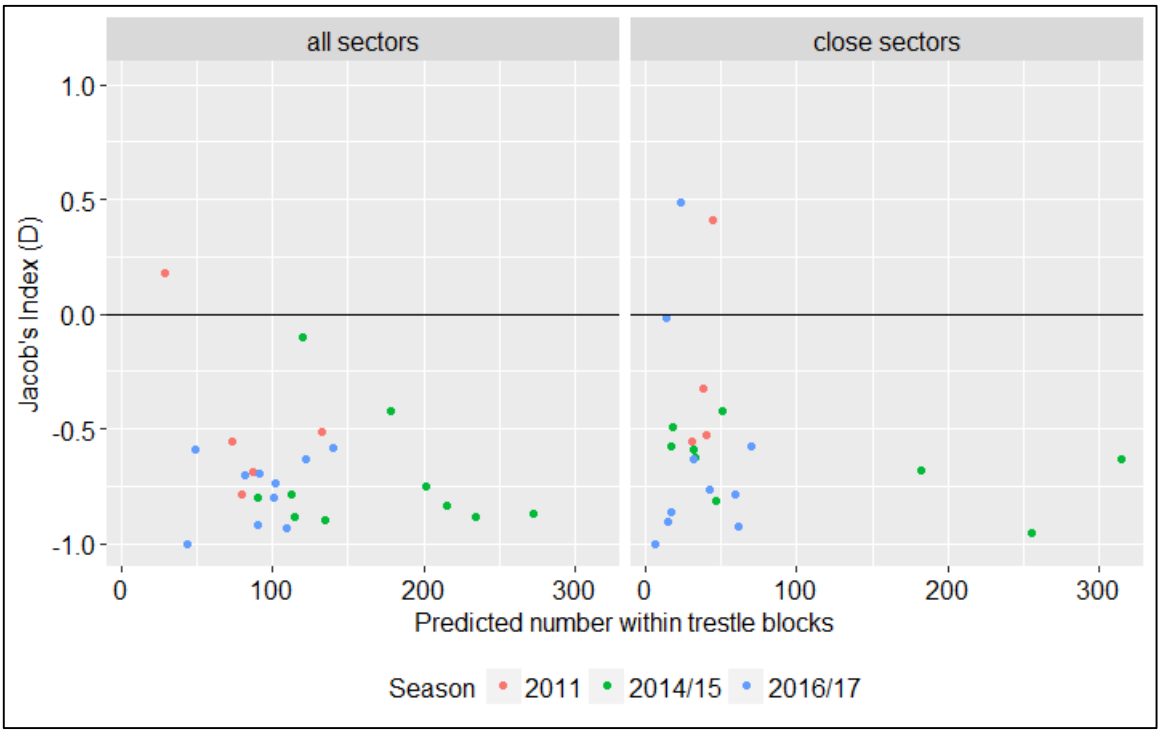
Analyses use the combined 2011, 2014/15 and 2016/17 datasets.



Text Figure 3.3 - Observed compared to predicted occurrence of Bar-tailed Godwit within oyster trestle blocks at Dungarvan Harbour.



Text Figure 3.4 - Relationship between the Jacob's Index values and the total count for Bar-tailed Godwit at Dungarvan Harbour.



Text Figure 3.5 - Relationship between the Jacob's Index values and the predicted occurrence of within oyster trestle blocks for Bar-tailed Godwit at Dungarvan Harbour.

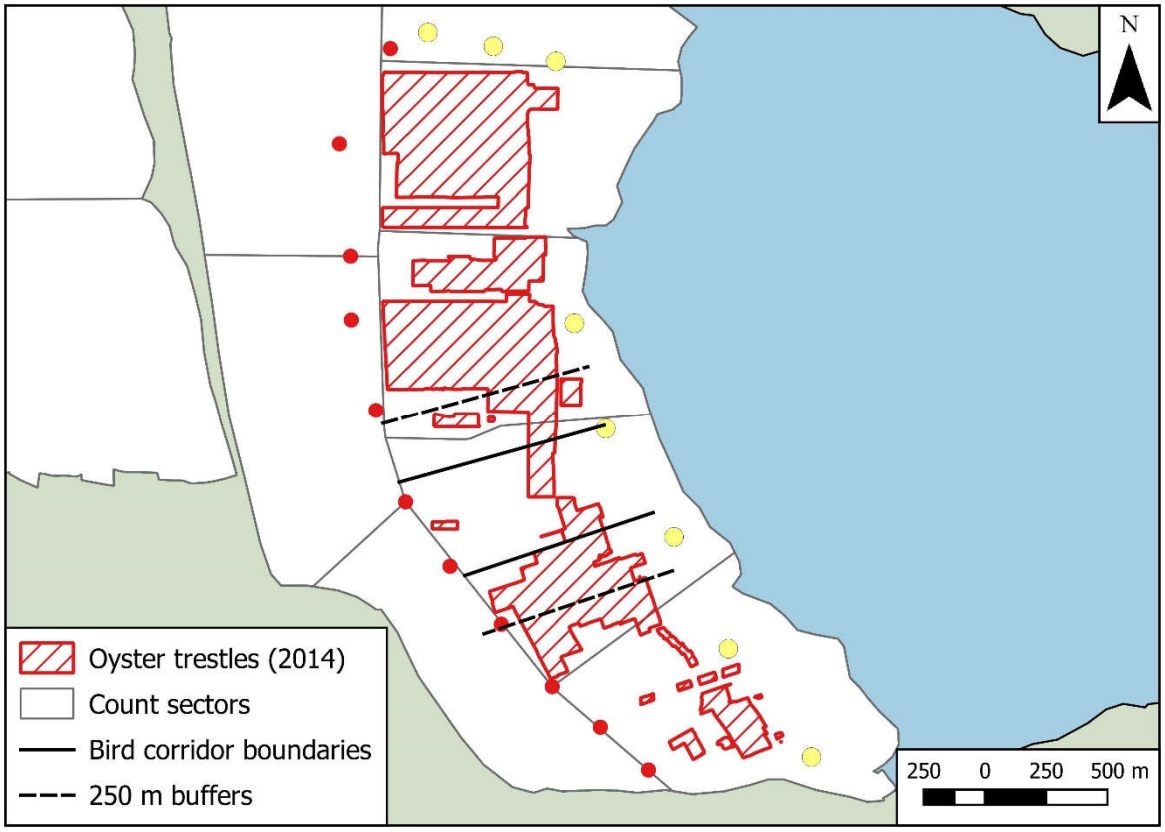


Figure 3.1 – Oyster trestle distribution on Whitehouse Bank in the summer of 2014.

4. Results: Bird corridor monitoring

Introduction

4.1 This chapter presents the results from the bird corridor monitoring counts on occurrence of the target species within the Bird Corridor, as well as summary data on the occurrence of other waterbird species within the Bird Corridor, and data from the tidal cycle counts on the occurrence of the target species within the Bird Corridor. The results of the bird corridor monitoring counts for the additional monitored species are included in Appendix A, while the full count data for other waterbird species within the Bird Corridor are included in Appendix B.

Oyster cultivation activity

4.2 At the start of the tidal cycle counts, the Bird Corridor still had trestles occupying most of the lower shore (Figure 4.1). By late November, the trestles had been removed from most of the lower shore, but with some trestles remaining close to the edges of the Bird Corridor, as well as an isolated block in the upper part of the Bird Corridor (Figure 4.1). Further removal of trestles took place over the winter, and by the end of February, the only trestles remaining were the isolated block in the upper part of the Bird Corridor and a small area at the southern edge of the lower part of the Bird Corridor (Figure 4.1). There were no further changes to the trestle configuration noted during the bird corridor monitoring counts in March.

4.3 During the tidal cycle counts, there were 1-6 tractors working within 250m of the Bird Corridor at the time the Bird Corridor was counted (Table 4.1). Tractor movements through the Bird Corridor were recorded on six of the ten count dates (Table 4.1).

Table 4.1 – Husbandry activity around the Bird Corridor recorded during the tidal cycle counts.

Date	Tractors within 250 m	Tractor movements through Bird Corridor:			
		upper	edge	middle	lower
04/10/2016	1	0	0	0	0
18/10/2016	2	1	0	0	0
02/11/2016	1	0	0	0	0
16/11/2016	4	1	0	0	1
30/11/2016	2	0	0	0	0
15/12/2016	2	0	1	0	0
13/01/2017	3	0	0	0	0
31/01/2017	2	2	0	0	0
13/02/2017	4	0	1	0	0
28/02/2017	6	0	0	3	0

4.4 On the bird corridor monitoring count days, there were usually several tractors working within 250m of the Bird Corridor for most of the period of tidal exposure of the Bird Corridor (Table 4.2). However, on 04/03/2017 (which was a Saturday), the overall level of husbandry activity was low, and tractors were only recorded working within 250m of the Bird Corridor during two of the count periods (Table 4.2). There was also a general pattern of higher levels of tractor numbers during the first half of the low tide period, compared to the second half (Table 4.2). There were 2-19 tractor movements within, and adjacent to, the Bird Corridor on the bird corridor monitoring count days and, again, there was a general pattern of higher levels of tractor movement during the first half of the low tide period, compared to the second half (Table 4.3). Most of the tractor movements were above, or within the upper part of, the Bird Corridor, but there were two tractor movements through the middle of the Bird Corridor and two movements along the tideline in the lower part of the Bird Corridor (Table 4.4).

Table 4.2 – Tractor numbers within 250m of the Bird Corridor.

Count period	02/03/2017	04/03/2017	13/03/2017	16/03/2017	Totals per count period
EBB4	6	-	3	1	10
EBB5	6	0	5	4	15
LT1	10	3	6	4	23
LT2	6	2	3	4	15
LT3	6	0	4	5	15
LT4	2	0	3	3	8
LT5	2	0	5	1	8
LT6	0	0	0	1	1
FLOOD0	0	0	0	2	2
FLOOD1	0	-	0	1	1
Totals per day	38	5	29	26	-

Note: on 04/03/2017, there was no exposure of intertidal habitat within the Bird Corridor in the EBB4 and FLOOD1 count periods.

Table 4.3 – Tractor movements within, and adjacent to, the Bird Corridor during the bird corridor monitoring counts.

Count period	02/03/2017	04/03/2017	13/03/2017	16/03/2017	Totals per count period
EBB4	0	-	1	0	1
EBB5	1	0	6	3	10
LT1	1	1	3	3	8
LT2	0	1	4	3	8
LT3	1	0	3	2	6
LT4	0	0	1	3	4
LT5	1	0	1	2	4
LT6	1	0	0	0	1
FLOOD0	0	0	0	0	0
FLOOD1	0	-	0	0	0
Totals per day	5	2	19	16	-

Note: on 04/03/2017, there was no exposure of intertidal habitat within the Bird Corridor in the EBB4 and FLOOD1 count periods.

Table 4.4 – Positions of the tractor movements recorded within, and adjacent to, the Bird Corridor during the bird corridor monitoring counts.

Position	02/03/2017	04/03/2017	13/03/2017	16/03/2017	Totals
above	2	3	7	6	18
edge	1	1	1	0	3
upper	2	0	7	10	19
middle	0	0	2	0	2
lower	0	0	2	0	2

Positions: above = movements along the line of buoys that demarcate the upper edge of the oyster trestle zone; edge = movements along, or just inside, the northern and southern edge of the Bird Corridor; upper = movements through the upper third of the Bird Corridor; middle = movements through the middle third of the Bird Corridor; lower = movements through the lower third of the Bird Corridor (usually along the tideline).

Tidal cycle counts

4.5 During the tidal cycle counts, the target species were only recorded infrequently and/or in low numbers in the Bird Corridor at low tide (Table 4.5). There were also occasional records, including a few larger counts, during the EBB4 and EBB5 and FLOOD1 counts (Table 4.5). Another 12 waterbird species were also recorded within the Bird Corridor at low tide, with Light-bellied Brent Goose, Oystercatcher, Redshank, Black-headed Gull, Common Gull and Herring Gull being the most abundant of these species (Table 4.6)

Table 4.5 – Observations of target species in the Bird Corridor during the tidal cycle counts.

Species	Date	EBB3	EBB4	LT	Flood 1	Flood 2
Grey Plover	18/10/2016	0	0	0	4	0
	02/11/2016	0	0	0	12	0
Bar-tailed Godwit	18/10/2016	2	5	11	6	0
	02/11/2016	0	0	5	2	0
	16/11/2016	0	6	7	82	43
	30/11/2016	0	0	4	4	0
	15/12/2016	0	116	17	46	0
Knot	15/12/2016	0	50	0	0	0
Dunlin	30/11/2016	0	0	4	0	0
	15/12/2016	0	0	1	0	0
	13/02/2017	0	0	2	0	0

Data only shown for days on which the species was recorded in the Bird Corridor on at least one count.

Table 4.6 – Summary of counts of other waterbird species in the Bird Corridor during the tidal cycle counts.

Species	Mean	Range	Non-zero counts
Light-bellied Brent Goose	45	0-136	8
Little Egret	< 1	0-1	2
Grey Heron	0	0-1	1
Oystercatcher	12	1-33	10
Curlew	4	1-7	10
Redshank	2	0-8	5
Greenshank	< 1	0-1	1
Black-headed Gull	48	15-177	10
Common Gull	25	6-56	10
Lesser Black-backed Gull	1	0-4	2
Herring Gull	1	0-5	6
Great Black-backed Gull	1	0-4	2

See Appendix A and Appendix B for the full count data.

Bird corridor monitoring

4.6 All four target species were recorded within the Bird Corridor on three of the four bird corridor monitoring days (Table 4.7). Grey Plover and Dunlin showed a general pattern of numbers building up across the low tide period, with the highest numbers occurring towards the end of the period of exposure of the Bird Corridor. Knot showed a similar pattern on 04/03/2017, but on 02/03/2017 they only occurred during the middle of the low tide period, while on 13/03/2017, they were only recorded during the FLOOD1 count period (Table 4.7). Grey Plover, Knot and Dunlin all occurred in higher numbers and (Grey Plover and Dunlin) for longer periods on 04/03/2017 compared to 02/03/2017 and 13/03/2017 (Table 4.7). Overall, the patterns of occurrence of these species correspond to times when there were low levels of husbandry activity (see above). Bar-tailed Godwit did not show consistent patterns of variation in numbers across the low tide period and occurred in lower numbers on 04/03/2017 compared to 02/03/2017 and 13/03/2017 (Table 4.7).

4.7 No target species were recorded within the Bird Corridor on 16/03/2017. However, apart from Knot, the numbers of these species recorded during the ebb and flood tide periods on 16/03/2017 were also much lower than on the other bird corridor monitoring days (Table 4.8), suggesting that there had been a large departure of birds over the previous three days.

4.8 Another eleven waterbird species were recorded within the Bird Corridor, with Light-bellied Brent Goose, Oystercatcher, Black-headed Gull, Common Gull and Herring Gull being the most regularly occurring/abundant species (Table 4.9).

Table 4.7 - Counts of target species in the Bird Corridor during the bird corridor monitoring counts.

Species	Date	EBB5	LT1	LT2	LT3	LT4	LT5	LT6	Flood 0
Grey Plover	02/03/2017	0	0	0	4	3	19	21	5
	04/03/2017	0	0	11	34	25	88	120	102
	13/03/2017	0	0	0	0	0	0	14	100
Bar-tailed Godwit	02/03/2017	29	23	16	0	25	25	21	23
	04/03/2017	0	0	0	0	2	5	5	0
	13/03/2017	3	5	12	14	22	5	9	0
Knot	02/03/2017	0	0	70	14	22	0	0	0
	04/03/2017	0	0	0	0	0	60	130	123
	13/03/2017	0	0	0	0	0	0	0	0
Dunlin	02/03/2017	0	0	240	17	5	280	260	0
	04/03/2017	0	240	310	358	416	370	780	580
	13/03/2017	0	0	30	33	33	0	4	154

No target species were observed in the Bird Corridor on 16/03/2017. EBB3 counts: 10 Dunlin on 13/03/2017. EBB4 counts: 12 Bar-tailed Godwit on 02/03/2017; 3 Bar-tailed Godwit on 1303/2017. Flood 1 counts: 165 Grey Plover on 13/03/2017; 2 Bar-tailed Godwit on 02/03/2017; 8 Bar-tailed Godwit on 13/03/2017; 32 Knot on 13/03/2017; 292 Dunlin on 13/03/2017. Flood 2 counts: 13 Grey Plover on 13/03/2017; 2 Bar-tailed Godwit on 13/03/2017.

Table 4.8 – Maximum counts of target species on Whitehouse Bank during the ebb and flood tide periods on the bird corridor monitoring days.

Species	Date	Maximum counts:	
		ebb tide	flood tide
Grey Plover	02/03/2017	0	64
	04/03/2017	22	212
	13/03/2017	0	165
	16/03/2017	32	0

Species	Date	Maximum counts:	
		ebb tide	flood tide
Bar-tailed Godwit	02/03/2017	177	93
	04/03/2017	546	200
	13/03/2017	331	8
	16/03/2017	96	0
Knot	02/03/2017	240	0
	04/03/2017	150	273
	13/03/2017	0	32
	16/03/2017	181	0
Dunlin	02/03/2017	300	50
	04/03/2017	130	1660
	13/03/2017	460	292
	16/03/2017	39	0

Note: the ebb and flood tide counts only covered sectors CS1 and CS2, and counts of birds in the northern section of CS2 were of low quality (see text).

Table 4.9 – Summary of counts of counts of other waterbird species in the Bird Corridor during the bird corridor monitoring counts.

Species	Days	Mean daily max	Maximum count	Non-zero counts
Light-bellied Brent Goose	4	72	146	75%
Grey Heron	3	1	1	42%
Oystercatcher	4	11	23	81%
Golden Plover	1	< 1	1	3%
Curlew	2	1	3	13%
Redshank	2	5	14	31%
Black-headed Gull	4	20	33	66%
Common Gull	4	68	120	91%
Lesser Black-backed Gull	1	1	4	50%
Herring Gull	4	11	22	91%
Great Black-backed Gull	3	2	4	29%

The non-zero counts shows the mean percentage of count periods (between the EBB5 and FLOOD0 counts) per day on which the species was recorded, excluding days when the species was not recorded. See Appendix A and Appendix B for the full count data.

Disturbance

4.9 The total numbers of target species in the Bird Corridor on each 30 minute count during the low tide period appears to show a negative relationship with the numbers of tractors working within 250m of the Bird Corridor (Text Figure 4.1). The overall relationship across the three bird corridor monitoring count days on which the target species were recorded is significant (Spearman's r = -0.656, 1-sided p = 0.002, n = 18), and the slope of the trend lines on each of the days was similar (Text Figure 4.1).

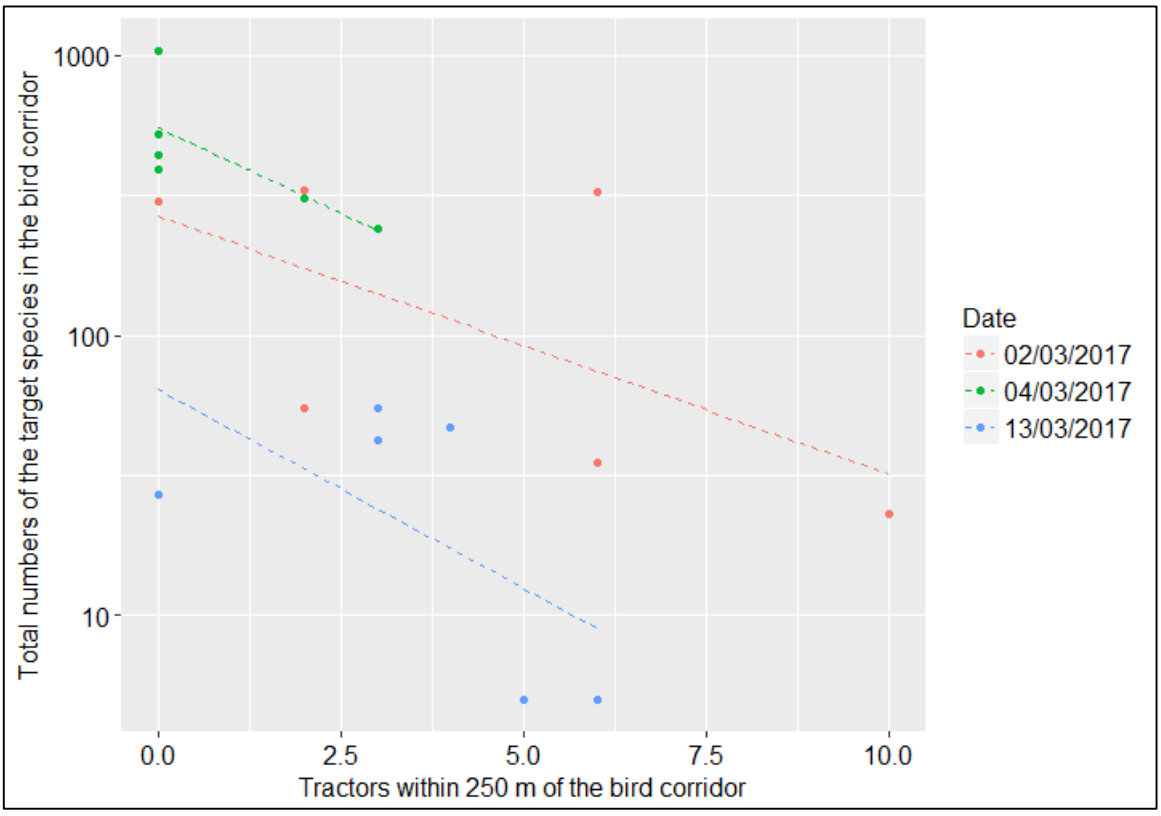
4.10 Eight instances of target species within the Bird Corridor apparently being flushed by tractor movements or husbandry activity were observed during the bird corridor monitoring counts (Table 4.10). These included three instances of birds being apparently flushed at distances of 200-300m, and one instance of birds being apparently flushed at distances of 300-400m. There were 34 instances where tractor movements or husbandry activity were observed to not have any detectable

disturbance impact on birds within the Bird Corridor (Table 4.10). However, all but two of these instances involved birds at distances of more than 200m from the potentially disturbing activity.

There was no obvious overall relationship between disturbance sensitivity and flock size (Table 4.11). However, the two instances of birds showing no response to tractor movements or husbandry activity within 200m both involved small groups (4-17 birds), while the instance of birds being flushed at a distance of 300-400m involved a large flock (260 birds).

Table 4.10 - Disturbance responses of the target species within the Bird Corridor to tractor movement and husbandry activity within and around the Bird Corridor.

Species	Response	Number of observations at distances of:					
		0-100m	100-200m	200-300m	300-400m	400-500m	> 500m
Grey Plover	none	0	0	2	0	1	0
	flush	1	0	1	0	0	0
Bar-tailed Godwit	none	1	1	3	3	5	4
	flush	1	0	0	0	0	0
Knot	none	0	0	0	1	0	0
	flush	0	0	1	0	0	0
Dunlin	none	0	0	2	2	4	3
	flush	1	1	1	1	0	0



Text Figure 4.1 - Relationship between tractor activity and numbers of target species in the Bird Corridor during the bird corridor monitoring low tide counts. The data from the EBB and FLOOD counts is excluded because the Bird Corridor has limited or no exposure during these periods. The data from the 16/03/2017 is excluded because no target species were recorded in the Bird Corridor on this date.

Table 4.11 – Relationship between flock size and disturbance responses of the target species within the Bird Corridor to tractor movement and husbandry activity within and around the Bird Corridor.

Distance	Mean flock size (range in parentheses) of birds showing:	
	no response	flush response
0-100 m	4 *n = 1*	21 (8-33) *n = 3*
100-200 m	17 *n = 1*	240 *n = 1*
200-300 m	25 (6-70) *n = 7*	41 (4-70) *n = 3*
300-400 m	11 (3-30) *n = 6*	260 *n = 1*
400-500 m	38 (3-240) *n = 10*	- *n = 0*
> 500 m	23 (12-33) *n = 7*	- *n = 0*

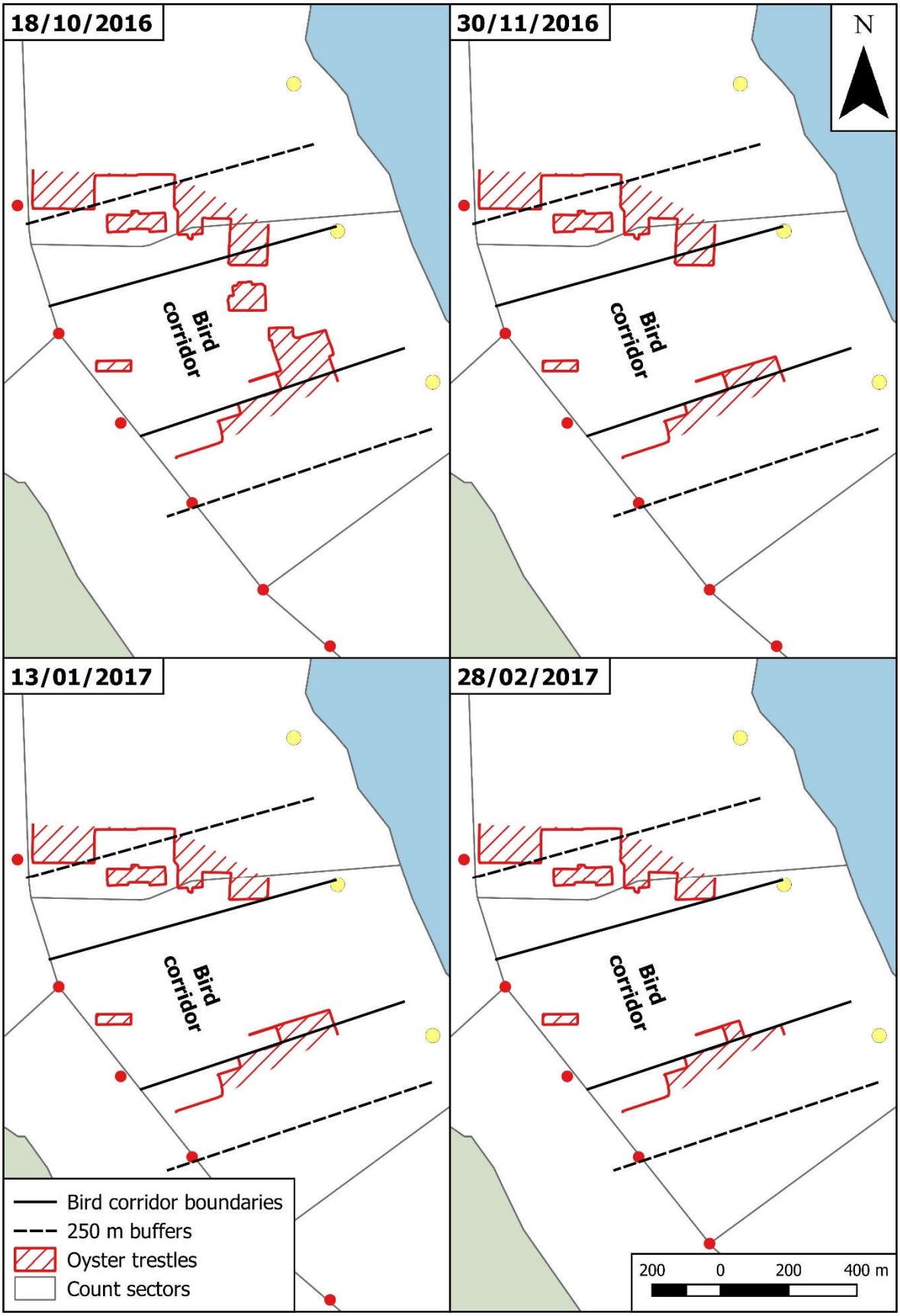


Figure 4.1 – Extent of oyster trestles within and around the Bird Corridor.

5. Discussion

Count accuracy

5.1 The ebb and flood tide counts followed the methodology established in 2014/15 (Gittings and O'Donoghue, 2015) and we consider that the ebb and flood tide counts on Whitehouse Bank were generally very accurate. This is reflected in the count data for target species in the ebb tide period that generally showed a consistent pattern of decrease across the ebb tide period, reflecting the movement of birds off Whitehouse Bank during this period. The count data in the flood tide period showed a less consistent pattern, but this appears to have reflected more complex movement patterns.

5.2 As in 2014/15, the fact that the maximum count on the ebb or flood tide counts often exceeded the low tide count shows that there were some issues with count accuracy during the low tide counts. In 2016/17, Grey Plover was particularly affected by these issues, with significantly lower numbers at low tide, compared to the maximum count ebb/flood tide count, on most of the ten count dates. There were a number of factors that probably affected the accuracy of the low tide counts (Gittings and O'Donoghue, 2015). These issues illustrate the challenges in carrying out accurate low tide counts of highly mobile species in complex intertidal sites. At Dungarvan Harbour, fully accurate low tide counts for the target species would probably require a team of at least six observers (Gittings and O'Donoghue, 2015).

Distribution patterns

5.3 The tidal cycle movements of Grey Plover and Bar-tailed Godwit in 2016/17 were similar to those observed in 2014/15. However, on the ebb tide counts, both Knot and Dunlin stayed longer on Whitehouse Bank in 2016/17 compared to 2014/15. Therefore, the pattern of the Knot and Dunlin tidal cycle counts in 2016/17 could be interpreted as indicating that the tideline reaching the trestle zone was a proximal cause of Knot and Dunlin movements off Whitehouse Bank is the tideline reaching the trestle zone.

5.4 The distribution patterns of Grey Plover and Bar-tailed Godwit at low tide were generally similar to those observed in 2014/15, with the Grey Plover continuing to be largely absent from Whitehouse Bank at low tide in contrast to its distribution patterns in 2009/10 and 2011. However, the distribution patterns of Knot and Dunlin at low tide differed from 2014/15 due to their lower numbers (Knot), or complete absence (Dunlin), from the Ballyrandle Sandflats. In addition, larger numbers of Dunlin occurred on Whitehouse Bank at low tide in 2016/17 compared to 2014/15. These Dunlin occurred mainly in sectors CS3, OY3 and OY4, suggesting that there may have been a concentration of food resources in the northern section of Whitehouse Bank. Dunlin numbers were also unusually high in the early part of the season (October/November).

5.5 In contrast to 2014/15, there were no observations of large flocks of the target species moving on to Whitehouse Bank, and into sector OY2 in particular, during the latter part of the low tide period during the tidal cycle counts. However, a pattern of build-up of numbers of the target species towards the end of the low tide period in the Bird Corridor was observed on three of the bird corridor monitoring count dates.

5.6 Overall, the comparison of the low tide distribution patterns between the four winters for which we have data shows that, while the broad distribution patterns remain fairly constant (i.e., the concentration of Grey Plover, Knot and Dunlin in the Inner Harbour and Bar-tailed Godwit on the Ballyrandle Sandflats), the finer scale patterns can be quite variable (e.g., the relative distribution of

Grey Plover and Dunlin between the Ballyrandle Sandflats and Whitehouse Bank, and the distribution of Dunlin within Whitehouse Bank). Without data on the availability of food resources, it is not possible to interpret the significance of these finer scale patterns.

Responses to intertidal oyster cultivation

5.7 As in previous winters, Grey Plover and Knot were more or less completely absent from the areas occupied by oyster trestles. Across the three winters that we have monitored waterbird distribution on Whitehouse Bank, there have only been two records of a total of five birds of Grey Plover within trestle blocks during low tide counts, as well as one record of a flock of 17 Grey Plover roosting on the isolated block of trestles in the upper part of the Bird Corridor at the start of the flood tide period, during the bird corridor monitoring counts. There have been no records of Knot in the oyster trestle areas on any of the counts carried out across these three winters. While it could be argued that the apparent avoidance of the oyster trestles is an artefact of the low numbers/absence of these species from Whitehouse Bank at low tide, the occurrence of large numbers of these species in the Bird Corridor during the bird corridor monitoring counts indicates that it is the presence of oyster trestles on Whitehouse Bank that is, at least in part, causing the low numbers/absence of these species from Whitehouse Bank.

5.8 The percentage occurrence of Bar-tailed Godwit in the oyster trestle areas at low tide in 2016/17, and the patterns of negative association with oyster trestles derived from analysis of the data, were similar to that recorded in 2014/15. Therefore, the 2016/17 data provides further evidence of a strong negative pattern of association between Bar-tailed Godwit and oyster trestles.

5.9 Dunlin distribution in the Outer Sandflats zone probably had a neutral/positive association with oyster trestles, in contrast to the negative association patterns shown in previous winters. This was due to the absence of Dunlin from the Ballyrandle Sandflats, and the occurrence of relatively large numbers of Dunlin in sectors OY3 and OY4. The latter was part of an apparent concentration of Dunlin at low tide in the northern part of Whitehouse Bank. This suggests that food resources, rather than the presence of oyster trestles, was the main factor determining Dunlin distribution patterns at low tide in the Outer Sandflats zone in 2016/17. However, the large Dunlin flocks recorded at low tide in the bird corridor monitoring on two of the bird corridor monitoring count days is a possible indication that the presence of trestles on Whitehouse Bank may have limited the overall numbers in the Outer Sandflats zone.

5.10 It was also notable that the Dunlin in the oyster trestle areas occurred in scattered small groups (usually less than 20 birds), while, when large numbers of Dunlin occurred in sectors CS2 and CS3, or in the Bird Corridor, at low tide, they were usually in one or two large flocks.

Bird corridor

5.11 There were only a few observations of small numbers of two of the target species (Bar-tailed Godwit and Dunlin) in the Bird Corridor at low tide during the tidal cycle counts, although there were slightly more frequent observations, with some larger counts, during the EBB4 and FLOOD1-FLOOD2 counts. During the early tidal cycle counts, there was still a significant presence of trestles along the lower shore in the Bird Corridor, which is likely to have affected the occurrence of the target species. However, by late November, most trestles had been removed from the Bird Corridor.

5.12 During the bird corridor monitoring counts, significant numbers of one or more of three of the target species (Grey Plover, Knot and Dunlin) were recorded in the Bird Corridor on three of the four count dates. It is possible that there was a seasonal factor involved, as the bird corridor monitoring counts were carried out after the tidal cycle counts had finished. However, it is likely that disturbance from husbandry activity had significant effects on the occurrence of the target species in the Bird Corridor.

5.13 Observations during the bird corridor monitoring counts indicated that birds in the Bird Corridor are sensitive to disturbance from tractor movements and husbandry activities, including when these take place above/adjacent to the Bird Corridor. The total numbers of target species within the Bird Corridor was negatively correlated with the numbers of tractors working within 250m of the Bird Corridor. There was a lot of variability in the data, presumably reflecting the coarseness of tractors working within 250m as a measure of disturbance pressure. However, it is notable that, despite this variability, the slopes of the trend lines were similar on the three bird corridor monitoring count days. We also observed eight instances of target species being flushed from the Bird Corridor by tractor activity or husbandry workers, including one instance of a large flock being flushed at a distance of 300-400m.

5.14 More generally, the overall pattern of husbandry activity on Whitehouse Bank, as indicated by the tractor counts, is of higher levels of husbandry activity before low tide, compared to after low tide. This fits in with the pattern of numbers of the target species building up across the low tide period observed during the bird corridor monitoring counts, and the movements of the target species onto Whitehouse Bank, observed during the 2014/15 monitoring (Gittings and O'Donoghue, 2015).

5.15 Overall, therefore, there is quite strong evidence to indicate that husbandry activity is limiting the occurrence of the target species on Whitehouse Bank. This effect may work at two time scales: direct disturbance of birds on a day to day basis; and longer-term avoidance of Whitehouse Bank in the first half of the low tide period resulting from sensitisation to the typical patterns of husbandry activity. As disturbance sensitivity is strongly correlated with flock size (Laursen *et al*., 2005), the above patterns are consistent with the regular occurrence of small groups of Bar-tailed Godwit and Dunlin on Whitehouse Bank across the low tide period.

5.16 As the Bird Corridor was only counted during a snapshot of the low tide period during the tidal cycle counts, the low numbers of target species recorded during these counts is perhaps not surprising given the movement patterns and disturbance effects observed during the bird corridor monitoring counts. Furthermore, the Bird Corridor was counted around full low tide during the tidal cycle counts (corresponding to the LT3 and LT4 periods of the bird corridor monitoring counts), while the target species would have been most likely to occur later in the low tide period.

Conclusions

5.17 The broad patterns of tidal cycle movements, low tide distribution and association with oyster trestles recorded in the 2016/17 waterbird monitoring of the target species at Dungarvan Harbour are largely similar to those recorded in previous winters. However, there were some other differences in detailed distribution patterns in the Outer Sandflats zone, and in contrast to previous winters, Dunlin distribution in the Outer Sandflats zone appeared to show a neutral/positive association with oyster trestles.

5.18 The target species occurred infrequently and in low numbers in the Bird Corridor during the tidal cycle low tide counts. However, this may have been due to disturbance from tractor movements and husbandry activities.

5.19 On three of the four bird corridor monitoring count days, significant numbers of one or more of three of the target species (Grey Plover, Knot and Dunlin) were recorded in the Bird Corridor during the low tide period.

5.20 Patterns of tractor activity in relation to waterbird numbers, and direct observations of disturbance incidents, indicate that tractor movements and husbandry activities were limiting the usage of the Bird Corridor, and may also be having larger-scale effects on waterbird utilisation of Whitehouse Bank at low tide.

6. References

Gittings, T. & O'Donoghue, P.D. (2012). *The Effects of Intertidal Oyster Culture on the Spatial Distribution of Waterbirds*. Report prepared for the Marine Institute, Atkins, Cork.

Gittings, T. & O'Donoghue, P.D. (2014). *Dungarvan Harbour SPA Appropriate Assessment*. Report prepared for the Marine Institute, Atkins, Cork.

Gittings, T. & O'Donoghue, P.D. (2015). *Dungarvan Harbour SPA Monitoring of Waterbird Distribution across the Tidal Cycle*. Report prepared for the Marine Institute, Atkins, Cork.

Laursen, K., Kahlert, J. & Frikke, J. (2005) Factors affecting escape distances of staging waterbirds. Wildlife Biology, 11, 13–19.

Appendix A
Count data for the additional monitored species

Table A.1 - Maximum counts of the additional monitored species recorded during ebb, low and flood tide periods on each count day.

Species	Date	Maximum count		
		Ebb	LT	Flood
Light-bellied Brent Goose	04/10/2016	-	-	-
	18/10/2016	36	38	68
	02/11/2016	663	800	840
	16/11/2016	671	730	622
	30/11/2016	708	827	720
	15/12/2016	891	788	579
	13/01/2017	526	467	300
	31/01/2017	242	695	432
	13/02/2017	379	510	707
	28/02/2017	310	429	160
Golden Plover	04/10/2016	726	791	819
	18/10/2016	2147	2392	2002
	02/11/2016	216	1854	335
	16/11/2016	2520	2750	3221
	30/11/2016	0	229	0
	15/12/2016	0	3550	0
	13/01/2017	1000	2713	1000
	31/01/2017	0	3800	0
	13/02/2017	300	4650	0
	28/02/2017	0	880	0
Ringed Plover	04/10/2016	118	87	145
	18/10/2016	144	46	117
	02/11/2016	74	36	98
	16/11/2016	148	100	78
	30/11/2016	34	35	35
	15/12/2016	9	32	42
	13/01/2017	69	0	82
	31/01/2017	34	62	80
	13/02/2017	74	63	54
	28/02/2017	26	0	51
Sanderling	04/10/2016	29	22	44
	18/10/2016	0	0	2
	02/11/2016	95	0	87
	16/11/2016	129	97	103
	30/11/2016	92	21	104
	15/12/2016	54	65	13
	13/01/2017	110	0	0
	31/01/2017	89	84	100
	13/02/2017	71	72	55
	28/02/2017	34	0	44

Data are the maxima across four ebb tide counts, one low tide count, and four flood tide counts. The areas covered varied between counts (see text for details). Light-bellied Brent Goose were not counted on 04/10/2017.

Table A.1 - Counts of the additional monitored species across the tidal cycle on Whitehouse Bank.

Species	Date	Ebb tide				Low tide	Flood tide			
		1	2	3	4		1	2	3	4
Light-bellied Brent Goose	04/10/2016	-	-	-	-	-	-	-	-	-
	18/10/2016	0	0	22	14	23	38	27	49	18
	02/11/2016	438	271	486	549	453	731	570	214	393
	16/11/2016	507	335	611	452	328	530	559	378	276
	30/11/2016	680	693	619	506	373	658	619	532	474
	15/12/2016	804	756	634	580	238	416	471	323	324
	13/01/2017	419	417	487	461	239	287	213	59	58
	31/01/2017	127	95	185	205	162	277	371	269	321
	13/02/2017	40	94	136	196	303	100	43	0	0
	28/02/2017	121	178	187	195	181	110	115	18	13
Golden Plover	04/10/2016	0	563	637	726	715	733	780	800	30
	18/10/2016	0	1718	2147	0	1	2	0	0	1
	02/11/2016	0	0	0	216	4	0	335	310	0
	16/11/2016	0	0	2500	2520	2500	3221	3000	35	0
	30/11/2016	0	0	0	0	0	0	0	0	0
	15/12/2016	0	0	0	0	0	0	0	0	0
	13/01/2017	0	0	0	0	0	0	0	0	0
	31/01/2017	0	0	0	0	0	0	0	0	0
	13/02/2017	0	0	0	0	0	0	0	0	0
	28/02/2017	0	0	0	0	0	0	0	0	0
Ringed Plover	04/10/2016	115	88	89	100	68	36	10	33	116
	18/10/2016	144	110	112	144	3	69	71	70	117
	02/11/2016	49	70	23	7	0	0	0	0	41
	16/11/2016	38	94	111	148	68	45	64	65	65
	30/11/2016	2	18	7	6	8	3	2	0	9
	15/12/2016	0	0	0	9	31	0	0	32	34
	13/01/2017	5	5	0	0	0	5	11	48	82
	31/01/2017	34	2	6	1	62	53	58	56	50
	13/02/2017	8	26	21	0	0	0	0	2	0
	28/02/2017	26	7	7	12	0	13	4	51	15
Sanderling	04/10/2016	11	7	23	29	22	44	8	21	29
	18/10/2016	0	0	0	0	0	2	0	0	0
	02/11/2016	95	48	78	84	0	68	44	87	81
	16/11/2016	0	60	68	129	97	35	93	89	103
	30/11/2016	30	92	83	72	21	16	80	102	104
	15/12/2016	50	0	54	29	65	0	0	13	10
	13/01/2017	110	100	0	0	0	0	0	0	0
	31/01/2017	89	50	6	86	84	100	91	69	0
	13/02/2017	51	71	50	60	72	55	44	37	39
	28/02/2017	34	4	14	25	0	4	12	13	12

See notes to Table 3.6. Light-bellied Brent Goose were not counted on 04/10/2017.

Table A.1 - Percentages of feeding birds of the additional monitored species across the tidal cycle on Whitehouse Bank.

Species	Date	Ebb tide				Low tide	Flood tide			
		1	2	3	4		1	2	3	4
Light-bellied Brent Goose	04/10/2016	-	-	-	-	-	-	-	-	-
	18/10/2016			68%	100%	30%	0%	0%	0%	50%
	02/11/2016	34%	76%	58%	74%	80%	66%	62%	38%	34%
	16/11/2016	64%	53%	58%	60%	77%	61%	38%	49%	42%
	30/11/2016	78%	79%	66%	68%	82%	80%	75%	73%	84%
	15/12/2016	40%	90%	75%	93%	73%	97%	76%	94%	90%
	13/01/2017	90%	99%	83%	98%	93%	83%	61%	71%	100%
	31/01/2017	33%	86%	79%	58%	83%	89%	82%	93%	100%
	13/02/2017	100%	79%	95%	100%	87%	56%	26%		
	28/02/2017	26%	98%	87%	100%	55%	95%	70%	44%	0%
Golden Plover	04/10/2016		1%	3%	1%	0%	3%	0%	0%	0%
	18/10/2016		4%	0%						
	02/11/2016				0%			1%	0%	
	16/11/2016			0%	0%	0%	2%	0%	20%	
	30/11/2016									
	15/12/2016									
	13/01/2017									
	31/01/2017									
	13/02/2017									
	28/02/2017									
Ringed Plover	04/10/2016	50%	100%	100%	76%	96%	89%	90%	91%	17%
	18/10/2016	78%	78%	80%	66%		71%	51%	11%	43%
	02/11/2016	100%	97%	100%						95%
	16/11/2016	76%	87%	97%	98%	85%	78%	31%	8%	62%
	30/11/2016		100%							
	15/12/2016					100%			31%	100%
	13/01/2017							91%	29%	4%
	31/01/2017	82%				50%	43%	21%	7%	20%
	13/02/2017		100%	100%						
	28/02/2017	100%			100%		100%		100%	100%
Sanderling	04/10/2016	100%		100%	100%	100%	93%		100%	100%
	18/10/2016									
	02/11/2016	100%	100%	100%	100%		100%	100%	100%	100%
	16/11/2016		100%	100%	100%	100%	100%	14%	100%	100%
	30/11/2016	100%	100%	100%	100%	100%	100%	100%	100%	100%
	15/12/2016	100%		94%	100%	100%			100%	100%
	13/01/2017	100%	100%							
	31/01/2017	89%	100%		100%	100%	100%	100%	100%	
	13/02/2017	100%	100%	100%	100%	100%	100%	100%	100%	100%
	28/02/2017	100%		100%	100%			100%	100%	100%

See notes to Table 3.4. Light-bellied Brent Goose were not counted on 04/10/2017.

Table A.1 - Distribution of the additional monitored species at low tide.

Species	Date	Inner Harbour		Outer Sandflats	
		upper	main	Ballyrandle	Whitehouse
Light-bellied Brent Goose	04/10/2016	-	-	-	-
	18/10/2016	13	0	2	23
	02/11/2016	66	183	98	453
	16/11/2016	109	239	54	328
	30/11/2016	17	261	176	373
	15/12/2016	0	270	280	238
	13/01/2017	0	0	228	239
	31/01/2017	27	402	104	162
	13/02/2017	0	167	40	303
	28/02/2017	10	153	85	181
Golden Plover	04/10/2016	0	76	0	715
	18/10/2016	0	2391	0	1
	02/11/2016	0	1850	0	4
	16/11/2016	0	0	250	2500
	30/11/2016	0	229	0	0
	15/12/2016	0	3550	0	0
	13/01/2017	63	2650	0	0
	31/01/2017	0	3800	0	0
	13/02/2017	0	4650	0	0
	28/02/2017	0	880	0	0
Ringed Plover	04/10/2016	0	19	0	68
	18/10/2016	0	43	0	3
	02/11/2016	0	36	0	0
	16/11/2016	0	32	0	68
	30/11/2016	0	27	0	8
	15/12/2016	0	1	0	31
	13/01/2017	0	0	0	0
	31/01/2017	0	0	0	62
	13/02/2017	0	63	0	0
	28/02/2017	0	0	0	0
Sanderling	04/10/2016	0	0	0	22
	18/10/2016	0	0	0	0
	02/11/2016	0	0	0	0
	16/11/2016	0	0	0	97
	30/11/2016	0	0	0	21
	15/12/2016	0	0	0	65
	13/01/2017	0	0	0	0
	31/01/2017	0	0	0	84
	13/02/2017	0	0	0	72
	28/02/2017	0	0	0	0

Table A.1 - Observations of additional monitored species in the Bird Corridor during the tidal cycle counts.

Species	Date	EBB3	EBB4	LT	Flood 1	Flood 2
Light-bellied Brent Goose	02/11/2016	0	0	63	0	0
	16/11/2016	0	0	15	0	0
	30/11/2016	29	0	136	0	0
	15/12/2016	0	0	52	0	0
	13/01/2017	32	45	37	0	0
	31/01/2017	0	0	50	0	0
	13/02/2017	0	0	18	0	0
	28/02/2017	0	0	80	0	26
Sanderling	02/11/2016	0	0	0	22	0

Data only shown for days on which the species was recorded in the Bird Corridor on at least one count. Golden Plover and Ringed Plover were not recorded in the Bird Corridor on any of the tidal cycle counts.

Table A.1 - Observations of the additional monitored species in the Bird Corridor during the bird corridor monitoring counts.

Species	Date	EBB5	LT1	LT2	LT3	LT4	LT5	LT6	Flood 0
Light-bellied Brent Goose	02/03/2017	0	11	31	86	9	0	0	0
	04/03/2017	1	20	18	49	42	17	0	0
	13/03/2017	7	63	146	133	124	82	52	56
	16/03/2017	0	0	2	4	20	8	11	16
Golden Plover	02/03/2017	0	0	0	0	0	0	0	0
	04/03/2017	0	0	0	0	0	0	0	0
	13/03/2017	0	0	0	0	0	0	0	0
	16/03/2017	0	1	0	0	0	0	0	0

Ringed Plover and Sanderling not recorded in the Bird Corridor on any of the bird corridor monitoring counts. EBB2 counts: 12 Light-bellied Brent Goose on 16/03/2017. EBB4 counts: 7 Light-bellied Brent Goose on 02/03/2017; 2 Light-bellied Brent Goose on 04/03/2017; 4 Light-bellied Brent Goose on 13/03/2017.

Appendix B

Bird corridor count data for other waterbird species

Table B.1 - Counts of other waterbird species in the Bird Corridor during the bird corridor monitoring watches.

Species	Date	EBB5	LT1	LT2	LT3	LT4	LT5	LT6	Flood 0
Grey Heron	02/03/2017	0	0	0	0	1	0	1	0
	04/03/2017	0	0	0	0	0	0	0	0
	13/03/2017	0	1	1	1	0	1	1	1
	16/03/2017	0	0	0	0	1	0	0	1
Oyster-catcher	02/03/2017	3	2	0	1	4	3	1	1
	04/03/2017	1	0	0	1	0	0	5	0
	13/03/2017	2	13	10	17	23	17	15	19
	16/03/2017	13	2	1	6	2	5	4	1
Curlew	02/03/2017	0	0	0	0	0	0	0	0
	04/03/2017	0	0	0	0	0	0	0	0
	13/03/2017	0	3	0	0	0	0	0	0
	16/03/2017	0	0	0	0	0	0	0	2
Red-shank	02/03/2017	0	0	5	0	0	0	3	1
	04/03/2017	0	0	0	0	0	0	0	0
	13/03/2017	4	0	14	0	0	0	0	0
	16/03/2017	0	0	0	0	0	0	0	0
Black-headed Gull	02/03/2017	1	22	6	25	0	0	0	3
	04/03/2017	17	2	9	8	3	15	17	0
	13/03/2017	25	31	14	33	2	26	3	0
	16/03/2017	0	1	4	0	0	0	0	0
Common Gull	02/03/2017	1	9	4	3	6	1	0	0
	04/03/2017	2	1	10	46	35	33	120	0
	13/03/2017	42	9	112	97	50	52	20	8
	16/03/2017	4	16	23	27	29	29	11	3
Herring Gull	02/03/2017	5	6	7	9	1	5	2	0
	04/03/2017	2	2	3	2	7	2	4	0
	13/03/2017	2	4	13	7	22	1	7	3
	16/03/2017	0	2	2	4	1	4	2	1
Lesser Black-backed Gull	02/03/2017	0	0	0	0	0	0	0	0
	04/03/2017	0	1	0	1	2	0	4	0
	13/03/2017	0	0	0	0	0	0	0	0
	16/03/2017	0	0	0	0	0	0	0	0
Great Black-backed Gull	02/03/2017	2	1	1	0	0	0	0	0
	04/03/2017	3	0	0	2	0	0	0	0
	13/03/2017	0	0	0	0	0	0	0	0
	16/03/2017	0	0	4	1	0	0	0	0

EBB3 counts: 7 Oystercatcher on 13/03/2017; 4 Oystercatcher on 16/03/2017; 1 Redshank on 13/03/2017; 1 Black-headed Gull on 13/03/2017; 43 Common Gull on 13/03/2017; 6 Common Gull on 16/03/2017. EBB4 counts: 1 Oystercatcher on 02/03/2017; 4 Oystercatcher on 13/03/2017; 6 Oystercatcher on 16/03/2017; 4 Black-headed Gull on 02/03/2017; 4 Black-headed Gull on 13/03/3027; 8 Common Gull on 13/03/2017; 1 Common Gull on 16/03/2017; 5 Herring Gull on 02/03/2017; 5 Herring Gull on 13/03/2017; 3 Great Black-backed Gull on 04/03/2017. Flood 1 counts: 1 Grey Heron on 13/03/2017; 15 Oystercatcher on 13/03/2017; 6 Oystercatcher on 16/03/2017.

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